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NPAC - Nozzle Performance Analysis Code

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Abstract

A simple and accurate nozzle performance analysis methodology has been developed. The geometry modeling requirements are minimal and very flexible, thus allowing rapid design evaluations. The solution techniques accurately couple: continuity, momentum, energy, state, and other relations which permit fast and accurate calculations of nozzle gross thrust. The control volume and internal flow analyses are capable of accounting for the effects of: over/under expansion, flow divergence, wall friction, heat transfer, and mass addition/loss across surfaces. The results from the nozzle performance methodology are shown to be in excellent agreement with experimental data for a variety of nozzle designs over a range of operating conditions.

Introduction

Propulsion installations can have a significant effect on the overall efficiency of engine systems, particularly for supersonic and hypersonic flight vehicles. To assess the impact of a nozzle design on the net thrust and specific fuel consumption for a given engine design, either the nozzle performance characteristics must be known in advance, or they must be calculated from a simple geometric design, or in the worst case the nozzle system must be designed from scratch and then analyzed to determine performance. This report describes a series of analyses which have been developed into a performance prediction methodology for engine nozzle systems. The methodology can be used to predict performance for a given nozzle geometric design. Additionally, the methodology can be employed to perform preliminary nozzle system design, and subsequent performance analyses.

Nozzle performance is typically described by determining three quantities: accepted engine airflow, W_7, gross thrust coefficient, C_{FG}, and aerodynamic drag coefficient, C_D. It is also very important to be able to characterize nozzle performance over the entire vehicle flight and engine operation range, not just at the nozzle design point. The methodology presented

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covers the calculation procedures used to determine nozzle performance, both on and off-design, for axisymmetric or two-dimensional, convergent and convergent-divergent geometries.

The geometric input used for the analysis modeling is simple and flexible. This permits rapid performance calculations and quick turn-around times for nozzle design assessments.

Method of Analysis

Figure 1 shows the basic physical elements in the nozzle performance analysis methodology. The geometry shown can be either axisymmetric or two-dimensional. Two-dimensional cases can be symmetric or asymmetric, but the symmetric case is shown in Figure 1. The nozzle geometry is specified by two distinct boundaries or surfaces. Surface i delineates the upper or outer boundary of the nozzle geometry. Surface j delineates the lower or inner boundary.

Surfaces i and j are constructed by a series of straight line segments. These segments in turn are specified by the (x,r) coordinate pairs of the segment end points, and these points are shown in Figure 1 as the upper and lower pointing triangular symbols. Straight line fits between the end points define the surface segments. Although not necessary, it is recommended that the points defining surfaces i and j share the same x coordinate. It is necessary that surfaces i and j each have the same total number of segments. Geometries are symmetric about the x axis and symmetric geometries are only defined in a half plain, the mirrored surfaces are automatically constructed. There is an implied surface k which extends between surfaces i and j closing off a finite volume. Surface k represents sidewalls for two-dimensional nozzles and sideplanes for partially circular axisymmetric nozzles. Surface k does not require direct geometric specification of coordinate locations, but rather is determined by other inputs.

Of particular interest in the analysis of nozzles are one-dimensional flow quantities at various locations within the nozzle. Figure 1 shows the location of three typical flow stations: 7 the nozzle entrance, 8 the nozzle throat, and 9 the nozzle exit. For convergent nozzles, stations 8 and 9 are coincident. One-dimensional flow quantities at these stations are often useful in subsequent thermodynamic cycle analysis of engine systems. In order to analyze a defined nozzle geometry, three additional flow quantities need to be specified. The nozzle entrance total pressure, P_{T7}, and total temperature, T_{T7}, are both required, as well as the ambient pressure, P_0, into which the nozzle flow will exhaust. For a fixed size nozzle the weight flow entering the nozzle, W_7, will be determined by the nozzle throat area, A_8, and the throat Mach number, M_8, which is usually 1 for choked flow. Alternatively, an entrance weight flow may be specified, and then the geometry will automatically re-scale to provide the correct throat area at the specified throat Mach number. Both of these options are available in the analysis.

Once the geometry and flow quantities are specified, the methodology employs a series of subsequently more complex analyses to determine the nozzle gross thrust and gross thrust coefficient. In the first pass through the nozzle the flow is computed isentropically. From this solution skin friction and heat transfer losses are calculated in the next pass. A third pass is performed using a fully-coupled system of equations to tie together all the physical effects occurring within the nozzle. From the results of the fully-coupled analyses the gross thrust is calculated by integrating the forces acting on a control volume around the nozzle. The details of these analyses are described below.

Basic One-Dimensional Relations

The principle objective of the nozzle performance analysis methodology is to determine the gross thrust and gross thrust coefficient for a given geometry and flow conditions. The gross thrust coefficient is the ratio of the actual gross thrust, F_G, to the ideal gross thrust, F_{GI}, which the nozzle could produce if perfectly expanded with no internal losses. This relation is given explicitly in Equation 1. Equation 2 gives a simple relation for determining the actual gross thrust in terms of one-dimensional quantities. Conceptually, the nozzle gross thrust is the sum of the exit momentum and exit pressure (relative to ambient) times exit area. For a perfectly expanded (though not necessarily ideal) nozzle, the last term in Equation 2 is zero.

Calculation of the ideal gross thrust is given in Equations 3 through 5. Reference 1 provides a good discussion on ideal thrust calculations. The ideal gross thrust can be conveniently normalized as shown in Equation 6. The terms on the right hand side of Equation 6 can be described by the relations given in Equations 7 through 10. Equation 7 is a statement of no internal loss within the nozzle flow, perfectly expanding to ambient pressure. Equation 8 uniquely determines the ideal exit Mach number for an idealized nozzle pressure ratio. Based on the ideal exit Mach number, an ideal area ratio for expansion can be determined by either Equation 9 or 10. Reference 2 provides many useful relations for developing Equations 8 through 10. Note that the quantities defined in Equations 8 through 10 are idealizations, not physical quantities of an actual nozzle design or operation.

Governing Control Volume Analysis

Although the gross thrust calculation using Equation 2 is conceptually simple, it is factually incorrect. The exhaust flows exiting a typical nozzle are neither uniform nor one-dimensional. To account for flow non-uniformities, Equation 11 is the correct general form for computing the gross thrust for a given nozzle design and operation. The first term in Equation 11 is the axial momentum flux integrated over the nozzle exit area, and the second term is the pressure difference integrated over the same area. Evaluation of the surface integrals in Equation 11, however, requires detailed or complete information of the velocity, density, and pressure fields at the nozzle exit. This level of information is practical only by using the results of extensive experimental measurements or computational fluid dynamics simulations.

Referring to Figure 1, Equation 11 determines the gross thrust by integration of: fluxes crossing, and forces acting on, the downstream boundary of the control volume at flow station 9. Alternatively, the gross thrust can also be determined by similar integrations around the other control volume boundaries. Equation 12 determines the gross thrust by applying the momentum theorem over the control volume bounded by the nozzle entrance, flow station 7, and the nozzle surfaces *i*, *j*, and *k*. Equations 11 and 12 are functionally equivalent, however, Equation 12 has some significant computational advantages despite the apparent additional complexity.

If the nozzle entrance flow is assumed to be one-dimensional then the first two integrals in Equation 12 become trivial. The remaining terms in Equation 12 represent: mass fluxes crossing, pressure forces acting normal to, and shear forces acting parallel to, the surface segments which comprise the nozzle geometry. The summations in Equation 12 correspond to the computations of the respective surface integrals over each nozzle surface segment. If the fluxes and forces (normal and tangential) acting on each surface segment can be adequately calculated, then Equation 12 can be employed as the governing control volume analysis to compute the nozzle gross thrust. This technique avoids the necessity to accurately compute the entire internal nozzle flow field, as would be required if Equation 11 were used instead. Equation 12 permits the use of relatively simple internal flow modeling techniques which give adequate solutions for the quantities in each of the surface integrals.

1-D Compressible Mass Flow Relations

As a starting point for the analysis of the internal flow within a given nozzle, a consistency must be established between the minimum flow area (the throat) and the mass flow through the nozzle. Since the flow through any typical nozzle is compressible, the development of a one-dimensional compressible mass flow relation is required. Equations 13 through 19 show the analysis and the resulting compressible mass flow function. The ideal gas assumption is inherent in Equations 14 and 15. Equation 19 determines the mass flow as a function of cross-sectional flow area, A, Mach number, M, total pressure and temperature, and gas properties. For compatibility with other engineering analyses, Equation 19 can be slightly recast as Equation 20, where the weight flow, W, is a compressible function of gas properties and total conditions.

In the methodology Equation 20 is used as the starting point for the nozzle performance analyses. For a given problem one of two basic cases is addressed. Either the nozzle entrance weight flow and throat Mach number are specified thus requiring the determination of the nozzle throat area by Equation 20, or the nozzle throat Mach number and area are specified thus requiring the determination of the nozzle entrance weight flow by Equation 20. In the first case, where the weight flow is specified, the nozzle geometry must be re-sized to provide the correct throat area. This procedure amounts to determining an appropriate length scaling factor and then re-sizing the input geometry according. The nozzle physical dimensions will then grow or shrink as required to satisfy Equation 20 while preserving the basic geometric shape. In the second case the entrance weight flow is directly calculated from the throat area as specified in the geometry model. It is inconsistent to specify both nozzle entrance weight flow and throat area.

1-D Compressible Stream-Tube Relations

In order to develop the remaining internal flow models, the physical domain within the nozzle control volume must be mapped to a simpler quasi-geometric representation. From the geometry definitions of surfaces i, j, and k the internal nozzle flow path is discretized into a series of one-dimensional volume elements. A conceptualization of a one-dimensional volume element is shown in Figure 2. The sum of these volume elements comprises a stream-tube representation of the internal nozzle control volume. Internal flow solutions from the one-dimensional stream-tube model are then mapped back to the corresponding physical geometry locations on the control volume surfaces. These results in turn are used in the evaluation of the surface integrals in Equation 12 to determine the nozzle gross thrust.

The geometric information required for the one-dimensional volume element in Figure 2 consists of only the upstream and downstream cross sectional flow areas, A_1 and A_2 respectively, and the total surface area, S. The total surface area is further broken down by the contributions from the geometric surfaces i, j, and k. All flow quantities are assumed constant perpendicular to the flow across the volume element, and flow quantities are only calculated at the volume element upstream and downstream boundaries. The flow quantities to be determined at each upstream and downstream boundary of the volume element are: axial velocity, U, pressure, P, temperature, T, density, ρ, Mach number, M, total pressure, P_T, and total temperature, T_T.

The first-pass flow analysis used in the methodology is simply a statement of conservation of mass as shown in Equation 21. By using Equation 19, a compressible one-dimensional stream-tube relation is developed in Equation 22. For any change in flow area across a volume element (or elements) there is a fixed relationship for the corresponding change in Mach number. Equation 22 also accounts for changes in total pressure and temperature across a volume element. In the first-pass analysis, however, the flow is modeled isentropically, and as a result the upstream and downstream total pressure and temperature are the same.

The solution technique for the first-pass analysis is to start at the entrance of the nozzle and march downstream, applying Equation 22 across each volume element, determining the downstream Mach number from known areas and the upstream Mach number. Once the downstream Mach number is determined, it becomes the upstream Mach number for the next volume element, thus marching the solution downstream. After determining the Mach number, the temperature and pressure are calculated by Equations 17 and 18. Total conditions are constant throughout the nozzle by the isentropic assumption. The velocity and density are then determined by Equations 14 and 15.

Equation 22 cannot be solved explicitly for the downstream Mach number, M_2, and must be solved iteratively. Equation 22 is rewritten as Equation 23 in a form which can be solved by a single-variable Newton-Raphson iteration scheme. The details of the iteration scheme are discussed in a later section. All equations to be iterated are written as left-hand-side = 0. The particular form of Equation 23 was chosen such that each term on the left-hand-side is properly normalized and approximately unity in magnitude. This is advantageous for the iteration scheme convergence criteria.

In order to start the first-pass analysis, the nozzle entrance Mach number must be determined. This is done by the application of Equation 23, where the upstream and downstream areas correspond to the nozzle entrance and throat areas, respectively. The nozzle throat Mach number becomes the downstream Mach number, and then Equation 23 is solved, yielding the upstream Mach number which then corresponds to the nozzle entrance Mach number.

To account for the effects of mass addition (or loss) across the nozzle surfaces the statement of conservation of mass, posed in Equation 21, is modified to become Equation 24. The term $\delta\dot{m}$ represents the additional mass flux crossing the volume element surface S, and this additional mass flux must be small in comparison to the nozzle mass flow, $\dot{m}$, otherwise the assumptions of the one-dimensional volume element model will no longer hold. Equation 25 is the final iterative form of the one-dimensional compressible stream-tube relation accounting for mass addition which is actually used in the methodology.

Compressible Turbulent Skin Friction Model

While the first-pass analysis calculates the inviscid flow solution throughout the nozzle, the second-pass analysis uses the results from the first-pass to calculate the surface shear force and heat transfer using boundary layer theory. The first-pass velocity, density, temperature, and Mach number solutions become the boundary layer edge quantities, denoted by the subscript e. Equation 26 gives the wall shear per unit surface area as a function of the density and velocity at the boundary layer edge, or equivalently the first-pass solution. What remains to be determined is the skin friction coefficient.

The flat plate compressible turbulent skin friction coefficient formulation of White[3] and Christoph is used in the second-pass analysis and is presented in Equations 27 through 30. A number of parameters are imbedded within the formulation. The adiabatic wall temperature, T_{aw}, is calculated by Equation 31. The wall temperature, T_w, can be directly specified in the methodology, or if desired the adiabatic wall temperature can be used for no wall heat transfer cases. The turbulent recovery factor, r, is determined by Equation 32 as a function of the gas Prandtl number, Pr. The Reynolds number based on length, Re_L, is defined in Equation 33 and is the predominant term in the calculation of the skin friction coefficient, C_f.

The length L used in Equation 33 is not a physical length, but rather is defined by Equation 34. The length used in calculating the Reynolds number is determined from dimensional arguments. Since the volume element model does not account for an axial length, an effective length is established by approximating the volume element as a truncated code with lateral surface area S. A running length is then the sum of all the effective lengths of the preceding volume elements, and this relation is given as the first term of Equation 34. To allow for an already developed boundary layer to exist at the nozzle entrance, the second term in Equation 34, L_0, is included. First, the nozzle entrance Reynolds number is chosen, then from the entrance flow quantities and Equation 33, L_0 is determined.

The viscosity is calculated by the Sutherland-law approximation and is given in Equation 35. In Equation 35, μ_s, T_s, and C_s are constants in the Sutherland-law approximation and are determined by the gas to be modeled. The wall shear is calculated for each of the geometry surfaces i, j, and k on the basis of their respective contribution to the volume element total surface area, S. In the case of axisymmetric geometries the skin friction coefficient for surfaces i and j is calculated by a modification given in Equation 36 accounting for the turbulent cone rule, or an approximate turbulent Mangler transformation. Surface k and all surfaces in two-dimensional geometries are always calculated by the flat plate skin friction coefficient given in Equation 27.

For surfaces where a wall temperature is specified heat transfer can occur. Equation 37 gives the heat transfer coefficient using the Reynolds analogy. The heat transfer coefficient is approximately one half the skin friction coefficient. The wall heat transfer per unit surface area, q_w, is determined by Equation 38. The specific heat for an ideal gas can be determined from other known gas properties, as shown in Equation 39. As in the procedure for determining the wall shear, the wall heat transfer is calculated for each surface i, j, and k based on the relative contributions to the volume element total surface area, S.

Fully-Coupled 1-D Stream-Tube Flow Model

The results from the second-pass analysis can be used to evaluate all of the integrals in Equation 12, yielding the nozzle gross thrust. However, since the wall shear and heat transfer were calculated after determining the internal nozzle flow isentropic solution, there is no coupling effect of the second-pass results on the first-pass flow solution. The effects of wall shear and heat transfer violate the assumptions of the isentropic flow model used in the first-pass solution. This therefore requires a third-pass analysis which couples the effects of wall shear and heat transfer on the internal nozzle flow solutions.

Referring back to volume element in Figure 2, it is necessary to determine all of the 7 downstream flow quantities (U_2, P_2, T_2, ρ_2, M_2, P_{T2}, and T_{T2}) from the known 7 upstream flow quantities (U_1, P_1, T_1, ρ_1, M_1, P_{T1}, and T_{T1}) including the effects of wall shear, heat transfer, and mass addition (τ_w, q_w, and $\delta\dot{m}$). Since there are 7 unknowns to determine, the solution requires 7 mathematical relations to achieve problem closure. Equations 40 through 46 form a coupled system of 7 governing equations for 7 unknown flow quantities (U_2, P_2, T_2, ρ_2, M_2, P_{T2}, and T_{T2}). The system of equations must be solved simultaneously, and a multi-variable Newton-Raphson iteration technique is used. Details of the iteration scheme are presented in a later section. The iteration scheme needs an initial guess for each of the 7 flow variables, and the solution from the first-pass analysis is used as the initial guess for the 7 unknowns.

Each of the 7 governing equations in the coupled 7 by 7 system used in the third-pass analysis represents a physical concept applied across the volume element shown in Figure 2.

Equation 40 is an equation-of-state relationship for an ideal gas. Equation 41 is a conservation of mass statement. Equation 42 is a conservation of momentum statement. Equation 43 is a conservation of energy statement. Equations 44 and 45 are defining relations between total and static quantities for temperature and pressure, respectively. Equation 46 is statement of the relation between velocity and Mach number for an ideal gas. Each term in Equations 40 through 46 is normalized by the appropriate upstream quantity so that the largest terms on the left-hand-side of each equation are of order unity. The quantities $\bar{P}$, $\bar{\tau}_w$, and $\bar{q}_w$ are the arithmetic averages of the upstream and downstream values across the volume element.

Equations 41 through 43 (continuity, momentum, and energy) also have terms pertaining to mass addition or loss across the nozzle surfaces. For mass addition, the mass flux crossing a surface is assumed to expand to the same pressure as the flow within the volume element at the upstream boundary. This complete expansion is stated in Equation 47. The Mach number and temperature of the mass addition are given in Equations 48 and 49. The total conditions for the mass addition, P_{Ta} and T_{Ta}, are specified as inputs to the methodology. The total velocity, V_a, and axial component, u_a, are calculated by Equations 50 and 51. Figure 3 gives the definition of the angles used in Equation 51. For mass loss, the assumption is that mass leaves the volume element at the same pressure, temperature, and velocity as the flow within the nozzle. The corresponding relations are given in Equations 52 through 54. The total mass added or lost across a surface segment is specified as an input to the methodology. The mass addition or loss is then distributed evenly across the entire surface segment.

As in the first-pass analysis, the third-pass analysis starts at the nozzle entrance and marches downstream to the nozzle exit. The coupled 7 by 7 system of equations is solved for the downstream unknowns, which in turn become the upstream knowns for the next volume element solution. In this manner the entire nozzle flow properties are determined, properly coupled, and accounting for non-isentropic flow losses. Reference 4 is a good source of information regarding the formulation of the coupled system of equations used in the development of the third-pass analysis.

Divergence Loss Model

A final correction is needed to the governing control volume analysis to account for nozzle exit flow divergence losses. If the nozzle exit flow is not purely axial, then the one-dimensional gross thrust given by Equation 2 can be corrected by a divergence factor, λ, as shown in Equation 55. The corresponding correction to the integral form is given next in Equation 56. By algebraic manipulation, equation 56 can be developed into a form analogous to Equation 12, but with a correction for divergence losses. This result is shown in Equation 57 which becomes the correct final version of the governing control volume analysis, replacing Equation 12.

The divergence loss factor is determined by the relations developed by Berton[5]. The axisymmetric and two-dimensional forms are given in Equations 58 and 59, respectively.

The angle ψ is the last nozzle surface segment inclination to the axial direction, and the subscripts refer to the corresponding surface. Refer to Figure 3 for a definition of the angle ψ.

Iteration Methods

Within the nozzle performance analysis methodology, a number of problems require solution by iterative techniques. The single-variable Newton-Raphson iteration method is outlined in Equations 60 through 66. The first step in the procedure is to write the function to iterate in the form left-hand-side = 0. This is shown in Equation 60, where x is the variable to solve for iteratively by driving the function f to zero. An initial guess is made for x, and the function value is checked for convergence (to zero) to within a small numerical tolerance range ϵ, as indicated in Equation 61. If the value of x satisfies Equation 62 the solution is converged. If not, an iteration scheme must be employed to determine a new value for x. Equation 62 is the iteration scheme, where Δx is the correction to be applied to the initial guess for x. The partial derivative for the function can be approximated as a finite difference by Equations 63 and 64. Equation 65 gives the calculation of the iteration correction step size, and Equation 66 steps the iteration variable to a new value. The process then repeats from Equation 61 again until convergence is reached.

The multi-variable Newton-Raphson iteration method is outlined in Equations 67 through 76. The first step in the multi-variable iteration method is to write all the functions in the form left-hand-side = 0, as shown in Equation 67. A series of initial guesses is required for the vector of unknowns, x_j. These values are used to evaluate the functions, f_i, and a check is made to see if all of the functions are converged to within a small tolerance, as indicated by Equation 68. If Equation 68 is not satisfied then an iteration scheme is required to determine the step sizes for each of the unknowns, and this iteration scheme is shown by the matrix notation in Equation 69. Equations 70 and 71 allow a notation simplification, where Equation 70 is a system of linear equations to be solved for the column vector $[\Delta x]$. The partial derivative matrix $[A]$ is evaluated numerically by a procedure analogous to that given in Equations 63 and 64. Equations 72 through 75 outline the solution of the linear system by Lower-Upper decomposition. Once the corrections Δx_j are determined, the solution is stepped toward convergence by Equation 76, and the procedure is repeated from Equation 68 again until convergence is reached.

The LU decomposition method for solving diagonally-dominant matrix systems presumes that the $[A]$ matrix can be decomposed into the product of lower and upper triangular matrices $[L]$ and $[U]$ as shown in Equation 72 and more elaborately by elements in Equation 77. The elemental decomposition formulas are given in Equations 78 through 81. The solution to Equation 70 is split into two steps. An intermediate vector $[y]$ is solved by forward substitution of the triangular system shown in Equation 74. From the intermediate vector $[y]$, the correction vector $[\Delta x]$ is solved by backward substitution of the triangular system shown in Equation 75. The forward substitution algorithm is given in Equations 82 and 83, while backward substitution is shown in Equations 84 and 85. Reference 6 contains excellent discussions on the LU decomposition method, as well as single and multi-variable Newton-

Raphson iteration techniques.

Additional Non-Dimensional Parameters

From the completed solution of the flow within a nozzle it is possible to determine a number of other performance parameters. The nozzle discharge coefficient, C_d, is the ratio of the flow actually passed through a nozzle throat relative to the ideal throat flow rate, as shown in Equation 86. The nozzle throat flow rate, W_8, is found from the fully-coupled 1-D stream-tube flow model, while the ideal throat flow rate is calculated by the expression in the denominator of Equation 87. In Equation 87, the throat Mach number, M_8, is one for choked nozzles, and less than one for unchoked flow. The nozzle exhaust velocity coefficient, C_V, is the ratio of the exit velocity relative to the ideally expanded exit velocity, as shown in Equation 88. The actual exit velocity, V_9, is also found from the fully-coupled 1-D stream-tube model, and the ideally expanded exit velocity is determined by the expression in the denominator of Equation 89. The exit Mach number, M_9, in Equation 89 is calculated by the relation given in Equation 20 for ideally expanded nozzle flows. An expansion coefficient, C_e, may be defined as the nozzle exit pressure difference relative the exit pressure difference for an ideal expansion, as shown in Equation 90. The numerator in Equation 90 is found from the fully-coupled 1-D stream-tube flow model, while the denominator is found from the compressible 1-D stream-tube model which neglects flow losses mechanisms. The denominator of Equation 90 is not necessarily zero, except for the case of perfect expansion when the exit pressure equals the ambient pressure. These additional non-dimensional parameters may be useful in characterizing the performance of exhaust nozzles.

Results

Results from the NPAC methodology are presented for two cases: a two-dimensional test model nozzle, and an axisymmetric rocket nozzle. Example case output files, each including a copy of the input set, can be found in Appendix II and Appendix III for the results presented in this section. The two-dimensional test model nozzle geometry, however, is slightly different in the example case shown in Appendix II. For the general discussion of results within this section, a slightly longer two-dimensional test model nozzle geometry is used, although the results are qualitatively similar to the example case provided in Appendix II. Additionally, a program User's Guide which describes the input set and program usage can be found in Appendix I.

For the discussion within this section, the geometry for a two-dimensional test model nozzle is shown in Figure 1. The results from the NPAC calculation of the nozzle pressure distribution are shown in Figure 4. The methodology solves the nozzle internal flow using a one-dimensional model, and thus flow quantities are uniform across the nozzle, normal to the nozzle axis. In reality, there are differences across the flow field, and the pressure distributions from a computational fluid dynamics solution are also shown in Figure 4 for comparison.

The geometry shown in Figure 1 was used to develop a two-dimensional 200x100 point viscous grid, with exponential wall packing of points, using the INGRID2D[7] code. This grid was then used with the NPARC2D code to model the internal nozzle flow field. The NPARC codes are enhanced, multi-block versions of the PARC[8] codes which solve the Reynolds-averaged Navier-Stokes equations for an ideal gas. A one-equation turbulence model developed by Baldwin[9] and Barth was also used to model the turbulent viscous transport terms in the full Navier-Stokes equations.

As can be seen from Figure 4, there are significant differences in the pressure distributions between the nozzle upper surface (surface *i*) and the nozzle centerline (surface *j*). The pressure distribution calculated by the NPAC methodology, however, is observed to be a very adequate average of the two distributions computed by the NPARC2D code. In the determination of the nozzle gross thrust, referring back to Equation 57, it is the integration of the pressure distribution over a surface area which contributes to the force balance around the control volume. Therefore, a one-dimensional flow quantity which is an adequate average representation of a two-dimensional flow field, can still yield a very accurate gross thrust calculation when used in the control volume formulation of Equation 57.

To verify this last assertion, the results of the gross thrust coefficient as determined from the NPAC methodology are compared to experimental data[10]. Figure 5 shows this comparison of the two-dimensional test model nozzle gross thrust coefficient over a range of operating nozzle pressure ratios. The gross thrust coefficient is shown normalized by the maximum experimental value at the nozzle design point pressure ratio. As can be seen in Figure 5, there is excellent agreement between the NPAC results and data over most of the range of nozzle pressure ratios.

At low nozzle pressure ratios the nozzle area ratio forces over-expansion, and the exhaust pressure decreases below the ambient pressure. If the exhaust pressure falls low enough, the flow within the nozzle separates from the internal walls, thus reducing the effective expansion area and raising the exit flow pressure. This separation process occurring for low pressure ratio nozzles raises the gross thrust by reducing the over-expansion pressure loss.

The analyses developed within the NPAC methodology do not permit flow separation, and thus for low pressure ratio nozzles the resulting gross thrust calculations will be significantly lower than those measured in actual nozzles. This behavior can clearly be seen in Figure 5 for the lowest nozzle pressure ratio calculation. For this particular geometry at nozzle pressure ratios of 10 or greater the agreement with test data is seen to be very good. It is therefore concluded that for unseparated flows the one-dimensional internal flow model used in the methodology is adequate for the application of Equation 57 in determining the nozzle gross thrust.

For the second example case, results for an axisymmetric rocket nozzle are shown in Figure 6 as a normalized comparison to experimental data. Two different expansion area ratio nozzle bell-mouths were tested, and the nozzles were operated at various oxidizer-fuel ratios. The nozzles used oxygen-hydrogen combustion at high pressure and high temperature. The gas model in the NPAC methodology was modified for these calculations to use gas properties approximating the combustion products. The combustion products were calculated from the computer code of reference 12 using limited test condition data found in the report of reference 11.

The results of the NPAC methodology are seen to be within approximately 5 percent of the experimental data over the entire oxidizer-fuel operating range for each of the different expansion area ratio nozzles. This is very good agreement considering the limitations of the ideal gas assumption when applied to non-ideal gas flows, in addition to the other one-dimensional flow approximations within the NPAC methodology. The example case for the axisymmetric rocket nozzle shown in Appendix III corresponds to the 440 expansion area ratio nozzle operating at the greatest oxidizer-fuel ratio. This is the farthest right data point shown in Figure 6.

Summary

A simple and accurate nozzle performance analysis methodology has been developed. The geometry modeling requirements are minimal and very flexible, thus allowing rapid design evaluations. The solution techniques accurately couple: continuity, momentum, energy, state, and other relations which permit fast and accurate calculations of nozzle gross thrust. The control volume and internal flow analyses are capable of accounting for the effects of: over/under expansion, flow divergence, wall friction, heat transfer, and mass addition/loss across surfaces. The results from the nozzle performance methodology are shown to be in excellent agreement with experimental data for a variety of nozzle designs over a range of operating condition.

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List of Symbols

a	element of partial derivative matrix
A	area, or cross-sectional flow area, or partial derivative matrix
c_p	specific heat at constant pressure
C_d	discharge coefficient
C_e	expansion coefficient
C_f	skin friction coefficient
C_h	heat transfer coefficient
C_{FG}	gross thrust coefficient
C_V	velocity coefficient
f	iteration function
F_G	gross thrust
F_{GI}	ideal gross thrust
g	gravitational constant
l	element of lower triangular matrix
L	length or lower triangular matrix
$\dot{m}$	mass flow rate
$\delta\dot{m}$	incremental mass flow rate
n	system of equations size
$\hat{n}$	unit normal vector
M	Mach number
N	number of surface segments
P	pressure
P_T	total pressure
Pr	Prandtl number
q	heat transfer per unit area
r	radial coordinate, or turbulent recovery factor
R	gas constant
Re	Reynolds number
S	surface area
T	temperature
T_T	total temperature
u	axial velocity component, or element of upper triangular matrix
U	axial velocity, or upper triangular matrix
V	total velocity
$\vec{V}$	total velocity vector
W	weight flow rate
x	axial coordinate, or iteration variable
y	temporary iteration vector, or element of temporary iteration vector
γ	ratio of specific heats
Δx	correction size, or correction size vector, or element of correction size vector
θ	mass addition/loss flow angle relative to surface segment
δ	differencing factor
ϵ	small number
ρ	density

λ	divergence factor
μ	viscosity
τ	shear force per unit area
ϕ	surface segment angle relative to axial
ψ	final surface segment angle relative to axial

Subscripts

0	ambient, or initial
1	upstream
2	downstream
7	nozzle entrance
8	nozzle throat
9	nozzle exit
a	mass addition/loss flow
aw	adiabatic wall
e	boundary layer edge
i	outer surface i, or general index
j	inner surface j, or general index
k	sidewall surface k, or general index
l	general index
L	length
w	wall
x	axial component

Equations

Basic One-Dimensional Relations

$$C_{FG} = \frac{\text{actual thrust}}{\text{ideal thrust}} = \frac{F_G}{F_{GI}} \quad (1)$$

$$F_G = \dot{m}_9 V_9 + (P_9 - P_0) A_9 \quad (2)$$

$$F_{GI} = \dot{m}_9 V_9 \quad (3)$$

$$= \gamma P_0 M_9^2 A_9 \quad (4)$$

$$= \gamma \left(\frac{P_0}{P_{T8}}\right) \left(\frac{A_9}{A_8}\right) M_9^2 P_{T8} A_8 \quad (5)$$

$$\frac{F_{GI}}{P_{T8} A_8} = \gamma M_9^2 \frac{\left(\frac{A_9}{A_8}\right)}{\left(\frac{P_{T8}}{P_0}\right)} \quad (6)$$

$$\left(\frac{P_{T8}}{P_0}\right) = \left(\frac{P_{T9}}{P_9}\right) \quad (7)$$

$$M_9 = \sqrt{\frac{2}{\gamma - 1}\left[\left(\frac{P_{T9}}{P_9}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]} \quad (8)$$

$M_9 \leq 1$ (convergent nozzle)

$$\left(\frac{A_9}{A_8}\right) = 1 \quad (9)$$

$M_9 > 1$ (convergent-divergent nozzle)

$$\left(\frac{A_9}{A_8}\right) = \left(\frac{\gamma+1}{2}\right)^{-\frac{\gamma+1}{2(\gamma-1)}} \frac{1}{M_9}\left[1 + \frac{\gamma-1}{2} M_9^2\right]^{\frac{\gamma+1}{2(\gamma-1)}} \quad (10)$$

Governing Control Volume Analysis

$$F_G = \iint_9 V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA + \iint_9 (P - P_0)\, \hat{n}_x dA \quad (11)$$

$$\begin{aligned} F_G = & -\iint_7 V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA - \iint_7 (P - P_0)\, \hat{n}_x dA \\ & - \sum_{i=1}^{N_i} \iint_i V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA - \sum_{j=1}^{N_j} \iint_j V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA - \sum_{k=1}^{N_k} \iint_k V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA \\ & - \sum_{i=1}^{N_i} \iint_i (P - P_0)\, \hat{n}_x dA - \sum_{j=1}^{N_j} \iint_j (P - P_0)\, \hat{n}_x dA - \sum_{k=1}^{N_k} \iint_k (P - P_0)\, \hat{n}_x dA \\ & - \sum_{i=1}^{N_i} \iint_i \tau_x dA - \sum_{j=1}^{N_j} \iint_j \tau_x dA - \sum_{k=1}^{N_k} \iint_k \tau_x dA \end{aligned} \quad (12)$$

1-D Compressible Mass Flow Relations

$$\dot{m} = \rho V A \tag{13}$$

$$V = M\sqrt{\gamma R T} \tag{14}$$

$$\rho = \frac{P}{RT} \tag{15}$$

$$\dot{m} = A\sqrt{\frac{\gamma}{R}}\frac{P}{\sqrt{T}}M \tag{16}$$

$$P = P_T\left[1+\frac{\gamma-1}{2}M^2\right]^{-\frac{\gamma}{\gamma-1}} \tag{17}$$

$$T = T_T\left[1+\frac{\gamma-1}{2}M^2\right]^{-1} \tag{18}$$

$$\dot{m} = A\sqrt{\frac{\gamma}{R}}\frac{P_T}{\sqrt{T_T}}M\left[1+\frac{\gamma-1}{2}M^2\right]^{-\frac{\gamma+1}{2(\gamma-1)}} \tag{19}$$

Weight flow, W, in lb_m/s (for air $R = 53.35\ \mathrm{ft{\cdot}lb/lb_m{\cdot}{}^\circ R}$)

$$W = A\sqrt{\frac{\gamma g}{R}}\frac{P_T}{\sqrt{T_T}}M\left[1+\frac{\gamma-1}{2}M^2\right]^{-\frac{\gamma+1}{2(\gamma-1)}} \tag{20}$$

1-D Compressible Stream-Tube Relations

$$\dot{m}_1 = \dot{m}_2 \tag{21}$$

$$A_1\frac{P_{T1}}{\sqrt{T_{T1}}}M_1\left[1+\frac{\gamma-1}{2}M_1^2\right]^{-\frac{\gamma+1}{2(\gamma-1)}} = A_2\frac{P_{T2}}{\sqrt{T_{T2}}}M_2\left[1+\frac{\gamma-1}{2}M_2^2\right]^{-\frac{\gamma+1}{2(\gamma-1)}} \tag{22}$$

$$\left(\frac{A_1}{A_2}\right)-\left(\frac{P_{T2}}{P_{T1}}\right)\sqrt{\frac{T_{T1}}{T_{T2}}}\frac{M_2}{M_1}\left[\frac{1+\frac{\gamma-1}{2}M_2^2}{1+\frac{\gamma-1}{2}M_1^2}\right]^{-\frac{\gamma+1}{2(\gamma-1)}} = 0 \tag{23}$$

Including mass addition

$$\dot{m}_1 + \delta\dot{m} = \dot{m}_2 \tag{24}$$

$$\left[1+\left(\frac{\delta\dot{m}}{\dot{m}_1}\right)\right]\left(\frac{A_1}{A_2}\right)-\left(\frac{P_{T2}}{P_{T1}}\right)\sqrt{\frac{T_{T1}}{T_{T2}}}\frac{M_2}{M_1}\left[\frac{1+\frac{\gamma-1}{2}M_2^2}{1+\frac{\gamma-1}{2}M_1^2}\right]^{-\frac{\gamma+1}{2(\gamma-1)}} = 0 \tag{25}$$

Compressible Turbulent Skin Friction Model

$$\tau_w = C_f \frac{1}{2} \rho_e U_e^2 \tag{26}$$

$$C_f \approx \frac{0.455}{\Omega^2 \ln^2 \left(\frac{0.06}{\Omega} Re_L \frac{\mu_e}{\mu_w} \sqrt{\frac{T_e}{T_w}} \right)} \tag{27}$$

$$\Omega = \frac{\sqrt{\frac{T_{aw}}{T_e} - 1}}{\sin^{-1}\left(\frac{2a^2 - b}{\sqrt{b^2 + 4a}} \right) + \sin^{-1}\left(\frac{b}{\sqrt{b^2 + 4a}} \right)} \tag{28}$$

$$a = \sqrt{\frac{\gamma - 1}{2} M_e^2 \frac{T_e}{T_w}} \tag{29}$$

$$b = \frac{T_{aw}}{T_w} - 1 \tag{30}$$

$$T_{aw} = T_e \left(1 + r \frac{\gamma - 1}{2} M_e^2 \right) \tag{31}$$

$$r = \sqrt[3]{Pr} \tag{32}$$

$$Re_L = \frac{\rho_e U_e L}{\mu_e} \tag{33}$$

$$L = \frac{1}{\sqrt{\pi}} \sum_{n=2}^{N} \frac{S_n}{\sqrt{A_{n-1}} + \sqrt{A_n}} + L_0 \tag{34}$$

$$\mu(T) \approx \mu_s \left(\frac{T}{T_s} \right)^{3/2} \frac{T_s + C_s}{T + C_s} \tag{35}$$

Mangler transformation

$$C_f \approx \frac{0.455}{\Omega^2 \ln^2 \left(\frac{0.06}{\Omega} \frac{Re_L}{2} \frac{\mu_e}{\mu_w} \sqrt{\frac{T_e}{T_w}} \right)} \tag{36}$$

Heat transfer

$$C_h \approx \frac{C_f}{2\sqrt[3]{Pr^2}} \tag{37}$$

$$q_w = C_h \rho_e U_e c_p (T_{aw} - T_w) \tag{38}$$

$$c_p = \frac{\gamma R}{\gamma - 1} \tag{39}$$

$$\frac{\rho_2}{\rho_1}\frac{P_1}{P_2}\frac{T_2}{T_1} - 1 = 0 \tag{40}$$

$$\frac{\rho_2 U_2 A_2 - \rho_1 U_1 A_1 - \delta \dot{m}}{\rho_1 U_1 A_1} = 0 \tag{41}$$

$$\frac{(\rho_1 U_1 A_1 + \delta\dot{m}) U_2 - \rho_1 U_1^2 A_1 + P_2 A_2 - P_1 A_1 - \bar{P}(A_2 - A_1) + \bar{\tau}_w S - u_a \delta\dot{m}}{\left(P_1 + \frac{1}{2}\rho_1 U_1^2\right) A_1} = 0 \tag{42}$$

$$\frac{\bar{q}_w S - c_p T_{T2} \rho_2 U_2 A_2 + c_p T_{T1} \rho_1 U_1 A_1 + \left(c_p T_a + \frac{1}{2} V_a^2\right)\delta\dot{m}}{c_p T_{T1} \rho_1 U_1 A_1} = 0 \tag{43}$$

$$\frac{T_{T2}}{T_{T1}} - \frac{T_2}{T_1}\left[\frac{1 + \frac{\gamma-1}{2} M_2^2}{1 + \frac{\gamma-1}{2} M_1^2}\right] = 0 \tag{44}$$

$$\frac{P_{T2}}{P_{T1}} - \frac{P_2}{P_1}\left[\frac{1 + \frac{\gamma-1}{2} M_2^2}{1 + \frac{\gamma-1}{2} M_1^2}\right]^{\frac{\gamma}{\gamma-1}} = 0 \tag{45}$$

$$\frac{U_2}{U_1}\frac{M_1}{M_2}\sqrt{\frac{T_1}{T_2}} - 1 = 0 \tag{46}$$

Mass addition

$$P_a = P_1 \tag{47}$$

$$M_a = \sqrt{\frac{2}{\gamma-1}\left[\left(\frac{P_{Ta}}{P_a}\right)^{\frac{\gamma-1}{\gamma}} - 1\right]} \tag{48}$$

$$T_a = T_{Ta}\left[1 + \frac{\gamma-1}{2} M_a^2\right]^{-1} \tag{49}$$

$$V_a = M_a \sqrt{\gamma R T_a} \tag{50}$$

$$u_a = V_a \cos(\theta - \phi) \tag{51}$$

Mass loss

$$T_a = T_1 \tag{52}$$

$$V_a = U_1 \tag{53}$$

$$u_a = V_a \cos(\theta + \phi) \tag{54}$$

Divergence Loss Model

$$F_G = \lambda \dot{m}_9 V_9 + (P_9 - P_0) A_9 \tag{55}$$

$$= \lambda \iint_9 V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA + \iint_9 (P - P_0) \hat{n}_x dA \tag{56}$$

$$\begin{aligned} F_G = -\lambda \Bigg\{ & \iint_7 V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA + \iint_7 (P - P_0) \hat{n}_x dA \\ & + \sum_{i=1}^{N_i} \iint_i V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA + \sum_{j=1}^{N_j} \iint_j V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA + \sum_{k=1}^{N_k} \iint_k V_x \rho \left(\vec{V} \cdot \hat{n}\right) dA \\ & + \sum_{i=1}^{N_i} \iint_i (P - P_0) \hat{n}_x dA + \sum_{j=1}^{N_j} \iint_j (P - P_0) \hat{n}_x dA + \sum_{k=1}^{N_k} \iint_k (P - P_0) \hat{n}_x dA \\ & + \sum_{i=1}^{N_i} \iint_i \tau_x dA + \sum_{j=1}^{N_j} \iint_j \tau_x dA + \sum_{k=1}^{N_k} \iint_k \tau_x dA \Bigg\} + (1 - \lambda) \iint_9 (P - P_0) \hat{n}_x dA \end{aligned} \tag{57}$$

Axisymmetric nozzles

$$\lambda = \frac{\frac{1}{2} (\sin \psi_i + \sin \psi_j)^2}{(\psi_i + \psi_j) \sin \psi_j + \cos \psi_j - \cos \psi_i} \tag{58}$$

Two-Dimensional nozzles

$$\lambda = \frac{\sin \psi_i + \sin \psi_j}{\psi_i + \psi_j} \tag{59}$$

Single-Variable Newton-Raphson Iteration Method

$$f(x) = 0 \tag{60}$$

$$|f(x)| < \epsilon \tag{61}$$

$$\frac{\partial f}{\partial x} \Delta x \approx f \tag{62}$$

$$\frac{\partial f}{\partial x} \approx \frac{f(x + \delta) - f(x - \delta)}{(x + \delta) - (x - \delta)} \tag{63}$$

$$\delta = \epsilon x \tag{64}$$

$$\Delta x = f \Big/ \frac{\partial f}{\partial x} \tag{65}$$

$$x = x - \Delta x \tag{66}$$

Multi-Variable Newton-Raphson Iteration Method

$$f_i\left(x_j\right) = 0 \tag{67}$$

$$\left|f_i\left(x_j\right)\right| < \epsilon, \quad i = 1, 2, ...n \tag{68}$$

$$\left[\frac{\partial f_i}{\partial x_j}\right]\left[\Delta x\right] \approx \left[f\right] \tag{69}$$

$$[A]\,[\Delta x] = [f] \tag{70}$$

$$a_{ij} = \frac{\partial f_i}{\partial x_j}, \quad i = 1, 2, ...n, \quad j = 1, 2, ...n \tag{71}$$

$$[A] = [L]\,[U] \tag{72}$$

$$[L]\left([U]\,[\Delta x]\right) = [f] \tag{73}$$

$$[L]\,[y] = [f] \tag{74}$$

$$[U]\,[\Delta x] = [y] \tag{75}$$

$$x_j = x_j - \Delta x_j, \quad j = 1, 2, ...n \tag{76}$$

LU Decomposition

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} = \begin{bmatrix} l_{11} & 0 & \dots & 0 \\ l_{21} & l_{22} & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ l_{n1} & l_{n2} & \dots & l_{nn} \end{bmatrix} \begin{bmatrix} 1 & u_{12} & \dots & u_{1n} \\ 0 & 1 & \dots & u_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{bmatrix} \tag{77}$$

$$l_{ij} = a_{ij} - \sum_{k=1}^{j-1} l_{ik} u_{kj}, \quad j \leq i, \quad i = 1, 2, ...n \tag{78}$$

$$u_{ij} = \frac{a_{ij} - \sum_{k=1}^{i-1} l_{ik} u_{kj}}{l_{ii}}, \quad i \leq j, \quad j = 2, 3, ...n \tag{79}$$

$$j = 1, \quad l_{i1} = a_{i1} \tag{80}$$

$$i = 1, \quad u_{1j} = \frac{a_{1j}}{l_{11}} = \frac{a_{1j}}{a_{11}} \tag{81}$$

Forward substitution

$$y_1 = \frac{f_1}{l_{11}} \tag{82}$$

$$y_i = \frac{f_i - \sum_{k=1}^{i-1} l_{ik} y_k}{l_{ii}}, \quad i = 2, 3, ...n \tag{83}$$

Backward substitution

$$\Delta x_n = y_n \tag{84}$$

$$\Delta x_j = y_j - \sum_{k=n}^{j+1} u_{jk} \Delta x_k, \quad j = n-1, n-2, ...1 \tag{85}$$

Additional Non-Dimensional Parameters

$$C_d = \frac{W_8}{(W_8)_{\text{ideal}}} \tag{86}$$

$$C_d = \frac{W_8}{A_8 \sqrt{\frac{\gamma g}{R}} \frac{P_{T7}}{\sqrt{T_{T7}}} M_8 \left[1 + \frac{\gamma - 1}{2} M_8^2\right]^{-\frac{\gamma+1}{2(\gamma-1)}}} \tag{87}$$

$$C_V = \frac{V_9}{(V_9)_{\text{ideal}}} \tag{88}$$

$$C_V = \frac{V_9}{M_9 \sqrt{\frac{\gamma R T_{T7}}{1 + \frac{\gamma - 1}{2} M_9^2}}} \tag{89}$$

$$C_e = \frac{P_9 - P_0}{(P_9 - P_0)_{\text{ideal}}} \tag{90}$$

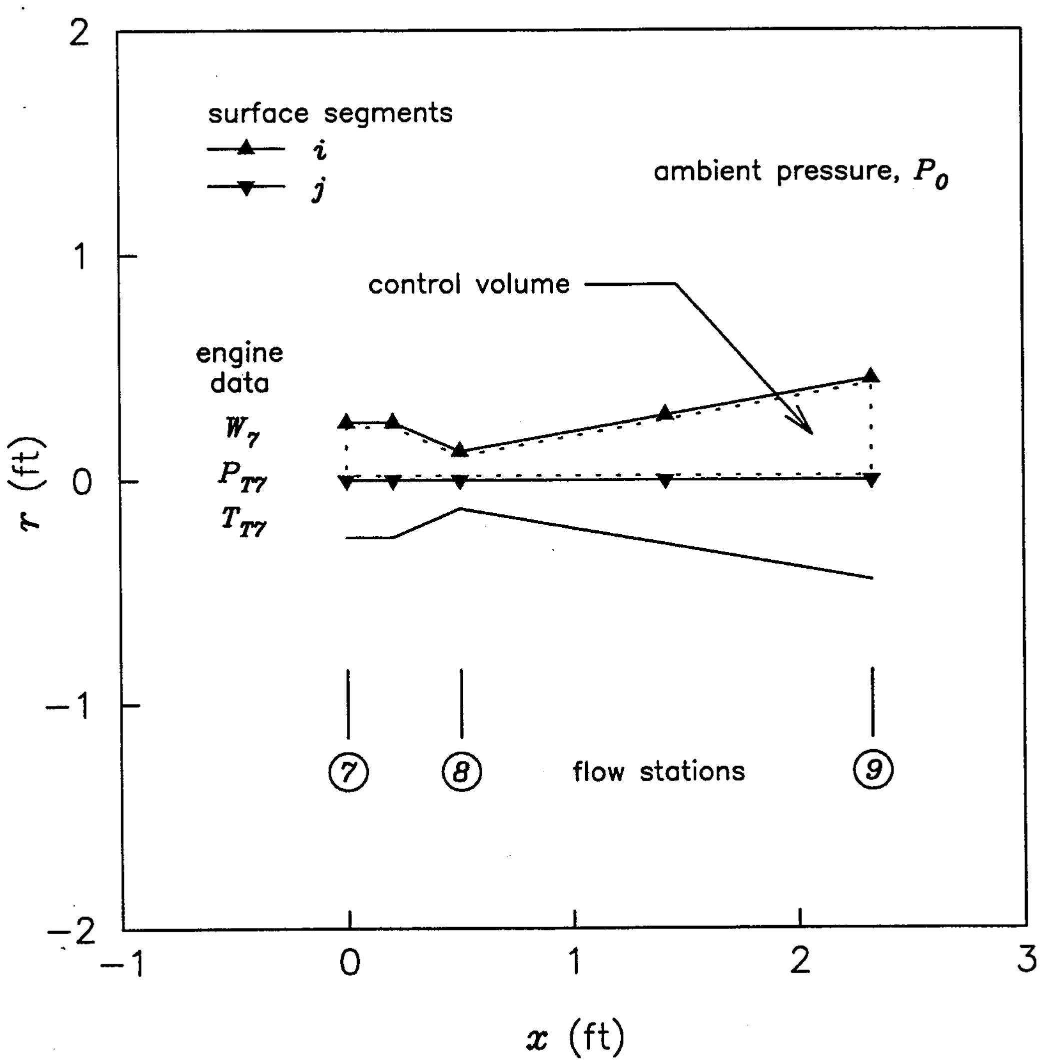


Figure 1 Geometric Elements for NPAC Control Volume Analysis

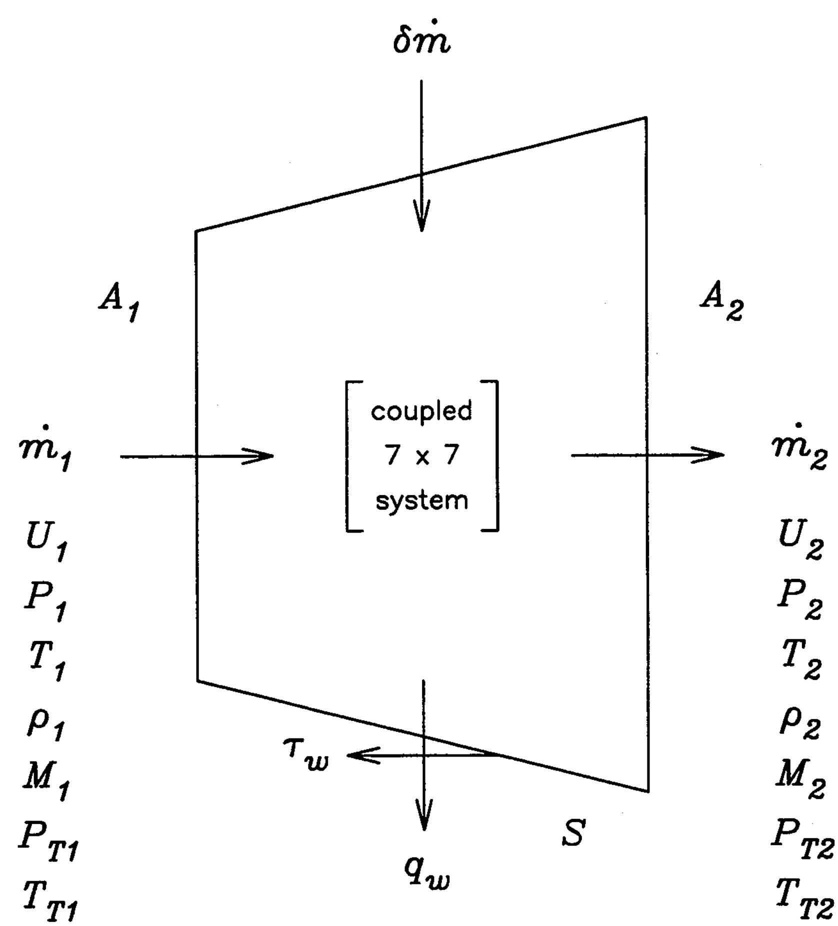


Figure 2 Discrete One-Dimensional Volume Element Internal Flow Model Representation

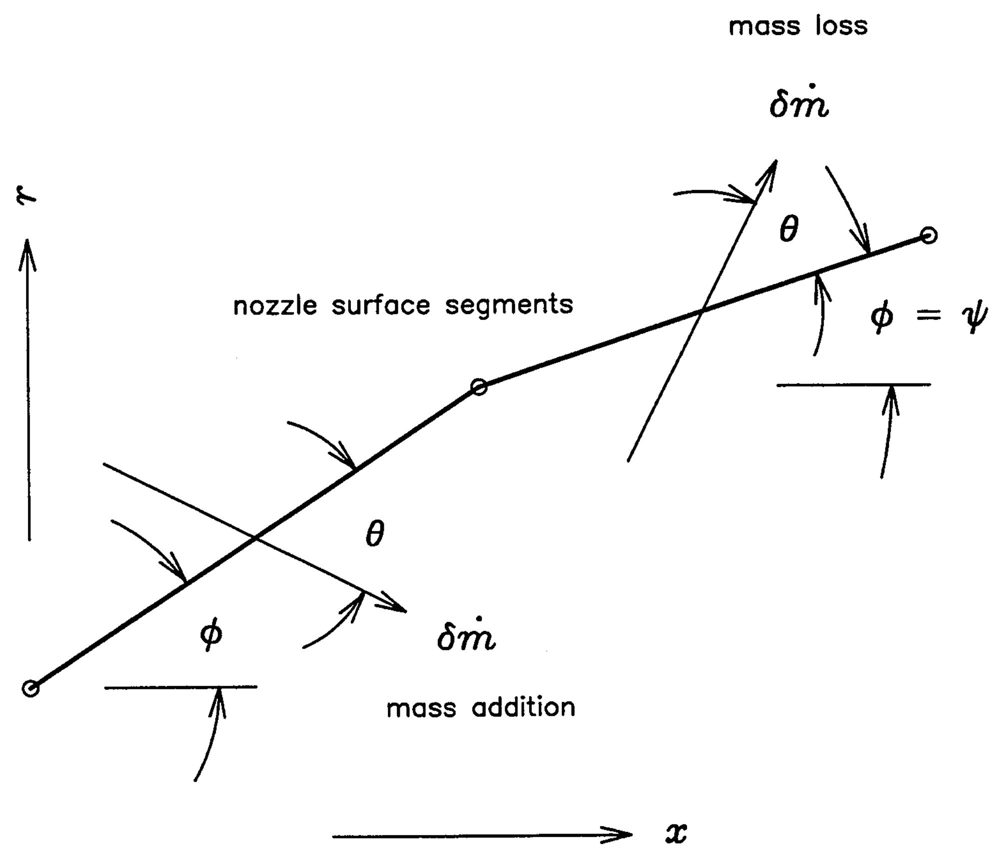


Figure 3 Angular Definitions for Nozzle Surface Segments and Mass Addition or Loss Flows

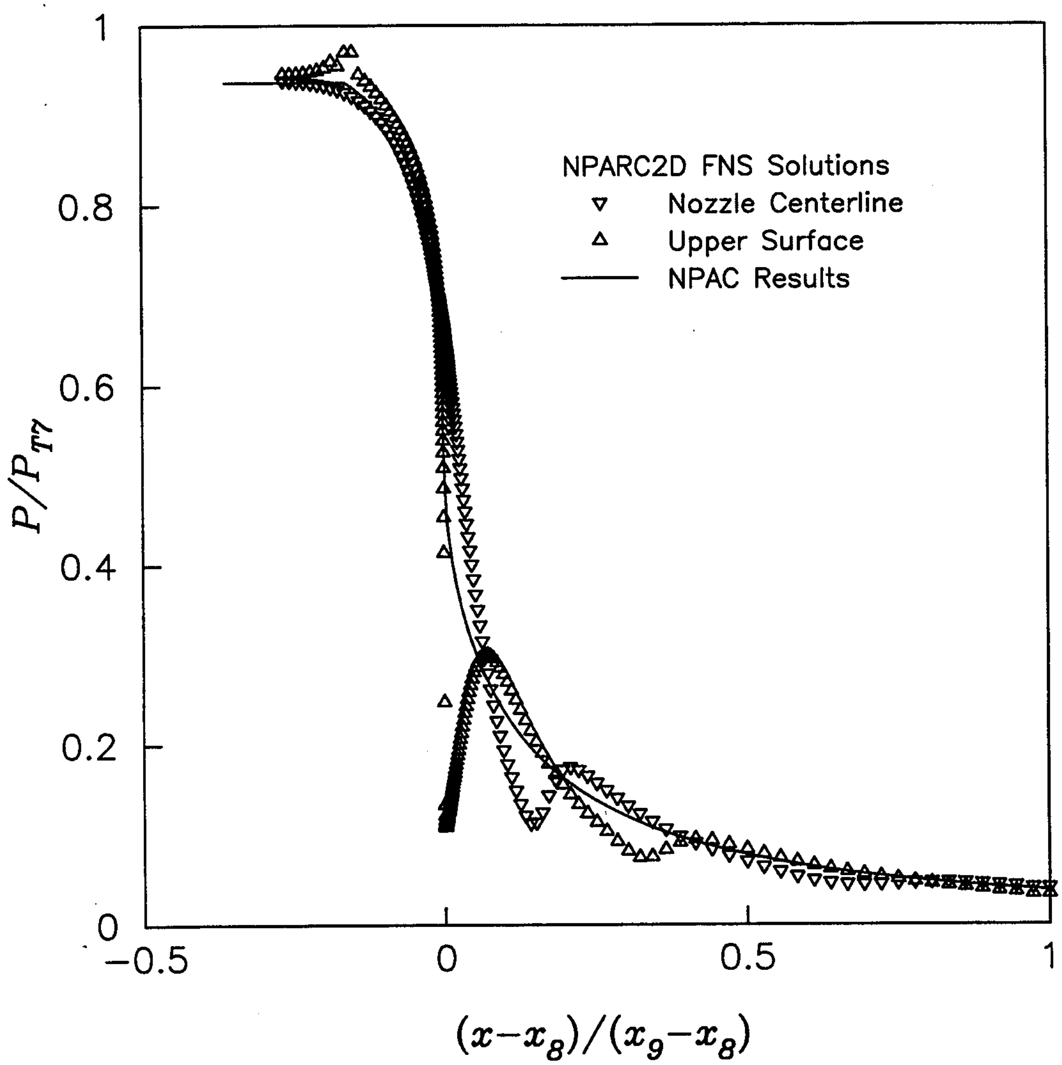


Figure 4 Surface Pressure Comparison of NPAC Results with a Full Navier-Stokes Flow Field Solution for a Two-Dimensional Test Model Nozzle

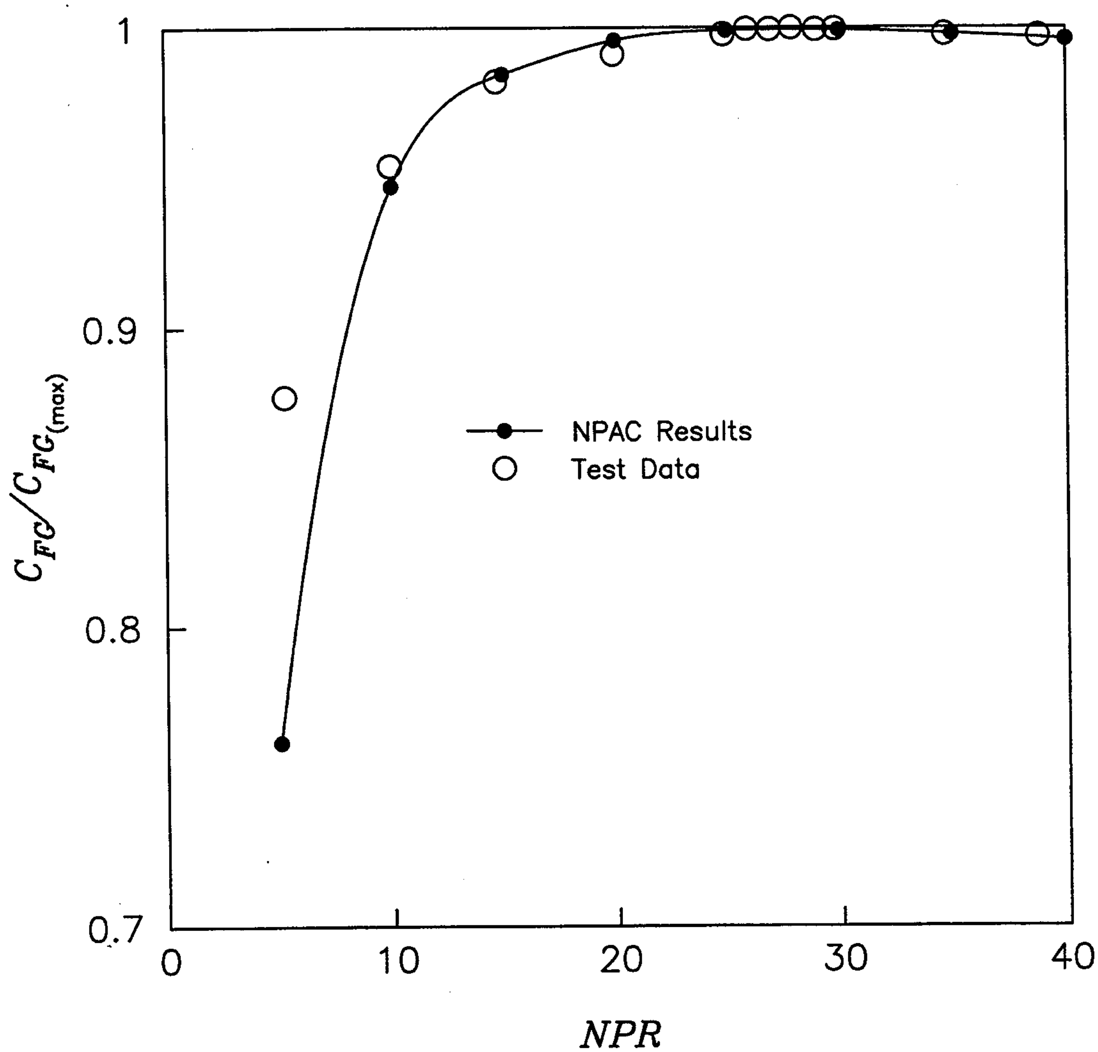


Figure 5 Gross Thrust Coefficient Normalized Comparison of NPAC Results with Experimental Data for a Two-Dimensional Test Model Nozzle at Various Nozzle Pressure Ratios

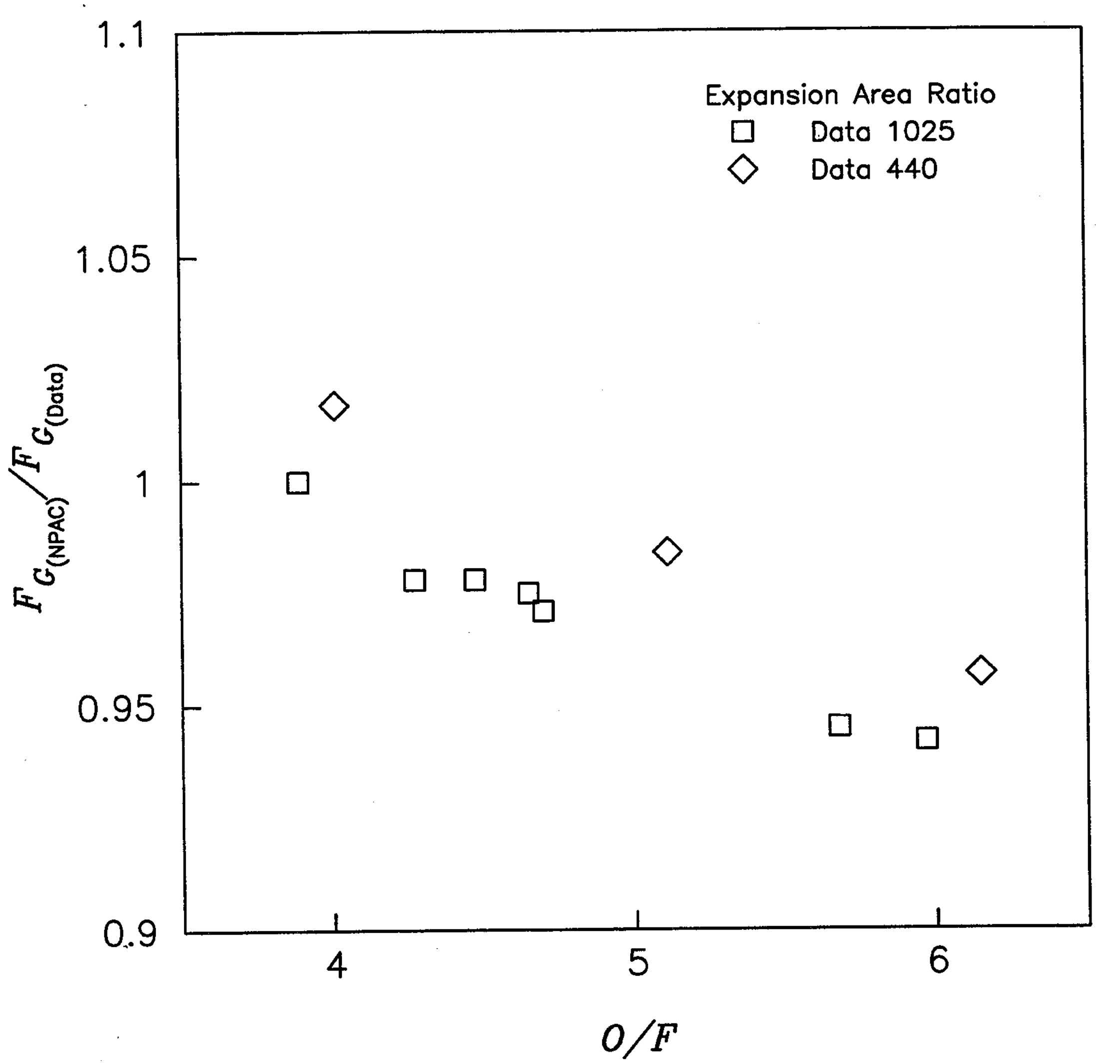


Figure 6 Gross Thrust Normalized Comparison of NPAC Results with Experimental Data for an Axisymmetric Rocket Nozzle at Various Oxidizer-Fuel Ratios

Appendix I

NPAC User's Guide

NPAC - Nozzle Performance Analysis Code

Input List Description

All variables are defined as implicit real*4 (a-h,o-z) unless otherwise noted in the following description. Variables beginning with letters i-n are defined as integer unless otherwise noted. Any array variables are noted below with dimensions, ie. var(10). Default values are listed in the given assignments below.

```
&npac           - namelist input set identifier, required

 table='npac.dat'  - tabular output data file name, character*80

 title=' '      - input case title, character*80

 echo=0         - echo flag, echoes input set to output if =1,
                  integer

 iout=1         - output control flag array, setting each element of
                  iout =1 writes additional data to output file,
                  iout(1)   geometry input check & execution summary
                  iout(2)   additional geometry & stream-tube data
                  iout(3)   inviscid flow, friction, & heat transfer
                  iout(4)   full-equations flow model solution
                  iout(5)   additional nozzle surface quantities
                  iout(10)

 ni             - number of i-surface segments in geometry input

 xri            - i-surface geometry definition array, for n=1,ni+1
                  xri(1,n)  x-coordinate
                  xri(2,n)  r-coordinate
                  xri(3,n)  variable geometry flag (not used)
                  xri(4,n)  surface type flag, no-slip=1, slip=-1,
                            symmetry=0
                  xri(5,n)  flow station number identifier, none=0,
                            entrance=7, throat=8, exit=9
                  xri(6,n)  wall temperature input, adiabatic=-1,
                            specified=Twall/tt7 (see tt7 below)
                  xri(7,n)  mass addition weight flow fraction,
                            input=w/w7 (see w7 below)
                  xri(8,n)  mass addition total pressure ratio,
                            input=Pt/pt7 (see pt7 below)
                  xri(9,n)  mass addition total temperature ratio,
                            input=Tt/tt7 (see tt7 below)
                  xri(10,n) mass addition injection angle relative
                            to segment surface (degrees)
```

waddi=0.0 - total mass addition weight flow fraction ahead of nozzle throat crossing i-surface

nj - number of j-surface segments in geometry input

xrj - j-surface geometry definition array, for n=1,nj+1

```
xrj(1,n)  x-coordinate
xrj(2,n)  r-coordinate
xrj(3,n)  variable geometry flag (not used)
xrj(4,n)  surface type flag, no-slip=1, slip=-1,
          symmetry=0
xrj(5,n)  flow station number identifier, none=0,
          entrance=7, throat=8, exit=9
xrj(6,n)  wall temperature input, adiabatic=-1,
          specified=Twall/tt7 (see tt7 below)
xrj(7,n)  mass addition weight flow fraction,
          input=w/w7 (see w7 below)
xrj(8,n)  mass addition total pressure ratio,
          input=Pt/pt7 (see pt7 below)
xrj(9,n)  mass addition total temperature ratio,
          input=Tt/tt7 (see tt7 below)
xrj(10,n) mass addition injection angle relative
          to segment surface (degrees)
```

waddj=0.0 - total mass addition weight flow fraction ahead of nozzle throat crossing j-surface

npts=51 - number of points per segment used to discretize geometry and construct computational stream-tube model

nspl=50 - number of points to use in cubic spline data enrichment scheme for numerical integration routines

idim=1 - geometry dimensionality, axisymmetric=1, symmetric 2-D=2, non-symmetric 2-D=-2

ar=1.0 - aspect ratio

scale=1.0 - geometric length scale factor

w7=0.0 - nozzle entrance weight flow (lb/s)

pt7 - nozzle entrance total pressure (psf)

tt7 - nozzle entrance total temperature (R)

xm8=1.0 - nozzle throat Mach number

rei=1.0E+7 - nozzle entrance Reynolds number p0=0.0 - ambient pressure (psf), or if <0, the negative of the nozzle pressure ratio (-NPR), or if =0, calculates pressure for ideal expansion

gamma=1.4 - ratio of specific heats

rgas=53.35 - gas constant (ft.lbf/lbm.R)

pr=0.72 - Prandtl number

xmus=3.584E-7 - reference viscosity in Sutherland-law (lb.s/ft**2)

ts=491.6 - reference temperature in Sutherland-law (R)

cs=198.6 - constant in Sutherland-law (R)

eps=1.0E-3 - differencing factor for evaluation of numerical derivatives in iteration routines

tol=1.0E-6 - tolerance factor for convergence in iteration routines

con=1.0E-6 - convergence tolerance for multi-variable iteration routine

del=1.0E-2 - error band for determining Mach=1 at the nozzle throat

&end - namelist identifier, required

Notes on Input Usage

The input and output filenames may be specified on the command line after the program name. The extensions .in and .out may be left off the filenames and will automatically be appended.

system_prompt> **npac npac.in npac.out**

The program NPAC reads the namelist input set from an input file (the default is npac.in) and executes the required calculations for that case. The output is written to an output file (the default is npac.out) and to another tabular data file specified by the input variable **table** in the namelist input set. If there are subsequent namelist input sets in the file, they in turn are executed, and in this manner numerous cases can be run to design and/or analyze a nozzle system over a range of operating conditions. Since the program uses namelist input reads, if a variable is defined once in an input set, it is not necessary to redefine it again in subsequent input sets, unless the value changes. Also since most of the input variables have predefined defaults, it is usually only necessary to assign values to a few variables to run the program properly.

There are a few subtleties which the user needs to be aware of to effectively use NPAC. The following paragraphs describe some of the ways the various input variables are used to model nozzle systems.

General Output Control: The first 4 variables listed above determine the output features for NPAC. The data file defined by the **table** variable will contain a summary tabular dataset of the dimensionless nozzle performance quantities: nozzle pressure ratio, gross thrust coefficient, expansion area ratio, discharge coefficient, velocity coefficient, divergence loss factor, and expansion coefficient. The **title** variable is printed at the top of the output file if it is defined. The **echo** variable can be set to 1, which will print the entire input file to the top of the output file. The array variable **iout** is used to control the level of data printed in the output file, npac.out. Setting the elements of **iout** =1 will result in additional output data. Currently there are 5 elements in **iout** which can be used for output control. Printout of geometry input check and program execution summary information is enabled/disabled by **iout(1)** =1/0. Printout of additional geometry data and the 1-D stream-tube equivalent is enabled/disabled by **iout(2)** =1/0. Printout of the inviscid flow solution, the wall friction, and heat transfer results is enabled/disabled by **iout(3)** =1/0. Printout of the viscous fully-coupled equations flow model solution is enabled/disabled by **iout(4)** =1/0. Printout of additional nozzle surface quantities used in the evaluation of the control volume integrals is enabled/disabled by **iout(5)** =1/0. Although **iout** will enable/disable printouts to the file npac.out, additional output files *.geo and *.1d are always written containing this information.

Geometry Definition: The user must specify 2 surfaces, i and j, in order to develop a nozzle geometry. The variables **ni** and **nj** must be assigned values for the number of segments comprising surfaces i and j respectively. It is a very good idea to make surfaces i and j with the same number of segments. Since the geometry definition arrays **xri** and **xrj** have the same input information, only the i surface inputs will be explicitly described. The j surface inputs are the same. The geometry definition arrays are 2-dimensional (or a matrix), and the first index corresponds to an input feature, and the second index corresponds to the segment being defined. In what follows, the second index n will run from 1 (the start of the first segment) to **ni**+1 (the end of the last segment). The x-coordinate, in ft, is assigned to **xri(1,n)**, and the r-coordinate, in ft, is assigned to **xri(2,n)**. The input **xri(3,n)** is a variable geometry input flag, however, it is not yet implemented in this version of the program and should be defaulted to 0. The type of surface for the segment is input in **xri(4,n)** as a flag. The flag types are 1 for a solid or no-slip wall, -1 for a slip surface, and 0 for an axis of symmetry. Flow station numbers are assigned to **xri(5,n)** and the values of 7, 8, 9 represent the nozzle entrance, throat, and exit respectively. Any other point should be assigned a value of 0. The wall temperature is input in **xri(6,n)**. A positive number is interpreted as a specified wall temperature normalized by the nozzle entrance total temperature, **tt7**. A value of -1 indicates that the adiabatic wall temperature will be used.

The mass addition weight flow ratio across a nozzle surface segment is specified in the input variable **xri(7,n)**. The mass is added (or removed) uniformly over the entire surface segment totaling the value which is specified for that surface segment. A positive value is added mass, a negative value is removed mass. The total weight flow added is normalized by the nozzle entrance weight flow **w7**. The mass addition total pressure and total temperature values are specified in input variables **xri(8,n)** and **xri(9,n)** respectively. The total conditions are normalized by the nozzle entrance total pressure and temperature, **pt7** and **tt7**. The injection angle relative to the nozzle surface segment is specified in the input variable **xri(10,n)** in degrees. The total mass addition (or removal) weight flow ratio crossing nozzle surface segments ahead of the nozzle throat must be specified in the input variable **waddi**. This information is necessary for proper nozzle throat size calculations within the program.

Again, the inputs for **xrj** have the same form as **xri**, as well as for input **waddj**. The variable **npts** specifies the number of points used per surface segment to construct the equivalent 1-D stream-tube model. The default is 51. The variable **nspl** specifies the number of cubic spline points to be used for data enrichment as part of the numerical integration routines which evaluate the control volume integrals and determine the nozzle gross thrust. The default value is 50. The variable **idim** specifies the dimensionality of the geometry. Permitted values are 1 for axisymmetric geometries, 2 for 2-dimensional geometries which are symmetric about the r=0 axis, and -2 for 2-dimensional geometries which are not symmetric. The ratio of the nozzle entrance width to height, or aspect ratio, is specified in the variable **ar**. A value of 1.0 implies a square entrance for 2-D nozzles or full circular for axisymmetric nozzles. A sizing factor is used in the geometry definition and is input through the variable **scale**, whose default is 1.0. For example, this enables geometry coordinates to be input in units of inches and then scaled to feet by setting the sizing factor = 1/12.

<u>Flow Conditions</u>: The user must supply the values for the nozzle entrance flow conditions. The variable **w7** is the nozzle entrance weight flow in lb/s. If **w7** =0, the default, then the nozzle entrance weight flow will be determined to match the input geometry, otherwise the input geometry will be re-scaled to match the specified nozzle entrance weight flow. The variable **pt7** is the nozzle entrance total pressure in psf, and the variable **tt7** is the nozzle entrance total temperature in R. The nozzle throat Mach number, **xm8**, is defaulted to 1.0 for choked flow. The Reynolds number at the nozzle entrance, **rei**, is defaulted to 1.0E+7, though this value may be changed if desired. The user

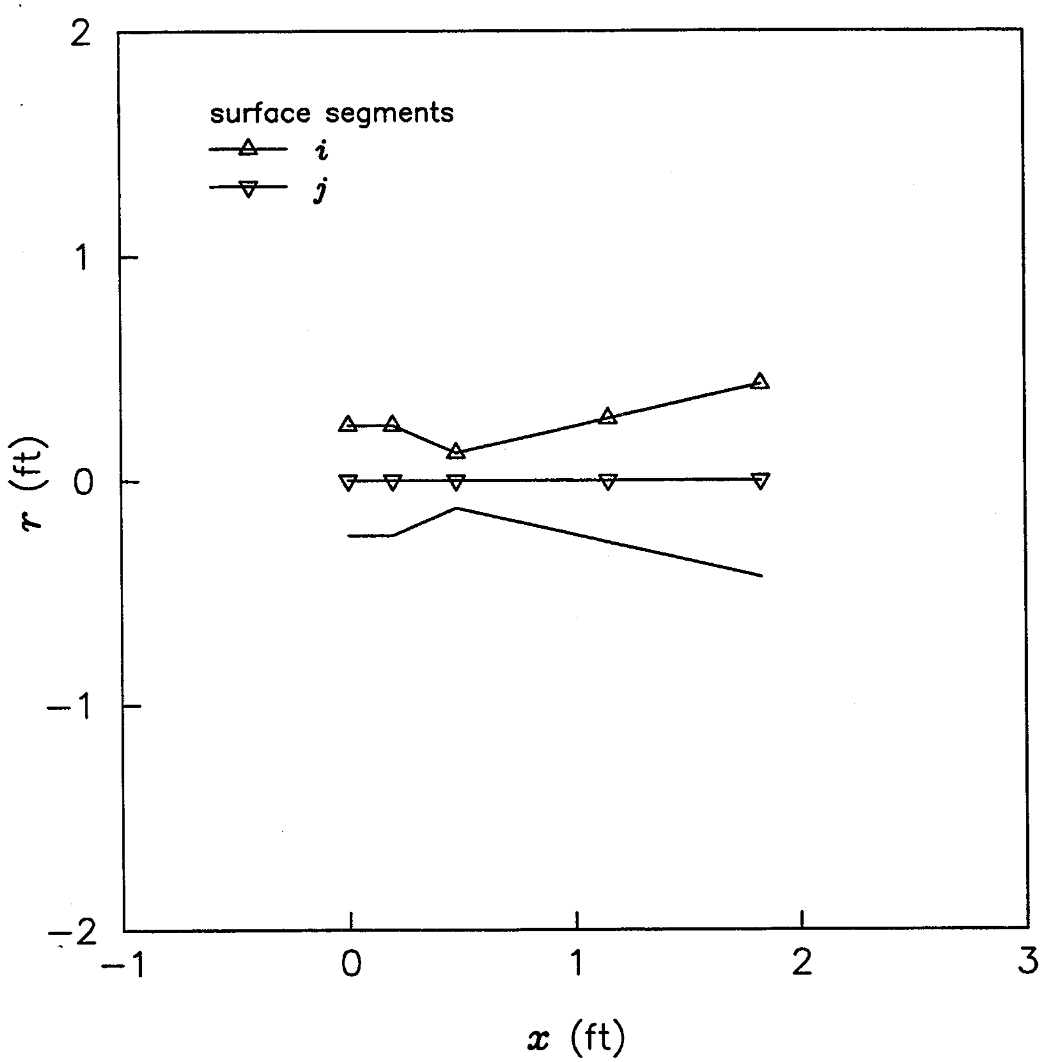
may specify the ambient pressure, variable **p0**. If a positive number is assigned to **p0** then the program will use that value as the ambient pressure in psf. If a negative number is assigned to **p0** then the program will assume that the user has entered a nozzle pressure ratio, NPR, and the proper value in psf will be calculated. If **p0** =0, the default, then the program will determine the ambient pressure such that the nozzle is perfectly expanded. The properties of the gas in the nozzle flow can also be adjusted. The variable **gamma** is the ratio of specific heats, and can be changed to model other gasses or air at high temperatures. The variables **rgas** and **pr** are the gas constant and Prandtl number, respectively. The constants in the Sutherland-law viscosity equation are input in variables **xmus**, **ts**, and **cs**. The default values for **gamma**, **rgas**, and **pr** are for air at standard conditions. The defaults for **xmus**, **ts**, and **cs** are also for air.

<u>Iteration Control</u>: A number of numerical iteration schemes are used in NPAC and these routines may require adjustments in control parameters to work properly. The single and multi-variable Newton-Raphson iteration routines employ a numerical differentiation algorithm to approximate first derivatives. The variable **eps** controls the size of the differencing interval and the default value is 0.001 which should not require any changes. The variable **tol** is the tolerance factor which established a converged solution in the single variable iterations. The default value is 0.000001 and may need to be relaxed for some applications. The variable **con** is the convergence factor used in the multi-variable iterations, and the default value of 0.000001 should work for most applications. The variable **del** is the allowable difference from Mach=1 at the nozzle throat, and the default value of 0.01 should not need to be changed. All of these values can be changed if the user is encountering difficulties reaching converged solutions in the code.

<u>Appendix II</u>

Two-Dimensional Test Model Nozzle

Example Case



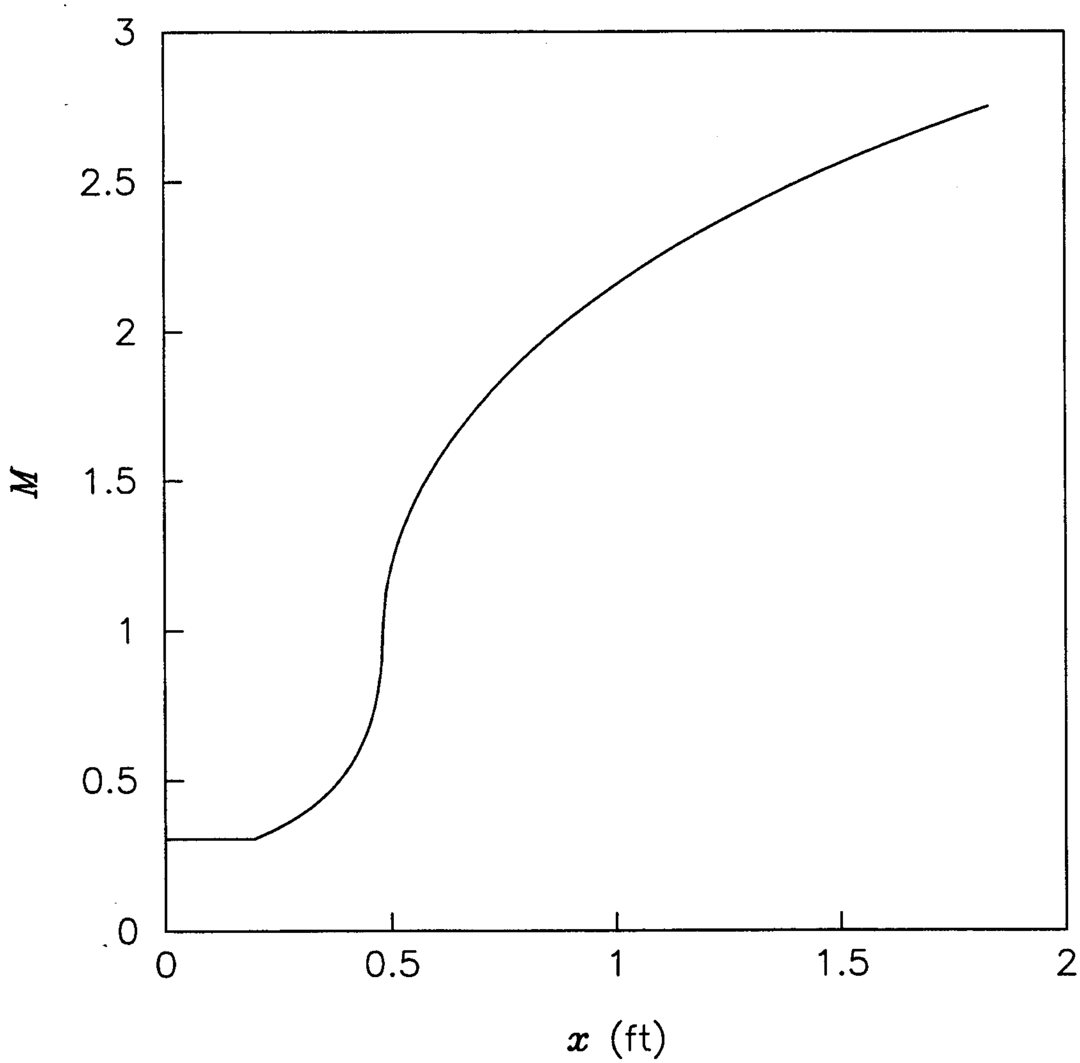


Figure II.1 Mach Number Distribution

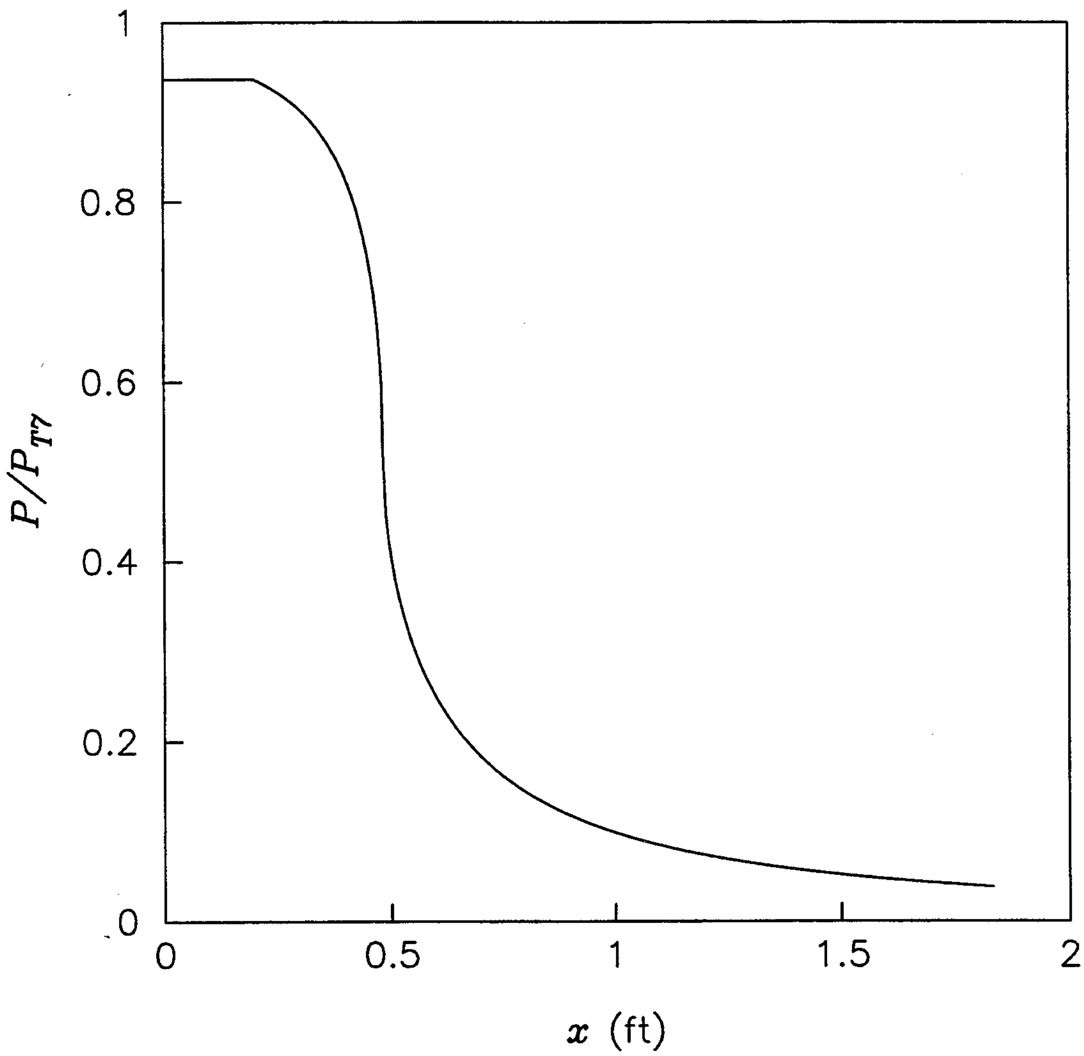


Figure II.2 Normalized Pressure Distribution

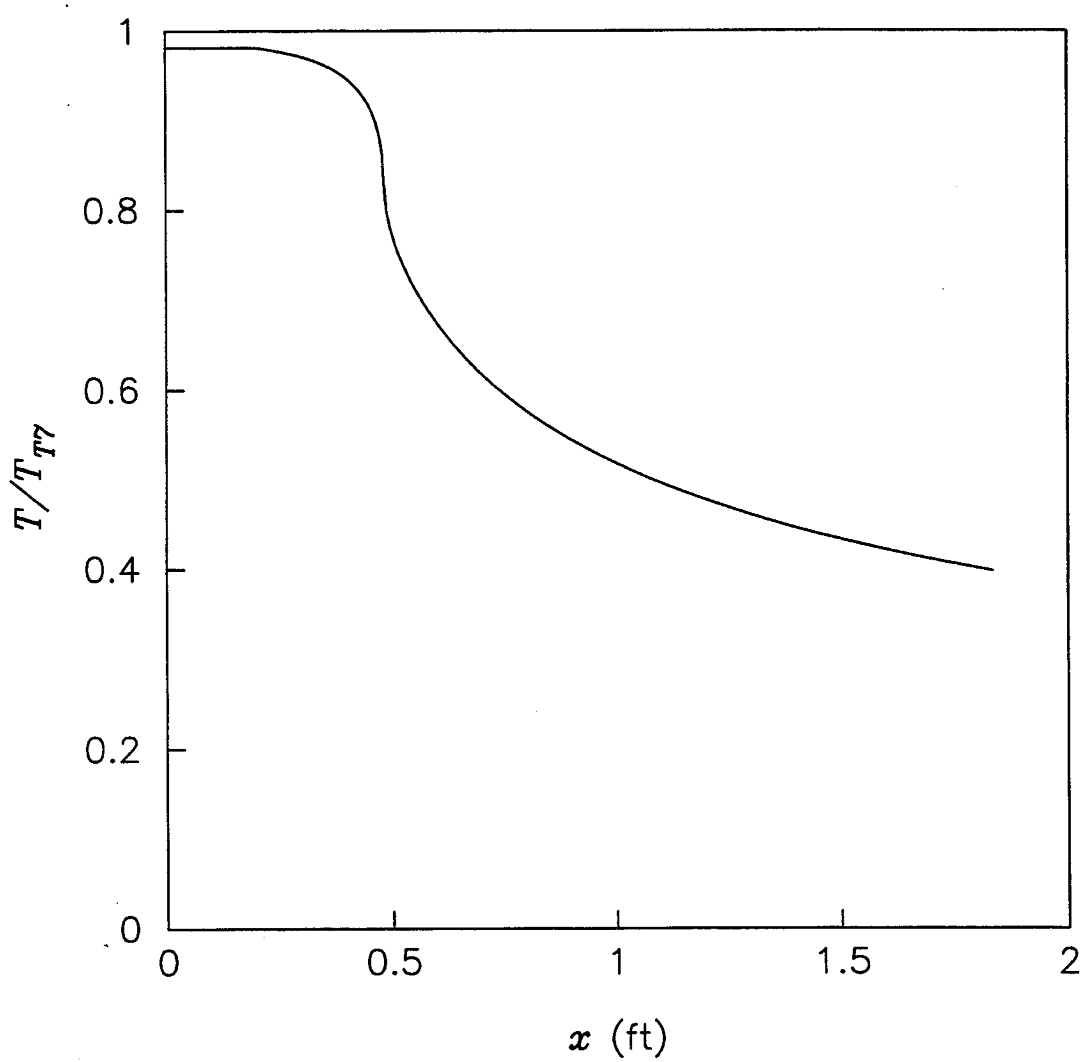


Figure II.3 Normalized Temperature Distribution

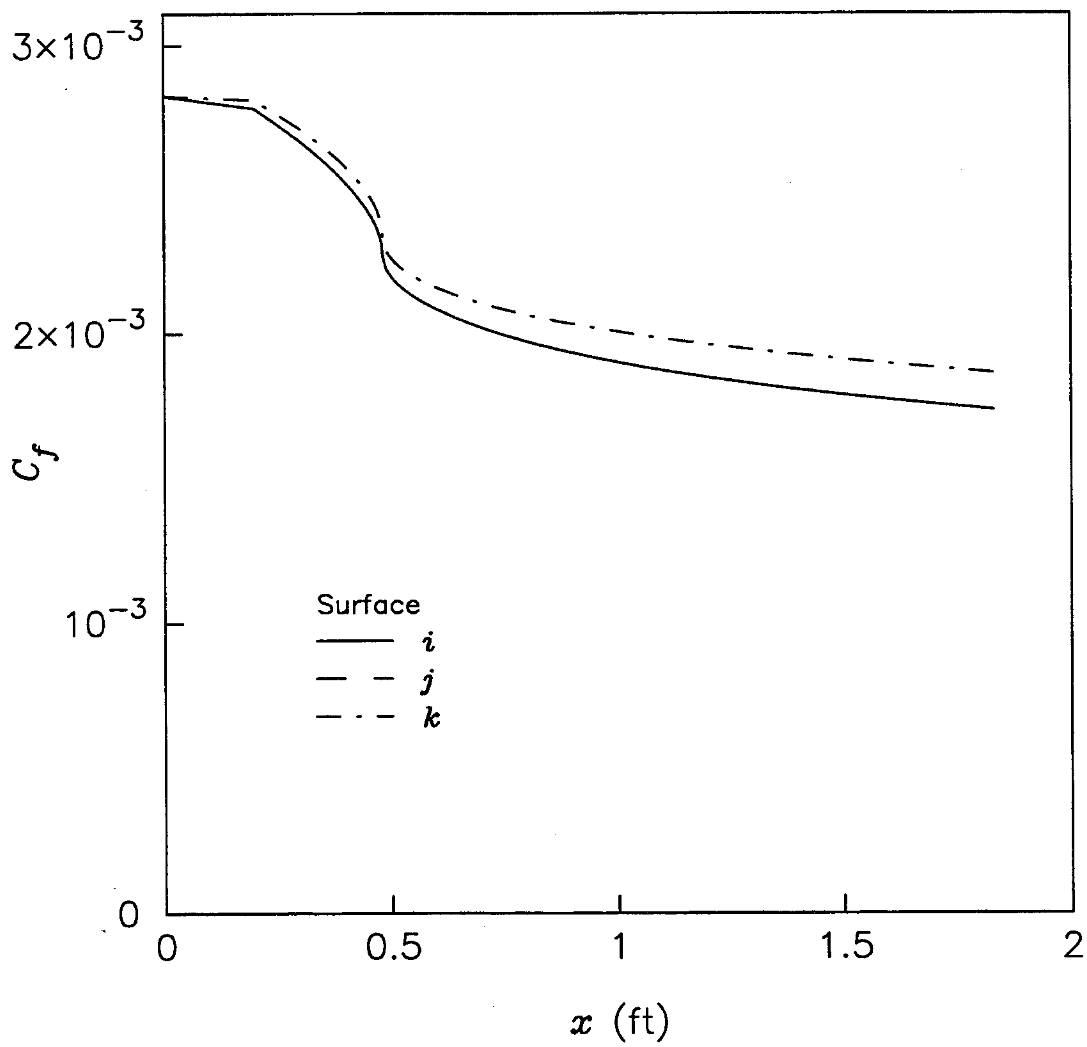


Figure II.4 Skin Friction Distributions

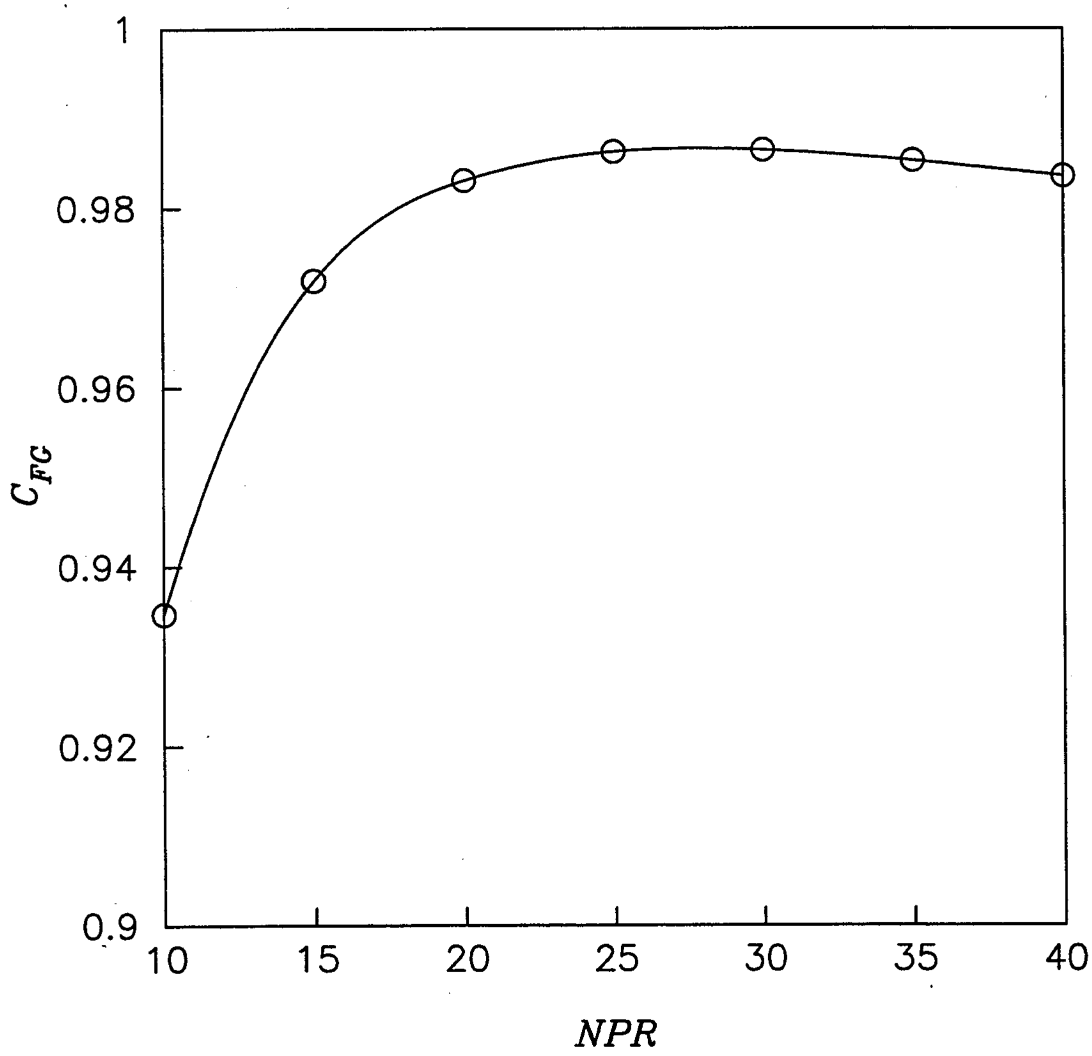


Figure II.5 Gross Thrust Coefficient

```
&npac
 echo=1,
 title='2-D Test Model Nozzle',
 iout=1,0,0,1,0,
 ni=4,                           waddi= 0.0,
 xri= 0.00, 2.48,  0,  0,  7,  0,  0.0,  0.0,  0.0,  0.0,
      2.00, 2.48,  0,  1,  0, -1,  0.0,  0.0,  0.0,  0.0,
      4.87, 1.24,  0,  1,  8, -1,  0.0,  0.0,  0.0,  0.0,
     11.69, 2.79,  0,  1,  0, -1,  0.0,  0.0,  0.0,  0.0,
     18.52, 4.34,  0,  1,  9, -1,  0.0,  0.0,  0.0,  0.0,
 nj=4,                           waddj= 0.0,
 xrj= 0.00,  0.0,  0,  0,  7,  0,  0.0,  0.0,  0.0,  0.0,
      2.00,  0.0,  0, -1,  0, -1,  0.0,  0.0,  0.0,  0.0,
      4.87,  0.0,  0, -1,  8, -1,  0.0,  0.0,  0.0,  0.0,
     11.69,  0.0,  0, -1,  0, -1,  0.0,  0.0,  0.0,  0.0,
     18.52,  0.0,  0, -1,  9, -1,  0.0,  0.0,  0.0,  0.0,
 npts=101,nspl=50,
 idim=2,ar=1.6,scale=1.0,
 w7=35.0,pt7=7876.0,tt7=530.0,
 xm8=1.0,rei=1.0E+7,gamma=1.4,
 p0=0.0,
 eps=1.0E-3,tol=1.0E-6,del=1.0E-2,con=1.0E-6,
&end
&npac  p0=-40.0, iout=0,0,0,0,0,   &end
&npac  p0=-35.0,  &end
&npac  p0=-30.0,  &end
&npac  p0=-25.0,  &end
&npac  p0=-20.0,  &end
&npac  p0=-15.0,  &end
&npac  p0=-10.0,  &end

NPAC   2-D Test Model Nozzle


i surface, ni =  4, geometry input values follow, scale =  1.0000E+00

          x           r        flags    Tw/Tt7     w/w7     Pt/Pt7    Tt/Tt7     phi

 0  0.000E+00  2.480E+00  0  0  7  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 1  2.000E+00  2.480E+00  0  1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 2  4.870E+00  1.240E+00  0  1  8 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 3  1.169E+01  2.790E+00  0  1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 4  1.852E+01  4.340E+00  0  1  9 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00

j surface, nj =  4, geometry input values follow, scale =  1.0000E+00
```

```
        x           r          flags     Tw/Tt7      w/w7       Pt/Pt7     Tt/Tt7      phi

 0  0.000E+00  0.000E+00   0  0  7  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 1  2.000E+00  0.000E+00   0 -1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 2  4.870E+00  0.000E+00   0 -1  8 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 3  1.169E+01  0.000E+00   0 -1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 4  1.852E+01  0.000E+00   0 -1  9 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00

geometric a8 is  1.9681E+01, required is  1.9240E-01, re-scaling geometry...

i surface, ni =  4, geometry input values follow, scale =  9.8871E-02

        x           r          flags     Tw/Tt7      w/w7       Pt/Pt7     Tt/Tt7      phi

 0  0.000E+00  2.452E-01   0  0  7  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 1  1.977E-01  2.452E-01   0  1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 2  4.815E-01  1.226E-01   0  1  8 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 3  1.156E+00  2.759E-01   0  1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 4  1.831E+00  4.291E-01   0  1  9 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00

j surface, nj =  4, geometry input values follow, scale =  9.8871E-02

        x           r          flags     Tw/Tt7      w/w7       Pt/Pt7     Tt/Tt7      phi

 0  0.000E+00  0.000E+00   0  0  7  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 1  1.977E-01  0.000E+00   0 -1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 2  4.815E-01  0.000E+00   0 -1  8 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 3  1.156E+00  0.000E+00   0 -1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 4  1.831E+00  0.000E+00   0 -1  9 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00

geometric a8 is  1.9240E-01, required is  1.9240E-01, re-scaling complete

nozzle entrance Mach number is  3.0590E-01, inviscid flow model

nozzle throat total pressure is  7.8672E+03, pass number 1, in full model

nozzle entrance Mach number is  3.0552E-01, viscous flow model

nozzle throat total pressure is  7.8670E+03, pass number 2, in full model

full-equations viscous flow model

          x            M            P            T           rho           U            Pt           Tt

   1  0.0000E+00  3.0552E-01  7.3823E+03  5.2029E+02  8.2662E-03  3.4162E+02  7.8760E+03  5.3000E+02
   2  1.9774E-03  3.0552E-01  7.3823E+03  5.2029E+02  8.2662E-03  3.4162E+02  7.8760E+03  5.3000E+02
```

93	3	3.9549E-03	3.0552E-01	7.3822E+03	5.2029E+02	8.2662E-03	3.4162E+02	7.8760E+03	5.3000E+02
94	4	5.9323E-03	3.0552E-01	7.3822E+03	5.2029E+02	8.2662E-03	3.4162E+02	7.8760E+03	5.3000E+02
95	5	7.9097E-03	3.0552E-01	7.3822E+03	5.2029E+02	8.2662E-03	3.4162E+02	7.8759E+03	5.3000E+02
96	6	9.8871E-03	3.0552E-01	7.3822E+03	5.2029E+02	8.2662E-03	3.4163E+02	7.8759E+03	5.3000E+02
97	7	1.1865E-02	3.0552E-01	7.3822E+03	5.2029E+02	8.2661E-03	3.4163E+02	7.8759E+03	5.3000E+02
98	8	1.3842E-02	3.0553E-01	7.3822E+03	5.2029E+02	8.2661E-03	3.4163E+02	7.8759E+03	5.3000E+02
99	9	1.5819E-02	3.0553E-01	7.3822E+03	5.2029E+02	8.2661E-03	3.4163E+02	7.8759E+03	5.3000E+02
100	10	1.7797E-02	3.0553E-01	7.3821E+03	5.2029E+02	8.2661E-03	3.4163E+02	7.8759E+03	5.3000E+02
101	11	1.9774E-02	3.0553E-01	7.3821E+03	5.2029E+02	8.2661E-03	3.4163E+02	7.8758E+03	5.3000E+02
102	12	2.1752E-02	3.0553E-01	7.3821E+03	5.2029E+02	8.2660E-03	3.4163E+02	7.8758E+03	5.3000E+02
103	13	2.3729E-02	3.0553E-01	7.3821E+03	5.2029E+02	8.2660E-03	3.4163E+02	7.8758E+03	5.3000E+02
104	14	2.5707E-02	3.0553E-01	7.3821E+03	5.2029E+02	8.2660E-03	3.4163E+02	7.8758E+03	5.3000E+02
105	15	2.7684E-02	3.0553E-01	7.3821E+03	5.2029E+02	8.2660E-03	3.4163E+02	7.8758E+03	5.3000E+02
106	16	2.9661E-02	3.0553E-01	7.3820E+03	5.2029E+02	8.2660E-03	3.4163E+02	7.8758E+03	5.3000E+02
107	17	3.1639E-02	3.0553E-01	7.3820E+03	5.2029E+02	8.2660E-03	3.4163E+02	7.8757E+03	5.3000E+02
108	18	3.3616E-02	3.0553E-01	7.3820E+03	5.2029E+02	8.2659E-03	3.4163E+02	7.8757E+03	5.3000E+02
109	19	3.5594E-02	3.0553E-01	7.3820E+03	5.2029E+02	8.2659E-03	3.4163E+02	7.8757E+03	5.3000E+02
110	20	3.7571E-02	3.0553E-01	7.3820E+03	5.2029E+02	8.2659E-03	3.4164E+02	7.8757E+03	5.3000E+02
111	21	3.9549E-02	3.0553E-01	7.3820E+03	5.2029E+02	8.2659E-03	3.4164E+02	7.8757E+03	5.3000E+02
112	22	4.1526E-02	3.0553E-01	7.3819E+03	5.2029E+02	8.2659E-03	3.4164E+02	7.8757E+03	5.3000E+02
113	23	4.3503E-02	3.0553E-01	7.3819E+03	5.2029E+02	8.2658E-03	3.4164E+02	7.8756E+03	5.3000E+02
114	24	4.5481E-02	3.0553E-01	7.3819E+03	5.2029E+02	8.2658E-03	3.4164E+02	7.8756E+03	5.3000E+02
115	25	4.7458E-02	3.0554E-01	7.3819E+03	5.2029E+02	8.2658E-03	3.4164E+02	7.8756E+03	5.3000E+02
116	26	4.9436E-02	3.0554E-01	7.3819E+03	5.2029E+02	8.2658E-03	3.4164E+02	7.8756E+03	5.3000E+02
117	27	5.1413E-02	3.0554E-01	7.3819E+03	5.2029E+02	8.2658E-03	3.4164E+02	7.8756E+03	5.3000E+02
118	28	5.3391E-02	3.0554E-01	7.3818E+03	5.2029E+02	8.2658E-03	3.4164E+02	7.8756E+03	5.3000E+02
119	29	5.5368E-02	3.0554E-01	7.3818E+03	5.2029E+02	8.2657E-03	3.4164E+02	7.8756E+03	5.3000E+02
120	30	5.7345E-02	3.0554E-01	7.3818E+03	5.2029E+02	8.2657E-03	3.4164E+02	7.8755E+03	5.3000E+02
121	31	5.9323E-02	3.0554E-01	7.3818E+03	5.2029E+02	8.2657E-03	3.4164E+02	7.8755E+03	5.3000E+02
122	32	6.1300E-02	3.0554E-01	7.3818E+03	5.2029E+02	8.2657E-03	3.4164E+02	7.8755E+03	5.3000E+02
123	33	6.3278E-02	3.0554E-01	7.3818E+03	5.2029E+02	8.2657E-03	3.4164E+02	7.8755E+03	5.3000E+02
124	34	6.5255E-02	3.0554E-01	7.3817E+03	5.2029E+02	8.2656E-03	3.4164E+02	7.8755E+03	5.3000E+02
125	35	6.7233E-02	3.0554E-01	7.3817E+03	5.2029E+02	8.2656E-03	3.4165E+02	7.8755E+03	5.3000E+02
126	36	6.9210E-02	3.0554E-01	7.3817E+03	5.2029E+02	8.2656E-03	3.4165E+02	7.8754E+03	5.3000E+02
127	37	7.1187E-02	3.0554E-01	7.3817E+03	5.2029E+02	8.2656E-03	3.4165E+02	7.8754E+03	5.3000E+02
128	38	7.3165E-02	3.0554E-01	7.3817E+03	5.2029E+02	8.2656E-03	3.4165E+02	7.8754E+03	5.3000E+02
129	39	7.5142E-02	3.0554E-01	7.3817E+03	5.2029E+02	8.2656E-03	3.4165E+02	7.8754E+03	5.3000E+02
130	40	7.7120E-02	3.0554E-01	7.3816E+03	5.2029E+02	8.2655E-03	3.4165E+02	7.8754E+03	5.3000E+02
131	41	7.9097E-02	3.0555E-01	7.3816E+03	5.2029E+02	8.2655E-03	3.4165E+02	7.8754E+03	5.3000E+02
132	42	8.1075E-02	3.0555E-01	7.3816E+03	5.2029E+02	8.2655E-03	3.4165E+02	7.8753E+03	5.3000E+02
133	43	8.3052E-02	3.0555E-01	7.3816E+03	5.2029E+02	8.2655E-03	3.4165E+02	7.8753E+03	5.3000E+02
134	44	8.5029E-02	3.0555E-01	7.3816E+03	5.2029E+02	8.2655E-03	3.4165E+02	7.8753E+03	5.3000E+02
135	45	8.7007E-02	3.0555E-01	7.3816E+03	5.2029E+02	8.2654E-03	3.4165E+02	7.8753E+03	5.3000E+02
136	46	8.8984E-02	3.0555E-01	7.3815E+03	5.2029E+02	8.2654E-03	3.4165E+02	7.8753E+03	5.3000E+02
137	47	9.0962E-02	3.0555E-01	7.3815E+03	5.2029E+02	8.2654E-03	3.4165E+02	7.8753E+03	5.3000E+02
138	48	9.2939E-02	3.0555E-01	7.3815E+03	5.2029E+02	8.2654E-03	3.4165E+02	7.8752E+03	5.3000E+02

139	49	9.4917E-02	3.0555E-01	7.3815E+03	5.2029E+02	8.2654E-03	3.4166E+02	7.8752E+03	5.3000E+02
140	50	9.6894E-02	3.0555E-01	7.3815E+03	5.2029E+02	8.2654E-03	3.4166E+02	7.8752E+03	5.3000E+02
141	51	9.8871E-02	3.0555E-01	7.3815E+03	5.2029E+02	8.2653E-03	3.4166E+02	7.8752E+03	5.3000E+02
142	52	1.0085E-01	3.0555E-01	7.3814E+03	5.2029E+02	8.2653E-03	3.4166E+02	7.8752E+03	5.3000E+02
143	53	1.0283E-01	3.0555E-01	7.3814E+03	5.2029E+02	8.2653E-03	3.4166E+02	7.8752E+03	5.3000E+02
144	54	1.0480E-01	3.0555E-01	7.3814E+03	5.2029E+02	8.2653E-03	3.4166E+02	7.8752E+03	5.3000E+02
145	55	1.0678E-01	3.0555E-01	7.3814E+03	5.2029E+02	8.2653E-03	3.4166E+02	7.8751E+03	5.3000E+02
146	56	1.0876E-01	3.0555E-01	7.3814E+03	5.2029E+02	8.2652E-03	3.4166E+02	7.8751E+03	5.3000E+02
147	57	1.1074E-01	3.0556E-01	7.3814E+03	5.2029E+02	8.2652E-03	3.4166E+02	7.8751E+03	5.3000E+02
148	58	1.1271E-01	3.0556E-01	7.3813E+03	5.2029E+02	8.2652E-03	3.4166E+02	7.8751E+03	5.3000E+02
149	59	1.1469E-01	3.0556E-01	7.3813E+03	5.2029E+02	8.2652E-03	3.4166E+02	7.8751E+03	5.3000E+02
150	60	1.1667E-01	3.0556E-01	7.3813E+03	5.2029E+02	8.2652E-03	3.4166E+02	7.8751E+03	5.3000E+02
151	61	1.1865E-01	3.0556E-01	7.3813E+03	5.2029E+02	8.2652E-03	3.4166E+02	7.8750E+03	5.3000E+02
152	62	1.2062E-01	3.0556E-01	7.3813E+03	5.2029E+02	8.2651E-03	3.4166E+02	7.8750E+03	5.3000E+02
153	63	1.2260E-01	3.0556E-01	7.3813E+03	5.2029E+02	8.2651E-03	3.4166E+02	7.8750E+03	5.3000E+02
154	64	1.2458E-01	3.0556E-01	7.3812E+03	5.2029E+02	8.2651E-03	3.4167E+02	7.8750E+03	5.3000E+02
155	65	1.2656E-01	3.0556E-01	7.3812E+03	5.2029E+02	8.2651E-03	3.4167E+02	7.8750E+03	5.3000E+02
156	66	1.2853E-01	3.0556E-01	7.3812E+03	5.2029E+02	8.2651E-03	3.4167E+02	7.8750E+03	5.3000E+02
157	67	1.3051E-01	3.0556E-01	7.3812E+03	5.2029E+02	8.2651E-03	3.4167E+02	7.8749E+03	5.3000E+02
158	68	1.3249E-01	3.0556E-01	7.3812E+03	5.2029E+02	8.2650E-03	3.4167E+02	7.8749E+03	5.3000E+02
159	69	1.3447E-01	3.0556E-01	7.3812E+03	5.2029E+02	8.2650E-03	3.4167E+02	7.8749E+03	5.3000E+02
160	70	1.3644E-01	3.0556E-01	7.3811E+03	5.2029E+02	8.2650E-03	3.4167E+02	7.8749E+03	5.3000E+02
161	71	1.3842E-01	3.0556E-01	7.3811E+03	5.2029E+02	8.2650E-03	3.4167E+02	7.8749E+03	5.3000E+02
162	72	1.4040E-01	3.0556E-01	7.3811E+03	5.2029E+02	8.2650E-03	3.4167E+02	7.8749E+03	5.3000E+02
163	73	1.4237E-01	3.0557E-01	7.3811E+03	5.2029E+02	8.2649E-03	3.4167E+02	7.8749E+03	5.3000E+02
164	74	1.4435E-01	3.0557E-01	7.3811E+03	5.2029E+02	8.2649E-03	3.4167E+02	7.8748E+03	5.3000E+02
165	75	1.4633E-01	3.0557E-01	7.3811E+03	5.2029E+02	8.2649E-03	3.4167E+02	7.8748E+03	5.3000E+02
166	76	1.4831E-01	3.0557E-01	7.3811E+03	5.2029E+02	8.2649E-03	3.4167E+02	7.8748E+03	5.3000E+02
167	77	1.5028E-01	3.0557E-01	7.3810E+03	5.2029E+02	8.2649E-03	3.4167E+02	7.8748E+03	5.3000E+02
168	78	1.5226E-01	3.0557E-01	7.3810E+03	5.2029E+02	8.2649E-03	3.4168E+02	7.8748E+03	5.3000E+02
169	79	1.5424E-01	3.0557E-01	7.3810E+03	5.2029E+02	8.2648E-03	3.4168E+02	7.8748E+03	5.3000E+02
170	80	1.5622E-01	3.0557E-01	7.3810E+03	5.2029E+02	8.2648E-03	3.4168E+02	7.8747E+03	5.3000E+02
171	81	1.5819E-01	3.0557E-01	7.3810E+03	5.2029E+02	8.2648E-03	3.4168E+02	7.8747E+03	5.3000E+02
172	82	1.6017E-01	3.0557E-01	7.3810E+03	5.2029E+02	8.2648E-03	3.4168E+02	7.8747E+03	5.3000E+02
173	83	1.6215E-01	3.0557E-01	7.3809E+03	5.2029E+02	8.2648E-03	3.4168E+02	7.8747E+03	5.3000E+02
174	84	1.6413E-01	3.0557E-01	7.3809E+03	5.2029E+02	8.2648E-03	3.4168E+02	7.8747E+03	5.3000E+02
175	85	1.6610E-01	3.0557E-01	7.3809E+03	5.2029E+02	8.2647E-03	3.4168E+02	7.8747E+03	5.3000E+02
176	86	1.6808E-01	3.0557E-01	7.3809E+03	5.2029E+02	8.2647E-03	3.4168E+02	7.8746E+03	5.3000E+02
177	87	1.7006E-01	3.0557E-01	7.3809E+03	5.2029E+02	8.2647E-03	3.4168E+02	7.8746E+03	5.3000E+02
178	88	1.7204E-01	3.0557E-01	7.3809E+03	5.2029E+02	8.2647E-03	3.4168E+02	7.8746E+03	5.3000E+02
179	89	1.7401E-01	3.0557E-01	7.3808E+03	5.2029E+02	8.2647E-03	3.4168E+02	7.8746E+03	5.3000E+02
180	90	1.7599E-01	3.0558E-01	7.3808E+03	5.2029E+02	8.2646E-03	3.4168E+02	7.8746E+03	5.3000E+02
181	91	1.7797E-01	3.0558E-01	7.3808E+03	5.2029E+02	8.2646E-03	3.4168E+02	7.8746E+03	5.3000E+02
182	92	1.7995E-01	3.0558E-01	7.3808E+03	5.2029E+02	8.2646E-03	3.4168E+02	7.8746E+03	5.3000E+02
183	93	1.8192E-01	3.0558E-01	7.3808E+03	5.2029E+02	8.2646E-03	3.4169E+02	7.8745E+03	5.3000E+02
184	94	1.8390E-01	3.0558E-01	7.3808E+03	5.2029E+02	8.2646E-03	3.4169E+02	7.8745E+03	5.3000E+02

185	95	1.8588E-01	3.0558E-01	7.3807E+03	5.2029E+02	8.2646E-03	3.4169E+02	7.8745E+03	5.3000E+02
186	96	1.8786E-01	3.0558E-01	7.3807E+03	5.2029E+02	8.2645E-03	3.4169E+02	7.8745E+03	5.3000E+02
187	97	1.8983E-01	3.0558E-01	7.3807E+03	5.2029E+02	8.2645E-03	3.4169E+02	7.8745E+03	5.3000E+02
188	98	1.9181E-01	3.0558E-01	7.3807E+03	5.2029E+02	8.2645E-03	3.4169E+02	7.8745E+03	5.3000E+02
189	99	1.9379E-01	3.0558E-01	7.3807E+03	5.2029E+02	8.2645E-03	3.4169E+02	7.8744E+03	5.3000E+02
190	100	1.9577E-01	3.0558E-01	7.3807E+03	5.2029E+02	8.2645E-03	3.4169E+02	7.8744E+03	5.3000E+02
191	101	1.9774E-01	3.0558E-01	7.3806E+03	5.2029E+02	8.2645E-03	3.4169E+02	7.8744E+03	5.3000E+02
192	102	2.0058E-01	3.0731E-01	7.3753E+03	5.2018E+02	8.2601E-03	3.4359E+02	7.8744E+03	5.3000E+02
193	103	2.0342E-01	3.0906E-01	7.3698E+03	5.2007E+02	8.2557E-03	3.4551E+02	7.8744E+03	5.3000E+02
194	104	2.0626E-01	3.1083E-01	7.3642E+03	5.1996E+02	8.2513E-03	3.4745E+02	7.8743E+03	5.3000E+02
195	105	2.0909E-01	3.1262E-01	7.3585E+03	5.1984E+02	8.2467E-03	3.4941E+02	7.8743E+03	5.3000E+02
196	106	2.1193E-01	3.1444E-01	7.3528E+03	5.1973E+02	8.2421E-03	3.5140E+02	7.8743E+03	5.3000E+02
197	107	2.1477E-01	3.1627E-01	7.3469E+03	5.1961E+02	8.2374E-03	3.5342E+02	7.8743E+03	5.3000E+02
198	108	2.1761E-01	3.1813E-01	7.3409E+03	5.1949E+02	8.2326E-03	3.5545E+02	7.8742E+03	5.3000E+02
199	109	2.2044E-01	3.2002E-01	7.3348E+03	5.1936E+02	8.2277E-03	3.5752E+02	7.8742E+03	5.3000E+02
200	110	2.2328E-01	3.2193E-01	7.3287E+03	5.1924E+02	8.2228E-03	3.5961E+02	7.8742E+03	5.3000E+02
201	111	2.2612E-01	3.2386E-01	7.3224E+03	5.1911E+02	8.2177E-03	3.6172E+02	7.8741E+03	5.3000E+02
202	112	2.2896E-01	3.2582E-01	7.3160E+03	5.1898E+02	8.2126E-03	3.6386E+02	7.8741E+03	5.3000E+02
203	113	2.3179E-01	3.2780E-01	7.3094E+03	5.1885E+02	8.2073E-03	3.6603E+02	7.8741E+03	5.3000E+02
204	114	2.3463E-01	3.2981E-01	7.3028E+03	5.1872E+02	8.2020E-03	3.6823E+02	7.8741E+03	5.3000E+02
205	115	2.3747E-01	3.3185E-01	7.2960E+03	5.1858E+02	8.1965E-03	3.7045E+02	7.8740E+03	5.3000E+02
206	116	2.4031E-01	3.3391E-01	7.2891E+03	5.1844E+02	8.1910E-03	3.7271E+02	7.8740E+03	5.3000E+02
207	117	2.4314E-01	3.3600E-01	7.2821E+03	5.1830E+02	8.1854E-03	3.7499E+02	7.8740E+03	5.3000E+02
208	118	2.4598E-01	3.3813E-01	7.2750E+03	5.1815E+02	8.1796E-03	3.7730E+02	7.8739E+03	5.3000E+02
209	119	2.4882E-01	3.4028E-01	7.2677E+03	5.1801E+02	8.1738E-03	3.7965E+02	7.8739E+03	5.3000E+02
210	120	2.5166E-01	3.4246E-01	7.2603E+03	5.1786E+02	8.1678E-03	3.8203E+02	7.8739E+03	5.3000E+02
211	121	2.5449E-01	3.4467E-01	7.2527E+03	5.1770E+02	8.1617E-03	3.8444E+02	7.8738E+03	5.3000E+02
212	122	2.5733E-01	3.4691E-01	7.2450E+03	5.1755E+02	8.1555E-03	3.8688E+02	7.8738E+03	5.3000E+02
213	123	2.6017E-01	3.4918E-01	7.2371E+03	5.1739E+02	8.1491E-03	3.8935E+02	7.8738E+03	5.3000E+02
214	124	2.6301E-01	3.5149E-01	7.2291E+03	5.1722E+02	8.1427E-03	3.9186E+02	7.8737E+03	5.3000E+02
215	125	2.6585E-01	3.5383E-01	7.2209E+03	5.1706E+02	8.1361E-03	3.9441E+02	7.8737E+03	5.3000E+02
216	126	2.6868E-01	3.5620E-01	7.2126E+03	5.1689E+02	8.1294E-03	3.9699E+02	7.8737E+03	5.3000E+02
217	127	2.7152E-01	3.5861E-01	7.2041E+03	5.1671E+02	8.1225E-03	3.9961E+02	7.8736E+03	5.3000E+02
218	128	2.7436E-01	3.6106E-01	7.1954E+03	5.1654E+02	8.1155E-03	4.0227E+02	7.8736E+03	5.3000E+02
219	129	2.7720E-01	3.6354E-01	7.1865E+03	5.1635E+02	8.1084E-03	4.0496E+02	7.8736E+03	5.3000E+02
220	130	2.8003E-01	3.6606E-01	7.1775E+03	5.1617E+02	8.1011E-03	4.0770E+02	7.8735E+03	5.3000E+02
221	131	2.8287E-01	3.6862E-01	7.1683E+03	5.1598E+02	8.0936E-03	4.1047E+02	7.8735E+03	5.3000E+02
222	132	2.8571E-01	3.7122E-01	7.1588E+03	5.1579E+02	8.0860E-03	4.1329E+02	7.8735E+03	5.3000E+02
223	133	2.8855E-01	3.7386E-01	7.1492E+03	5.1559E+02	8.0782E-03	4.1615E+02	7.8734E+03	5.3000E+02
224	134	2.9138E-01	3.7655E-01	7.1394E+03	5.1539E+02	8.0703E-03	4.1905E+02	7.8734E+03	5.3000E+02
225	135	2.9422E-01	3.7927E-01	7.1294E+03	5.1518E+02	8.0622E-03	4.2200E+02	7.8733E+03	5.3000E+02
226	136	2.9706E-01	3.8204E-01	7.1191E+03	5.1497E+02	8.0539E-03	4.2500E+02	7.8733E+03	5.3000E+02
227	137	2.9990E-01	3.8486E-01	7.1086E+03	5.1475E+02	8.0454E-03	4.2804E+02	7.8733E+03	5.3000E+02
228	138	3.0273E-01	3.8772E-01	7.0979E+03	5.1453E+02	8.0367E-03	4.3113E+02	7.8732E+03	5.3000E+02
229	139	3.0557E-01	3.9063E-01	7.0870E+03	5.1431E+02	8.0278E-03	4.3427E+02	7.8732E+03	5.3000E+02
230	140	3.0841E-01	3.9359E-01	7.0758E+03	5.1408E+02	8.0188E-03	4.3746E+02	7.8731E+03	5.3000E+02

231	141	3.1125E-01	3.9660E-01	7.0643E+03	5.1384E+02	8.0095E-03	4.4071E+02	7.8731E+03	5.3000E+02
232	142	3.1408E-01	3.9966E-01	7.0526E+03	5.1360E+02	8.0000E-03	4.4401E+02	7.8730E+03	5.3000E+02
233	143	3.1692E-01	4.0278E-01	7.0406E+03	5.1335E+02	7.9902E-03	4.4736E+02	7.8730E+03	5.3000E+02
234	144	3.1976E-01	4.0595E-01	7.0283E+03	5.1309E+02	7.9803E-03	4.5077E+02	7.8729E+03	5.3000E+02
235	145	3.2260E-01	4.0918E-01	7.0157E+03	5.1283E+02	7.9700E-03	4.5424E+02	7.8729E+03	5.3000E+02
236	146	3.2544E-01	4.1247E-01	7.0029E+03	5.1256E+02	7.9596E-03	4.5777E+02	7.8728E+03	5.3000E+02
237	147	3.2827E-01	4.1582E-01	6.9897E+03	5.1229E+02	7.9489E-03	4.6137E+02	7.8728E+03	5.3000E+02
238	148	3.3111E-01	4.1923E-01	6.9762E+03	5.1201E+02	7.9379E-03	4.6503E+02	7.8727E+03	5.3000E+02
239	149	3.3395E-01	4.2271E-01	6.9623E+03	5.1172E+02	7.9266E-03	4.6875E+02	7.8727E+03	5.3000E+02
240	150	3.3679E-01	4.2625E-01	6.9482E+03	5.1142E+02	7.9151E-03	4.7254E+02	7.8726E+03	5.3000E+02
241	151	3.3962E-01	4.2987E-01	6.9336E+03	5.1111E+02	7.9032E-03	4.7641E+02	7.8726E+03	5.3000E+02
242	152	3.4246E-01	4.3355E-01	6.9187E+03	5.1080E+02	7.8910E-03	4.8034E+02	7.8725E+03	5.3000E+02
243	153	3.4530E-01	4.3731E-01	6.9034E+03	5.1048E+02	7.8785E-03	4.8436E+02	7.8725E+03	5.3000E+02
244	154	3.4814E-01	4.4115E-01	6.8877E+03	5.1015E+02	7.8657E-03	4.8845E+02	7.8724E+03	5.3000E+02
245	155	3.5097E-01	4.4506E-01	6.8715E+03	5.0981E+02	7.8525E-03	4.9262E+02	7.8723E+03	5.3000E+02
246	156	3.5381E-01	4.4906E-01	6.8550E+03	5.0946E+02	7.8390E-03	4.9687E+02	7.8723E+03	5.3000E+02
247	157	3.5665E-01	4.5314E-01	6.8380E+03	5.0910E+02	7.8251E-03	5.0121E+02	7.8722E+03	5.3000E+02
248	158	3.5949E-01	4.5731E-01	6.8205E+03	5.0873E+02	7.8108E-03	5.0564E+02	7.8721E+03	5.3000E+02
249	159	3.6232E-01	4.6158E-01	6.8025E+03	5.0834E+02	7.7960E-03	5.1016E+02	7.8721E+03	5.3000E+02
250	160	3.6516E-01	4.6594E-01	6.7840E+03	5.0795E+02	7.7809E-03	5.1478E+02	7.8720E+03	5.3000E+02
251	161	3.6800E-01	4.7040E-01	6.7650E+03	5.0754E+02	7.7652E-03	5.1950E+02	7.8719E+03	5.3000E+02
252	162	3.7084E-01	4.7496E-01	6.7454E+03	5.0712E+02	7.7492E-03	5.2433E+02	7.8719E+03	5.3000E+02
253	163	3.7367E-01	4.7963E-01	6.7252E+03	5.0669E+02	7.7326E-03	5.2926E+02	7.8718E+03	5.3000E+02
254	164	3.7651E-01	4.8442E-01	6.7044E+03	5.0624E+02	7.7155E-03	5.3430E+02	7.8717E+03	5.3000E+02
255	165	3.7935E-01	4.8932E-01	6.6830E+03	5.0578E+02	7.6978E-03	5.3946E+02	7.8716E+03	5.3000E+02
256	166	3.8219E-01	4.9435E-01	6.6609E+03	5.0531E+02	7.6796E-03	5.4475E+02	7.8716E+03	5.3000E+02
257	167	3.8503E-01	4.9950E-01	6.6381E+03	5.0481E+02	7.6608E-03	5.5016E+02	7.8715E+03	5.3000E+02
258	168	3.8786E-01	5.0479E-01	6.6146E+03	5.0430E+02	7.6414E-03	5.5570E+02	7.8714E+03	5.3000E+02
259	169	3.9070E-01	5.1022E-01	6.5903E+03	5.0378E+02	7.6213E-03	5.6139E+02	7.8713E+03	5.3000E+02
260	170	3.9354E-01	5.1580E-01	6.5652E+03	5.0323E+02	7.6005E-03	5.6722E+02	7.8712E+03	5.3000E+02
261	171	3.9638E-01	5.2154E-01	6.5392E+03	5.0266E+02	7.5790E-03	5.7321E+02	7.8711E+03	5.3000E+02
262	172	3.9921E-01	5.2744E-01	6.5123E+03	5.0207E+02	7.5567E-03	5.7935E+02	7.8710E+03	5.3000E+02
263	173	4.0205E-01	5.3352E-01	6.4845E+03	5.0146E+02	7.5336E-03	5.8567E+02	7.8710E+03	5.3000E+02
264	174	4.0489E-01	5.3978E-01	6.4556E+03	5.0082E+02	7.5096E-03	5.9217E+02	7.8709E+03	5.3000E+02
265	175	4.0773E-01	5.4624E-01	6.4257E+03	5.0016E+02	7.4847E-03	5.9885E+02	7.8708E+03	5.3000E+02
266	176	4.1056E-01	5.5290E-01	6.3946E+03	4.9947E+02	7.4588E-03	6.0574E+02	7.8707E+03	5.3000E+02
267	177	4.1340E-01	5.5978E-01	6.3624E+03	4.9875E+02	7.4319E-03	6.1284E+02	7.8706E+03	5.3000E+02
268	178	4.1624E-01	5.6690E-01	6.3288E+03	4.9800E+02	7.4038E-03	6.2016E+02	7.8704E+03	5.3000E+02
269	179	4.1908E-01	5.7427E-01	6.2938E+03	4.9721E+02	7.3746E-03	6.2773E+02	7.8703E+03	5.3000E+02
270	180	4.2191E-01	5.8190E-01	6.2574E+03	4.9639E+02	7.3440E-03	6.3555E+02	7.8702E+03	5.3000E+02
271	181	4.2475E-01	5.8983E-01	6.2193E+03	4.9553E+02	7.3121E-03	6.4364E+02	7.8701E+03	5.3000E+02
272	182	4.2759E-01	5.9806E-01	6.1796E+03	4.9462E+02	7.2786E-03	6.5203E+02	7.8700E+03	5.3000E+02
273	183	4.3043E-01	6.0663E-01	6.1380E+03	4.9367E+02	7.2435E-03	6.6074E+02	7.8699E+03	5.3000E+02
274	184	4.3326E-01	6.1557E-01	6.0944E+03	4.9267E+02	7.2067E-03	6.6980E+02	7.8697E+03	5.3000E+02
275	185	4.3610E-01	6.2491E-01	6.0486E+03	4.9161E+02	7.1679E-03	6.7922E+02	7.8696E+03	5.3000E+02
276	186	4.3894E-01	6.3468E-01	6.0004E+03	4.9049E+02	7.1271E-03	6.8906E+02	7.8695E+03	5.3000E+02

277	187	4.4178E-01	6.4494E-01	5.9495E+03	4.8930E+02	7.0838E-03	6.9935E+02	7.8693E+03	5.3000E+02
278	188	4.4461E-01	6.5573E-01	5.8958E+03	4.8804E+02	7.0380E-03	7.1013E+02	7.8692E+03	5.3000E+02
279	189	4.4745E-01	6.6712E-01	5.8387E+03	4.8669E+02	6.9893E-03	7.2146E+02	7.8690E+03	5.3000E+02
280	190	4.5029E-01	6.7918E-01	5.7781E+03	4.8524E+02	6.9373E-03	7.3342E+02	7.8689E+03	5.3000E+02
281	191	4.5313E-01	6.9202E-01	5.7132E+03	4.8368E+02	6.8816E-03	7.4608E+02	7.8687E+03	5.3000E+02
282	192	4.5597E-01	7.0575E-01	5.6436E+03	4.8199E+02	6.8215E-03	7.5955E+02	7.8685E+03	5.3000E+02
283	193	4.5880E-01	7.2052E-01	5.5685E+03	4.8015E+02	6.7565E-03	7.7396E+02	7.8684E+03	5.3000E+02
284	194	4.6164E-01	7.3653E-01	5.4867E+03	4.7813E+02	6.6854E-03	7.8950E+02	7.8682E+03	5.3000E+02
285	195	4.6448E-01	7.5407E-01	5.3970E+03	4.7589E+02	6.6071E-03	8.0640E+02	7.8680E+03	5.3000E+02
286	196	4.6732E-01	7.7352E-01	5.2972E+03	4.7336E+02	6.5196E-03	8.2500E+02	7.8678E+03	5.3000E+02
287	197	4.7015E-01	7.9550E-01	5.1845E+03	4.7046E+02	6.4201E-03	8.4584E+02	7.8676E+03	5.3000E+02
288	198	4.7299E-01	8.2103E-01	5.0535E+03	4.6704E+02	6.3038E-03	8.6981E+02	7.8674E+03	5.3000E+02
289	199	4.7583E-01	8.5210E-01	4.8946E+03	4.6280E+02	6.1616E-03	8.9862E+02	7.8671E+03	5.3000E+02
290	200	4.7867E-01	8.9380E-01	4.6828E+03	4.5699E+02	5.9698E-03	9.3666E+02	7.8670E+03	5.3000E+02
291	201	4.8150E-01	1.0000E+00	4.1537E+03	4.4167E+02	5.4790E-03	1.0308E+03	7.8670E+03	5.3000E+02
292	202	4.8825E-01	1.1265E+00	3.5626E+03	4.2271E+02	4.9100E-03	1.1360E+03	7.8673E+03	5.3000E+02
293	203	4.9499E-01	1.1801E+00	3.3269E+03	4.1455E+02	4.6755E-03	1.1784E+03	7.8659E+03	5.3000E+02
294	204	5.0173E-01	1.2218E+00	3.1499E+03	4.0814E+02	4.4962E-03	1.2107E+03	7.8644E+03	5.3000E+02
295	205	5.0848E-01	1.2574E+00	3.0039E+03	4.0267E+02	4.3461E-03	1.2376E+03	7.8629E+03	5.3000E+02
296	206	5.1522E-01	1.2890E+00	2.8782E+03	3.9781E+02	4.2152E-03	1.2610E+03	7.8614E+03	5.3000E+02
297	207	5.2196E-01	1.3178E+00	2.7672E+03	3.9338E+02	4.0982E-03	1.2819E+03	7.8598E+03	5.3000E+02
298	208	5.2870E-01	1.3443E+00	2.6675E+03	3.8930E+02	3.9919E-03	1.3009E+03	7.8582E+03	5.3000E+02
299	209	5.3545E-01	1.3691E+00	2.5767E+03	3.8549E+02	3.8942E-03	1.3184E+03	7.8566E+03	5.3000E+02
300	210	5.4219E-01	1.3924E+00	2.4934E+03	3.8191E+02	3.8036E-03	1.3347E+03	7.8550E+03	5.3000E+02
301	211	5.4893E-01	1.4146E+00	2.4163E+03	3.7852E+02	3.7190E-03	1.3499E+03	7.8534E+03	5.3000E+02
302	212	5.5568E-01	1.4356E+00	2.3446E+03	3.7530E+02	3.6397E-03	1.3641E+03	7.8518E+03	5.3000E+02
303	213	5.6242E-01	1.4558E+00	2.2777E+03	3.7223E+02	3.5649E-03	1.3776E+03	7.8501E+03	5.3000E+02
304	214	5.6916E-01	1.4752E+00	2.2148E+03	3.6929E+02	3.4941E-03	1.3904E+03	7.8485E+03	5.3000E+02
305	215	5.7591E-01	1.4938E+00	2.1556E+03	3.6646E+02	3.4270E-03	1.4025E+03	7.8468E+03	5.3000E+02
306	216	5.8265E-01	1.5118E+00	2.0998E+03	3.6375E+02	3.3631E-03	1.4142E+03	7.8451E+03	5.3000E+02
307	217	5.8939E-01	1.5291E+00	2.0469E+03	3.6113E+02	3.3021E-03	1.4252E+03	7.8434E+03	5.3000E+02
308	218	5.9614E-01	1.5460E+00	1.9967E+03	3.5859E+02	3.2439E-03	1.4359E+03	7.8417E+03	5.3000E+02
309	219	6.0288E-01	1.5623E+00	1.9489E+03	3.5615E+02	3.1881E-03	1.4461E+03	7.8399E+03	5.3000E+02
310	220	6.0962E-01	1.5782E+00	1.9034E+03	3.5377E+02	3.1346E-03	1.4559E+03	7.8382E+03	5.3000E+02
311	221	6.1636E-01	1.5937E+00	1.8601E+03	3.5147E+02	3.0832E-03	1.4654E+03	7.8365E+03	5.3000E+02
312	222	6.2311E-01	1.6087E+00	1.8186E+03	3.4924E+02	3.0337E-03	1.4746E+03	7.8347E+03	5.3000E+02
313	223	6.2985E-01	1.6234E+00	1.7789E+03	3.4707E+02	2.9861E-03	1.4834E+03	7.8329E+03	5.3000E+02
314	224	6.3659E-01	1.6378E+00	1.7409E+03	3.4495E+02	2.9401E-03	1.4919E+03	7.8312E+03	5.3000E+02
315	225	6.4334E-01	1.6518E+00	1.7044E+03	3.4289E+02	2.8958E-03	1.5002E+03	7.8294E+03	5.3000E+02
316	226	6.5008E-01	1.6655E+00	1.6693E+03	3.4089E+02	2.8530E-03	1.5082E+03	7.8276E+03	5.3000E+02
317	227	6.5682E-01	1.6789E+00	1.6356E+03	3.3893E+02	2.8115E-03	1.5160E+03	7.8258E+03	5.3000E+02
318	228	6.6357E-01	1.6921E+00	1.6032E+03	3.3702E+02	2.7714E-03	1.5236E+03	7.8240E+03	5.3000E+02
319	229	6.7031E-01	1.7050E+00	1.5720E+03	3.3515E+02	2.7326E-03	1.5309E+03	7.8222E+03	5.3000E+02
320	230	6.7705E-01	1.7176E+00	1.5419E+03	3.3333E+02	2.6949E-03	1.5381E+03	7.8204E+03	5.3000E+02
321	231	6.8379E-01	1.7300E+00	1.5129E+03	3.3154E+02	2.6584E-03	1.5450E+03	7.8186E+03	5.3000E+02
322	232	6.9054E-01	1.7422E+00	1.4848E+03	3.2980E+02	2.6230E-03	1.5518E+03	7.8167E+03	5.3000E+02

323	233	6.9728E-01	1.7542E+00	1.4577E+03	3.2809E+02	2.5885E-03	1.5584E+03	7.8149E+03	5.3000E+02
324	234	7.0402E-01	1.7659E+00	1.4316E+03	3.2642E+02	2.5550E-03	1.5649E+03	7.8131E+03	5.3000E+02
325	235	7.1077E-01	1.7775E+00	1.4062E+03	3.2478E+02	2.5225E-03	1.5712E+03	7.8112E+03	5.3000E+02
326	236	7.1751E-01	1.7889E+00	1.3817E+03	3.2317E+02	2.4908E-03	1.5773E+03	7.8094E+03	5.3000E+02
327	237	7.2425E-01	1.8001E+00	1.3580E+03	3.2160E+02	2.4600E-03	1.5833E+03	7.8076E+03	5.3000E+02
328	238	7.3100E-01	1.8111E+00	1.3349E+03	3.2005E+02	2.4300E-03	1.5891E+03	7.8057E+03	5.3000E+02
329	239	7.3774E-01	1.8219E+00	1.3126E+03	3.1854E+02	2.4008E-03	1.5949E+03	7.8038E+03	5.3000E+02
330	240	7.4448E-01	1.8326E+00	1.2910E+03	3.1705E+02	2.3722E-03	1.6005E+03	7.8020E+03	5.3000E+02
331	241	7.5122E-01	1.8431E+00	1.2700E+03	3.1559E+02	2.3444E-03	1.6060E+03	7.8001E+03	5.3000E+02
332	242	7.5797E-01	1.8535E+00	1.2496E+03	3.1415E+02	2.3173E-03	1.6113E+03	7.7983E+03	5.3000E+02
333	243	7.6471E-01	1.8637E+00	1.2298E+03	3.1274E+02	2.2909E-03	1.6166E+03	7.7964E+03	5.3000E+02
334	244	7.7145E-01	1.8738E+00	1.2105E+03	3.1136E+02	2.2650E-03	1.6217E+03	7.7945E+03	5.3000E+02
335	245	7.7820E-01	1.8838E+00	1.1918E+03	3.0999E+02	2.2398E-03	1.6268E+03	7.7926E+03	5.3000E+02
336	246	7.8494E-01	1.8936E+00	1.1736E+03	3.0865E+02	2.2151E-03	1.6317E+03	7.7908E+03	5.3000E+02
337	247	7.9168E-01	1.9033E+00	1.1559E+03	3.0734E+02	2.1911E-03	1.6366E+03	7.7889E+03	5.3000E+02
338	248	7.9843E-01	1.9129E+00	1.1386E+03	3.0604E+02	2.1675E-03	1.6413E+03	7.7870E+03	5.3000E+02
339	249	8.0517E-01	1.9223E+00	1.1218E+03	3.0476E+02	2.1445E-03	1.6460E+03	7.7851E+03	5.3000E+02
340	250	8.1191E-01	1.9317E+00	1.1055E+03	3.0351E+02	2.1219E-03	1.6506E+03	7.7832E+03	5.3000E+02
341	251	8.1866E-01	1.9409E+00	1.0895E+03	3.0227E+02	2.0999E-03	1.6551E+03	7.7813E+03	5.3000E+02
342	252	8.2540E-01	1.9500E+00	1.0740E+03	3.0106E+02	2.0783E-03	1.6595E+03	7.7794E+03	5.3000E+02
343	253	8.3214E-01	1.9590E+00	1.0588E+03	2.9986E+02	2.0572E-03	1.6638E+03	7.7776E+03	5.3000E+02
344	254	8.3888E-01	1.9679E+00	1.0441E+03	2.9868E+02	2.0365E-03	1.6681E+03	7.7757E+03	5.3000E+02
345	255	8.4563E-01	1.9767E+00	1.0297E+03	2.9751E+02	2.0163E-03	1.6723E+03	7.7738E+03	5.3000E+02
346	256	8.5237E-01	1.9854E+00	1.0156E+03	2.9637E+02	1.9964E-03	1.6764E+03	7.7719E+03	5.3000E+02
347	257	8.5911E-01	1.9940E+00	1.0019E+03	2.9524E+02	1.9770E-03	1.6804E+03	7.7700E+03	5.3000E+02
348	258	8.6586E-01	2.0025E+00	9.8845E+02	2.9412E+02	1.9579E-03	1.6844E+03	7.7681E+03	5.3000E+02
349	259	8.7260E-01	2.0109E+00	9.7536E+02	2.9303E+02	1.9392E-03	1.6883E+03	7.7662E+03	5.3000E+02
350	260	8.7934E-01	2.0192E+00	9.6257E+02	2.9194E+02	1.9209E-03	1.6922E+03	7.7643E+03	5.3000E+02
351	261	8.8609E-01	2.0274E+00	9.5007E+02	2.9088E+02	1.9029E-03	1.6960E+03	7.7624E+03	5.3000E+02
352	262	8.9283E-01	2.0356E+00	9.3785E+02	2.8982E+02	1.8852E-03	1.6997E+03	7.7605E+03	5.3000E+02
353	263	8.9957E-01	2.0437E+00	9.2590E+02	2.8878E+02	1.8679E-03	1.7034E+03	7.7586E+03	5.3000E+02
354	264	9.0631E-01	2.0516E+00	9.1422E+02	2.8776E+02	1.8509E-03	1.7070E+03	7.7566E+03	5.3000E+02
355	265	9.1306E-01	2.0595E+00	9.0280E+02	2.8675E+02	1.8342E-03	1.7106E+03	7.7547E+03	5.3000E+02
356	266	9.1980E-01	2.0674E+00	8.9162E+02	2.8575E+02	1.8179E-03	1.7141E+03	7.7528E+03	5.3000E+02
357	267	9.2654E-01	2.0751E+00	8.8068E+02	2.8476E+02	1.8018E-03	1.7175E+03	7.7509E+03	5.3000E+02
358	268	9.3329E-01	2.0828E+00	8.6998E+02	2.8379E+02	1.7860E-03	1.7209E+03	7.7490E+03	5.3000E+02
359	269	9.4003E-01	2.0904E+00	8.5950E+02	2.8283E+02	1.7705E-03	1.7243E+03	7.7471E+03	5.3000E+02
360	270	9.4677E-01	2.0979E+00	8.4923E+02	2.8188E+02	1.7552E-03	1.7276E+03	7.7452E+03	5.3000E+02
361	271	9.5352E-01	2.1054E+00	8.3918E+02	2.8094E+02	1.7402E-03	1.7308E+03	7.7433E+03	5.3000E+02
362	272	9.6026E-01	2.1128E+00	8.2934E+02	2.8001E+02	1.7255E-03	1.7341E+03	7.7414E+03	5.3000E+02
363	273	9.6700E-01	2.1201E+00	8.1969E+02	2.7910E+02	1.7110E-03	1.7372E+03	7.7395E+03	5.3000E+02
364	274	9.7374E-01	2.1274E+00	8.1024E+02	2.7820E+02	1.6968E-03	1.7404E+03	7.7376E+03	5.3000E+02
365	275	9.8049E-01	2.1346E+00	8.0098E+02	2.7730E+02	1.6828E-03	1.7434E+03	7.7357E+03	5.3000E+02
366	276	9.8723E-01	2.1417E+00	7.9189E+02	2.7642E+02	1.6690E-03	1.7465E+03	7.7337E+03	5.3000E+02
367	277	9.9397E-01	2.1488E+00	7.8299E+02	2.7555E+02	1.6555E-03	1.7495E+03	7.7318E+03	5.3000E+02
368	278	1.0007E+00	2.1558E+00	7.7426E+02	2.7469E+02	1.6421E-03	1.7524E+03	7.7299E+03	5.3000E+02

369	279	1.0075E+00	2.1628E+00	7.6569E+02	2.7383E+02	1.6290E-03	1.7554E+03	7.7280E+03	5.3000E+02
370	280	1.0142E+00	2.1696E+00	7.5729E+02	2.7299E+02	1.6161E-03	1.7582E+03	7.7261E+03	5.3000E+02
371	281	1.0209E+00	2.1765E+00	7.4905E+02	2.7216E+02	1.6034E-03	1.7611E+03	7.7242E+03	5.3000E+02
372	282	1.0277E+00	2.1833E+00	7.4096E+02	2.7133E+02	1.5909E-03	1.7639E+03	7.7223E+03	5.3000E+02
373	283	1.0344E+00	2.1900E+00	7.3302E+02	2.7052E+02	1.5786E-03	1.7667E+03	7.7204E+03	5.3000E+02
374	284	1.0412E+00	2.1967E+00	7.2523E+02	2.6971E+02	1.5665E-03	1.7694E+03	7.7185E+03	5.3000E+02
375	285	1.0479E+00	2.2033E+00	7.1758E+02	2.6892E+02	1.5546E-03	1.7721E+03	7.7166E+03	5.3000E+02
376	286	1.0547E+00	2.2098E+00	7.1007E+02	2.6813E+02	1.5428E-03	1.7748E+03	7.7146E+03	5.3000E+02
377	287	1.0614E+00	2.2164E+00	7.0270E+02	2.6735E+02	1.5313E-03	1.7774E+03	7.7127E+03	5.3000E+02
378	288	1.0681E+00	2.2228E+00	6.9545E+02	2.6658E+02	1.5199E-03	1.7800E+03	7.7108E+03	5.3000E+02
379	289	1.0749E+00	2.2292E+00	6.8834E+02	2.6581E+02	1.5086E-03	1.7826E+03	7.7089E+03	5.3000E+02
380	290	1.0816E+00	2.2356E+00	6.8135E+02	2.6506E+02	1.4976E-03	1.7852E+03	7.7070E+03	5.3000E+02
381	291	1.0884E+00	2.2419E+00	6.7448E+02	2.6431E+02	1.4867E-03	1.7877E+03	7.7051E+03	5.3000E+02
382	292	1.0951E+00	2.2482E+00	6.6773E+02	2.6357E+02	1.4759E-03	1.7902E+03	7.7032E+03	5.3000E+02
383	293	1.1019E+00	2.2544E+00	6.6109E+02	2.6284E+02	1.4653E-03	1.7926E+03	7.7013E+03	5.3000E+02
384	294	1.1086E+00	2.2606E+00	6.5457E+02	2.6211E+02	1.4549E-03	1.7951E+03	7.6994E+03	5.3000E+02
385	295	1.1153E+00	2.2667E+00	6.4816E+02	2.6140E+02	1.4446E-03	1.7975E+03	7.6975E+03	5.3000E+02
386	296	1.1221E+00	2.2728E+00	6.4186E+02	2.6069E+02	1.4344E-03	1.7998E+03	7.6956E+03	5.3000E+02
387	297	1.1288E+00	2.2788E+00	6.3566E+02	2.5998E+02	1.4244E-03	1.8022E+03	7.6937E+03	5.3000E+02
388	298	1.1356E+00	2.2848E+00	6.2956E+02	2.5929E+02	1.4146E-03	1.8045E+03	7.6918E+03	5.3000E+02
389	299	1.1423E+00	2.2908E+00	6.2357E+02	2.5860E+02	1.4048E-03	1.8068E+03	7.6899E+03	5.3000E+02
390	300	1.1491E+00	2.2967E+00	6.1767E+02	2.5791E+02	1.3952E-03	1.8091E+03	7.6880E+03	5.3000E+02
391	301	1.1558E+00	2.3026E+00	6.1186E+02	2.5724E+02	1.3857E-03	1.8113E+03	7.6861E+03	5.3000E+02
392	302	1.1626E+00	2.3084E+00	6.0616E+02	2.5657E+02	1.3764E-03	1.8136E+03	7.6842E+03	5.3000E+02
393	303	1.1693E+00	2.3142E+00	6.0054E+02	2.5590E+02	1.3672E-03	1.8158E+03	7.6822E+03	5.3000E+02
394	304	1.1761E+00	2.3200E+00	5.9501E+02	2.5525E+02	1.3581E-03	1.8179E+03	7.6803E+03	5.3000E+02
395	305	1.1828E+00	2.3257E+00	5.8957E+02	2.5460E+02	1.3491E-03	1.8201E+03	7.6784E+03	5.3000E+02
396	306	1.1896E+00	2.3314E+00	5.8421E+02	2.5395E+02	1.3402E-03	1.8222E+03	7.6765E+03	5.3000E+02
397	307	1.1963E+00	2.3370E+00	5.7894E+02	2.5331E+02	1.3315E-03	1.8243E+03	7.6746E+03	5.3000E+02
398	308	1.2031E+00	2.3426E+00	5.7375E+02	2.5268E+02	1.3229E-03	1.8264E+03	7.6727E+03	5.3000E+02
399	309	1.2098E+00	2.3482E+00	5.6864E+02	2.5205E+02	1.3143E-03	1.8285E+03	7.6708E+03	5.3000E+02
400	310	1.2166E+00	2.3537E+00	5.6360E+02	2.5143E+02	1.3059E-03	1.8305E+03	7.6689E+03	5.3000E+02
401	311	1.2233E+00	2.3592E+00	5.5864E+02	2.5081E+02	1.2976E-03	1.8325E+03	7.6670E+03	5.3000E+02
402	312	1.2301E+00	2.3646E+00	5.5376E+02	2.5020E+02	1.2894E-03	1.8345E+03	7.6651E+03	5.3000E+02
403	313	1.2368E+00	2.3701E+00	5.4895E+02	2.4960E+02	1.2813E-03	1.8365E+03	7.6633E+03	5.3000E+02
404	314	1.2436E+00	2.3755E+00	5.4421E+02	2.4900E+02	1.2733E-03	1.8385E+03	7.6614E+03	5.3000E+02
405	315	1.2503E+00	2.3808E+00	5.3954E+02	2.4840E+02	1.2654E-03	1.8404E+03	7.6595E+03	5.3000E+02
406	316	1.2571E+00	2.3861E+00	5.3494E+02	2.4781E+02	1.2576E-03	1.8424E+03	7.6576E+03	5.3000E+02
407	317	1.2639E+00	2.3914E+00	5.3041E+02	2.4723E+02	1.2499E-03	1.8443E+03	7.6557E+03	5.3000E+02
408	318	1.2706E+00	2.3967E+00	5.2594E+02	2.4665E+02	1.2423E-03	1.8462E+03	7.6538E+03	5.3000E+02
409	319	1.2774E+00	2.4019E+00	5.2154E+02	2.4607E+02	1.2348E-03	1.8480E+03	7.6519E+03	5.3000E+02
410	320	1.2841E+00	2.4071E+00	5.1720E+02	2.4551E+02	1.2273E-03	1.8499E+03	7.6500E+03	5.3000E+02
411	321	1.2909E+00	2.4123E+00	5.1292E+02	2.4494E+02	1.2200E-03	1.8517E+03	7.6481E+03	5.3000E+02
412	322	1.2976E+00	2.4174E+00	5.0870E+02	2.4438E+02	1.2127E-03	1.8535E+03	7.6462E+03	5.3000E+02
413	323	1.3044E+00	2.4225E+00	5.0454E+02	2.4383E+02	1.2055E-03	1.8553E+03	7.6443E+03	5.3000E+02
414	324	1.3111E+00	2.4276E+00	5.0044E+02	2.4327E+02	1.1985E-03	1.8571E+03	7.6425E+03	5.3000E+02

415	325	1.3179E+00	2.4326E+00	4.9640E+02	2.4273E+02	1.1914E-03	1.8589E+03	7.6406E+03	5.3000E+02
416	326	1.3246E+00	2.4376E+00	4.9241E+02	2.4219E+02	1.1845E-03	1.8606E+03	7.6387E+03	5.3000E+02
417	327	1.3314E+00	2.4426E+00	4.8848E+02	2.4165E+02	1.1777E-03	1.8624E+03	7.6368E+03	5.3000E+02
418	328	1.3381E+00	2.4476E+00	4.8460E+02	2.4112E+02	1.1709E-03	1.8641E+03	7.6349E+03	5.3000E+02
419	329	1.3449E+00	2.4525E+00	4.8077E+02	2.4059E+02	1.1642E-03	1.8658E+03	7.6330E+03	5.3000E+02
420	330	1.3516E+00	2.4574E+00	4.7700E+02	2.4006E+02	1.1576E-03	1.8675E+03	7.6311E+03	5.3000E+02
421	331	1.3584E+00	2.4623E+00	4.7327E+02	2.3954E+02	1.1510E-03	1.8692E+03	7.6293E+03	5.3000E+02
422	332	1.3651E+00	2.4671E+00	4.6960E+02	2.3903E+02	1.1446E-03	1.8708E+03	7.6274E+03	5.3000E+02
423	333	1.3719E+00	2.4719E+00	4.6597E+02	2.3852E+02	1.1382E-03	1.8725E+03	7.6255E+03	5.3000E+02
424	334	1.3787E+00	2.4767E+00	4.6239E+02	2.3801E+02	1.1318E-03	1.8741E+03	7.6236E+03	5.3000E+02
425	335	1.3854E+00	2.4815E+00	4.5886E+02	2.3750E+02	1.1256E-03	1.8757E+03	7.6218E+03	5.3000E+02
426	336	1.3922E+00	2.4862E+00	4.5538E+02	2.3700E+02	1.1194E-03	1.8773E+03	7.6199E+03	5.3000E+02
427	337	1.3989E+00	2.4910E+00	4.5194E+02	2.3651E+02	1.1133E-03	1.8789E+03	7.6180E+03	5.3000E+02
428	338	1.4057E+00	2.4956E+00	4.4854E+02	2.3601E+02	1.1072E-03	1.8805E+03	7.6161E+03	5.3000E+02
429	339	1.4124E+00	2.5003E+00	4.4519E+02	2.3553E+02	1.1012E-03	1.8820E+03	7.6143E+03	5.3000E+02
430	340	1.4192E+00	2.5049E+00	4.4188E+02	2.3504E+02	1.0953E-03	1.8836E+03	7.6124E+03	5.3000E+02
431	341	1.4259E+00	2.5096E+00	4.3861E+02	2.3456E+02	1.0894E-03	1.8851E+03	7.6105E+03	5.3000E+02
432	342	1.4327E+00	2.5141E+00	4.3539E+02	2.3408E+02	1.0836E-03	1.8867E+03	7.6086E+03	5.3000E+02
433	343	1.4394E+00	2.5187E+00	4.3220E+02	2.3361E+02	1.0779E-03	1.8882E+03	7.6068E+03	5.3000E+02
434	344	1.4462E+00	2.5233E+00	4.2906E+02	2.3314E+02	1.0722E-03	1.8897E+03	7.6049E+03	5.3000E+02
435	345	1.4529E+00	2.5278E+00	4.2595E+02	2.3267E+02	1.0666E-03	1.8911E+03	7.6030E+03	5.3000E+02
436	346	1.4597E+00	2.5323E+00	4.2288E+02	2.3221E+02	1.0610E-03	1.8926E+03	7.6012E+03	5.3000E+02
437	347	1.4664E+00	2.5367E+00	4.1985E+02	2.3175E+02	1.0555E-03	1.8941E+03	7.5993E+03	5.3000E+02
438	348	1.4732E+00	2.5412E+00	4.1686E+02	2.3129E+02	1.0500E-03	1.8955E+03	7.5974E+03	5.3000E+02
439	349	1.4799E+00	2.5456E+00	4.1390E+02	2.3083E+02	1.0446E-03	1.8970E+03	7.5956E+03	5.3000E+02
440	350	1.4867E+00	2.5500E+00	4.1098E+02	2.3038E+02	1.0393E-03	1.8984E+03	7.5937E+03	5.3000E+02
441	351	1.4935E+00	2.5544E+00	4.0810E+02	2.2994E+02	1.0340E-03	1.8998E+03	7.5918E+03	5.3000E+02
442	352	1.5002E+00	2.5588E+00	4.0524E+02	2.2949E+02	1.0288E-03	1.9012E+03	7.5900E+03	5.3000E+02
443	353	1.5070E+00	2.5631E+00	4.0243E+02	2.2905E+02	1.0236E-03	1.9026E+03	7.5881E+03	5.3000E+02
444	354	1.5137E+00	2.5674E+00	3.9964E+02	2.2861E+02	1.0184E-03	1.9040E+03	7.5863E+03	5.3000E+02
445	355	1.5205E+00	2.5717E+00	3.9689E+02	2.2818E+02	1.0133E-03	1.9054E+03	7.5844E+03	5.3000E+02
446	356	1.5272E+00	2.5760E+00	3.9417E+02	2.2775E+02	1.0083E-03	1.9067E+03	7.5826E+03	5.3000E+02
447	357	1.5340E+00	2.5803E+00	3.9149E+02	2.2732E+02	1.0033E-03	1.9081E+03	7.5807E+03	5.3000E+02
448	358	1.5407E+00	2.5845E+00	3.8883E+02	2.2689E+02	9.9840E-04	1.9094E+03	7.5788E+03	5.3000E+02
449	359	1.5475E+00	2.5887E+00	3.8621E+02	2.2647E+02	9.9351E-04	1.9108E+03	7.5770E+03	5.3000E+02
450	360	1.5542E+00	2.5929E+00	3.8361E+02	2.2605E+02	9.8867E-04	1.9121E+03	7.5751E+03	5.3000E+02
451	361	1.5610E+00	2.5971E+00	3.8105E+02	2.2563E+02	9.8387E-04	1.9134E+03	7.5733E+03	5.3000E+02
452	362	1.5677E+00	2.6012E+00	3.7851E+02	2.2522E+02	9.7913E-04	1.9147E+03	7.5714E+03	5.3000E+02
453	363	1.5745E+00	2.6054E+00	3.7601E+02	2.2481E+02	9.7442E-04	1.9160E+03	7.5696E+03	5.3000E+02
454	364	1.5812E+00	2.6095E+00	3.7353E+02	2.2440E+02	9.6976E-04	1.9173E+03	7.5677E+03	5.3000E+02
455	365	1.5880E+00	2.6136E+00	3.7108E+02	2.2399E+02	9.6515E-04	1.9185E+03	7.5659E+03	5.3000E+02
456	366	1.5947E+00	2.6177E+00	3.6866E+02	2.2359E+02	9.6058E-04	1.9198E+03	7.5640E+03	5.3000E+02
457	367	1.6015E+00	2.6217E+00	3.6626E+02	2.2319E+02	9.5605E-04	1.9211E+03	7.5622E+03	5.3000E+02
458	368	1.6083E+00	2.6258E+00	3.6389E+02	2.2279E+02	9.5156E-04	1.9223E+03	7.5603E+03	5.3000E+02
459	369	1.6150E+00	2.6298E+00	3.6155E+02	2.2240E+02	9.4711E-04	1.9235E+03	7.5585E+03	5.3000E+02
460	370	1.6218E+00	2.6338E+00	3.5923E+02	2.2200E+02	9.4271E-04	1.9248E+03	7.5567E+03	5.3000E+02

371	1.6285E+00	2.6378E+00	3.5694E+02	2.2161E+02	9.3834E-04	1.9260E+03	7.5548E+03	5.3000E+02
372	1.6353E+00	2.6417E+00	3.5467E+02	2.2123E+02	9.3402E-04	1.9272E+03	7.5530E+03	5.3000E+02
373	1.6420E+00	2.6457E+00	3.5243E+02	2.2084E+02	9.2973E-04	1.9284E+03	7.5511E+03	5.3000E+02
374	1.6488E+00	2.6496E+00	3.5021E+02	2.2046E+02	9.2548E-04	1.9296E+03	7.5493E+03	5.3000E+02
375	1.6555E+00	2.6535E+00	3.4802E+02	2.2008E+02	9.2128E-04	1.9308E+03	7.5475E+03	5.3000E+02
376	1.6623E+00	2.6574E+00	3.4585E+02	2.1970E+02	9.1710E-04	1.9320E+03	7.5456E+03	5.3000E+02
377	1.6690E+00	2.6613E+00	3.4370E+02	2.1933E+02	9.1297E-04	1.9331E+03	7.5438E+03	5.3000E+02
378	1.6758E+00	2.6652E+00	3.4158E+02	2.1895E+02	9.0887E-04	1.9343E+03	7.5420E+03	5.3000E+02
379	1.6825E+00	2.6690E+00	3.3947E+02	2.1858E+02	9.0481E-04	1.9354E+03	7.5401E+03	5.3000E+02
380	1.6893E+00	2.6729E+00	3.3739E+02	2.1821E+02	9.0078E-04	1.9366E+03	7.5383E+03	5.3000E+02
381	1.6960E+00	2.6767E+00	3.3534E+02	2.1785E+02	8.9679E-04	1.9377E+03	7.5365E+03	5.3000E+02
382	1.7028E+00	2.6805E+00	3.3330E+02	2.1748E+02	8.9284E-04	1.9388E+03	7.5347E+03	5.3000E+02
383	1.7095E+00	2.6843E+00	3.3128E+02	2.1712E+02	8.8891E-04	1.9400E+03	7.5328E+03	5.3000E+02
384	1.7163E+00	2.6880E+00	3.2929E+02	2.1676E+02	8.8503E-04	1.9411E+03	7.5310E+03	5.3000E+02
385	1.7231E+00	2.6918E+00	3.2731E+02	2.1641E+02	8.8117E-04	1.9422E+03	7.5292E+03	5.3000E+02
386	1.7298E+00	2.6955E+00	3.2536E+02	2.1605E+02	8.7735E-04	1.9433E+03	7.5273E+03	5.3000E+02
387	1.7366E+00	2.6992E+00	3.2343E+02	2.1570E+02	8.7356E-04	1.9444E+03	7.5255E+03	5.3000E+02
388	1.7433E+00	2.7029E+00	3.2151E+02	2.1535E+02	8.6980E-04	1.9455E+03	7.5237E+03	5.3000E+02
389	1.7501E+00	2.7066E+00	3.1962E+02	2.1500E+02	8.6608E-04	1.9465E+03	7.5219E+03	5.3000E+02
390	1.7568E+00	2.7103E+00	3.1774E+02	2.1465E+02	8.6239E-04	1.9476E+03	7.5200E+03	5.3000E+02
391	1.7636E+00	2.7140E+00	3.1588E+02	2.1431E+02	8.5872E-04	1.9487E+03	7.5182E+03	5.3000E+02
392	1.7703E+00	2.7176E+00	3.1405E+02	2.1397E+02	8.5509E-04	1.9497E+03	7.5164E+03	5.3000E+02
393	1.7771E+00	2.7212E+00	3.1223E+02	2.1362E+02	8.5149E-04	1.9508E+03	7.5146E+03	5.3000E+02
394	1.7838E+00	2.7248E+00	3.1042E+02	2.1329E+02	8.4792E-04	1.9518E+03	7.5128E+03	5.3000E+02
395	1.7906E+00	2.7284E+00	3.0864E+02	2.1295E+02	8.4437E-04	1.9529E+03	7.5109E+03	5.3000E+02
396	1.7973E+00	2.7320E+00	3.0687E+02	2.1262E+02	8.4086E-04	1.9539E+03	7.5091E+03	5.3000E+02
397	1.8041E+00	2.7356E+00	3.0512E+02	2.1228E+02	8.3738E-04	1.9549E+03	7.5073E+03	5.3000E+02
398	1.8108E+00	2.7391E+00	3.0339E+02	2.1195E+02	8.3392E-04	1.9559E+03	7.5055E+03	5.3000E+02
399	1.8176E+00	2.7427E+00	3.0167E+02	2.1162E+02	8.3049E-04	1.9569E+03	7.5037E+03	5.3000E+02
400	1.8243E+00	2.7462E+00	2.9997E+02	2.1130E+02	8.2709E-04	1.9579E+03	7.5019E+03	5.3000E+02
401	1.8311E+00	2.7497E+00	2.9829E+02	2.1097E+02	8.2372E-04	1.9589E+03	7.5001E+03	5.3000E+02

nozzle pressure ratio (NPR) 2.7136E+01

nozzle area ratio (a9/a8) 3.5000E+00

flow station number	7	8	9
flow area (ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number	3.055E-01	1.000E+00	2.750E+00
pressure (lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02

```
             temperature  (R)               5.203E+02  4.417E+02  2.110E+02

                 density  (slg/ft**3)       8.266E-03  5.479E-03  8.237E-04

                velocity  (ft/s)            3.416E+02  1.031E+03  1.959E+03

          total pressure  (lbf/ft**2)       7.876E+03  7.867E+03  7.500E+03

       total temperature  (R)               5.300E+02  5.300E+02  5.300E+02

               mass flux  (lbm/s)           3.496E+01  3.496E+01  3.496E+01

           momentum flux  (lbf)             3.712E+02  1.120E+03  2.129E+03

           pressure*area  (lbf)             2.729E+03  7.433E+02  5.423E+00


segment: surface i      momentum flux     pressure*area       shear*area

    1                     0.000E+00         0.000E+00         -4.207E-01
    2                     0.000E+00        -1.235E+03         -1.214E+00
    3                     0.000E+00         2.517E+02         -6.096E+00
    4                     0.000E+00         3.199E+01         -3.617E+00

segment: surface j      momentum flux     pressure*area       shear*area

    1                     0.000E+00         0.000E+00          0.000E+00
    2                     0.000E+00         0.000E+00          0.000E+00
    3                     0.000E+00         0.000E+00          0.000E+00
    4                     0.000E+00         0.000E+00          0.000E+00

segment: surface k      momentum flux     pressure*area       shear*area

    1                     0.000E+00         0.000E+00         -1.317E-01
    2                     0.000E+00         0.000E+00         -2.666E-01
    3                     0.000E+00         0.000E+00         -1.560E+00
    4                     0.000E+00         0.000E+00         -1.707E+00


       divergence factor                     .9917

     nozzle gross thrust  (lbf)             2.116E+03

      ideal gross thrust  (lbf)             2.145E+03

      thrust coefficient                     .9866
```

NPAC   2-D Test Model Nozzle

nozzle pressure ratio (NPR)	4.0000E+01
nozzle area ratio (a9/a8)	3.5000E+00

flow station number		7	8	9
flow area	(ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number		3.055E-01	1.000E+00	2.750E+00
pressure	(lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02
temperature	(R)	5.203E+02	4.417E+02	2.110E+02
density	(slg/ft**3)	8.266E-03	5.479E-03	8.237E-04
velocity	(ft/s)	3.416E+02	1.031E+03	1.959E+03
total pressure	(lbf/ft**2)	7.876E+03	7.867E+03	7.500E+03
total temperature	(R)	5.300E+02	5.300E+02	5.300E+02
mass flux	(lbm/s)	3.496E+01	3.496E+01	3.496E+01
momentum flux	(lbf)	3.712E+02	1.120E+03	2.129E+03
pressure*area	(lbf)	2.765E+03	7.613E+02	6.828E+01

divergence factor		.9917
nozzle gross thrust	(lbf)	2.179E+03
ideal gross thrust	(lbf)	2.216E+03
thrust coefficient		.9836

NPAC 2-D Test Model Nozzle

nozzle pressure ratio (NPR)		3.5000E+01		
nozzle area ratio (a9/a8)		3.5000E+00		
flow station number		7	8	9
flow area	(ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number		3.055E-01	1.000E+00	2.750E+00
pressure	(lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02
temperature	(R)	5.203E+02	4.417E+02	2.110E+02
density	(slg/ft**3)	8.266E-03	5.479E-03	8.237E-04
velocity	(ft/s)	3.416E+02	1.031E+03	1.959E+03
total pressure	(lbf/ft**2)	7.876E+03	7.867E+03	7.500E+03
total temperature	(R)	5.300E+02	5.300E+02	5.300E+02
mass flux	(lbm/s)	3.496E+01	3.496E+01	3.496E+01
momentum flux	(lbf)	3.712E+02	1.120E+03	2.129E+03
pressure*area	(lbf)	2.754E+03	7.559E+02	4.933E+01

divergence factor		.9917
nozzle gross thrust	(lbf)	2.160E+03
ideal gross thrust	(lbf)	2.193E+03
thrust coefficient		.9853

NPAC 2-D Test Model Nozzle

nozzle pressure ratio (NPR)	3.0000E+01
nozzle area ratio (a9/a8)	3.5000E+00

flow station number		7	8	9
flow area	(ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number		3.055E-01	1.000E+00	2.750E+00
pressure	(lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02
temperature	(R)	5.203E+02	4.417E+02	2.110E+02
density	(slg/ft**3)	8.266E-03	5.479E-03	8.237E-04
velocity	(ft/s)	3.416E+02	1.031E+03	1.959E+03
total pressure	(lbf/ft**2)	7.876E+03	7.867E+03	7.500E+03
total temperature	(R)	5.300E+02	5.300E+02	5.300E+02
mass flux	(lbm/s)	3.496E+01	3.496E+01	3.496E+01
momentum flux	(lbf)	3.712E+02	1.120E+03	2.129E+03
pressure*area	(lbf)	2.740E+03	7.486E+02	2.408E+01

divergence factor		.9917
nozzle gross thrust	(lbf)	2.135E+03
ideal gross thrust	(lbf)	2.164E+03
thrust coefficient		.9865

NPAC 2-D Test Model Nozzle

nozzle pressure ratio (NPR)	2.5000E+01
nozzle area ratio (a9/a8)	3.5000E+00

flow station number		7	8	9
flow area	(ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number		3.055E-01	1.000E+00	2.750E+00
pressure	(lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02
temperature	(R)	5.203E+02	4.417E+02	2.110E+02
density	(slg/ft**3)	8.266E-03	5.479E-03	8.237E-04
velocity	(ft/s)	3.416E+02	1.031E+03	1.959E+03
total pressure	(lbf/ft**2)	7.876E+03	7.867E+03	7.500E+03
total temperature	(R)	5.300E+02	5.300E+02	5.300E+02
mass flux	(lbm/s)	3.496E+01	3.496E+01	3.496E+01
momentum flux	(lbf)	3.712E+02	1.120E+03	2.129E+03
pressure*area	(lbf)	2.719E+03	7.385E+02	-1.128E+01

divergence factor		.9917
nozzle gross thrust	(lbf)	2.100E+03
ideal gross thrust	(lbf)	2.129E+03
thrust coefficient		.9863

NPAC 2-D Test Model Nozzle

nozzle pressure ratio (NPR)	2.0000E+01
nozzle area ratio (a9/a8)	3.5000E+00

flow station number		7	8	9
flow area	(ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number		3.055E-01	1.000E+00	2.750E+00
pressure	(lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02
temperature	(R)	5.203E+02	4.417E+02	2.110E+02
density	(slg/ft**3)	8.266E-03	5.479E-03	8.237E-04
velocity	(ft/s)	3.416E+02	1.031E+03	1.959E+03
total pressure	(lbf/ft**2)	7.876E+03	7.867E+03	7.500E+03
total temperature	(R)	5.300E+02	5.300E+02	5.300E+02
mass flux	(lbm/s)	3.496E+01	3.496E+01	3.496E+01
momentum flux	(lbf)	3.712E+02	1.120E+03	2.129E+03
pressure*area	(lbf)	2.689E+03	7.234E+02	-6.431E+01

divergence factor		.9917
nozzle gross thrust	(lbf)	2.047E+03
ideal gross thrust	(lbf)	2.082E+03
thrust coefficient		.9831

NPAC 2-D Test Model Nozzle

nozzle pressure ratio (NPR)		1.5000E+01		
nozzle area ratio (a9/a8)		3.5000E+00		
flow station number		7	8	9
flow area	(ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number		3.055E-01	1.000E+00	2.750E+00
pressure	(lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02
temperature	(R)	5.203E+02	4.417E+02	2.110E+02
density	(slg/ft**3)	8.266E-03	5.479E-03	8.237E-04
velocity	(ft/s)	3.416E+02	1.031E+03	1.959E+03
total pressure	(lbf/ft**2)	7.876E+03	7.867E+03	7.500E+03
total temperature	(R)	5.300E+02	5.300E+02	5.300E+02
mass flux	(lbm/s)	3.496E+01	3.496E+01	3.496E+01
momentum flux	(lbf)	3.712E+02	1.120E+03	2.129E+03
pressure*area	(lbf)	2.639E+03	6.981E+02	-1.527E+02
divergence factor		.9917		
nozzle gross thrust	(lbf)	1.958E+03		
ideal gross thrust	(lbf)	2.015E+03		
thrust coefficient		.9719		

NPAC 2-D Test Model Nozzle

nozzle pressure ratio (NPR) 1.0000E+01

nozzle area ratio (a9/a8) 3.5000E+00

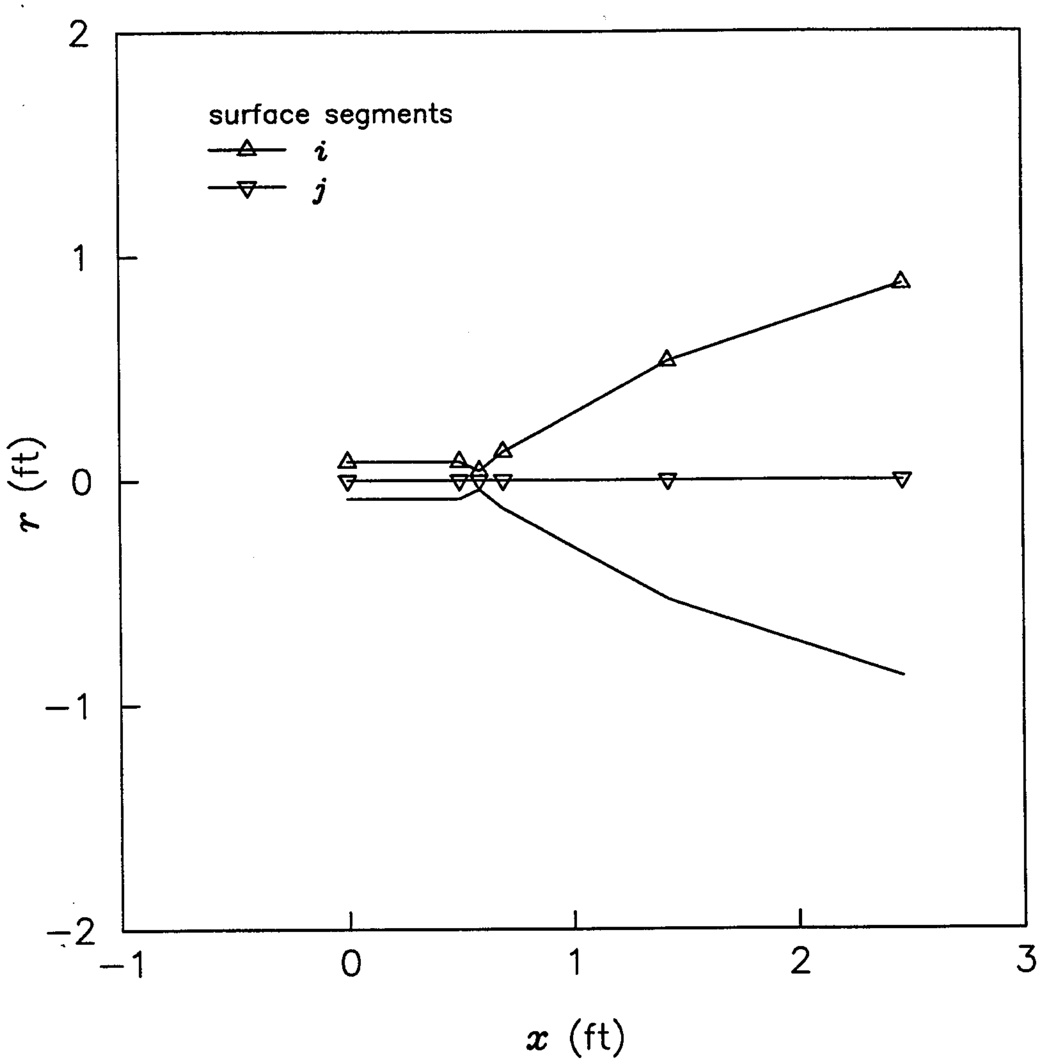
flow station number		7	8	9
flow area	(ft**2)	3.848E-01	1.924E-01	6.734E-01
Mach number		3.055E-01	1.000E+00	2.750E+00
pressure	(lbf/ft**2)	7.382E+03	4.154E+03	2.983E+02
temperature	(R)	5.203E+02	4.417E+02	2.110E+02
density	(slg/ft**3)	8.266E-03	5.479E-03	8.237E-04
velocity	(ft/s)	3.416E+02	1.031E+03	1.959E+03
total pressure	(lbf/ft**2)	7.876E+03	7.867E+03	7.500E+03
total temperature	(R)	5.300E+02	5.300E+02	5.300E+02
mass flux	(lbm/s)	3.496E+01	3.496E+01	3.496E+01
momentum flux	(lbf)	3.712E+02	1.120E+03	2.129E+03
pressure*area	(lbf)	2.538E+03	6.476E+02	-3.295E+02

divergence factor		.9917
nozzle gross thrust	(lbf)	1.781E+03
ideal gross thrust	(lbf)	1.906E+03
thrust coefficient		.9347

Appendix III

Axisymmetric Rocket Nozzle

Example Case



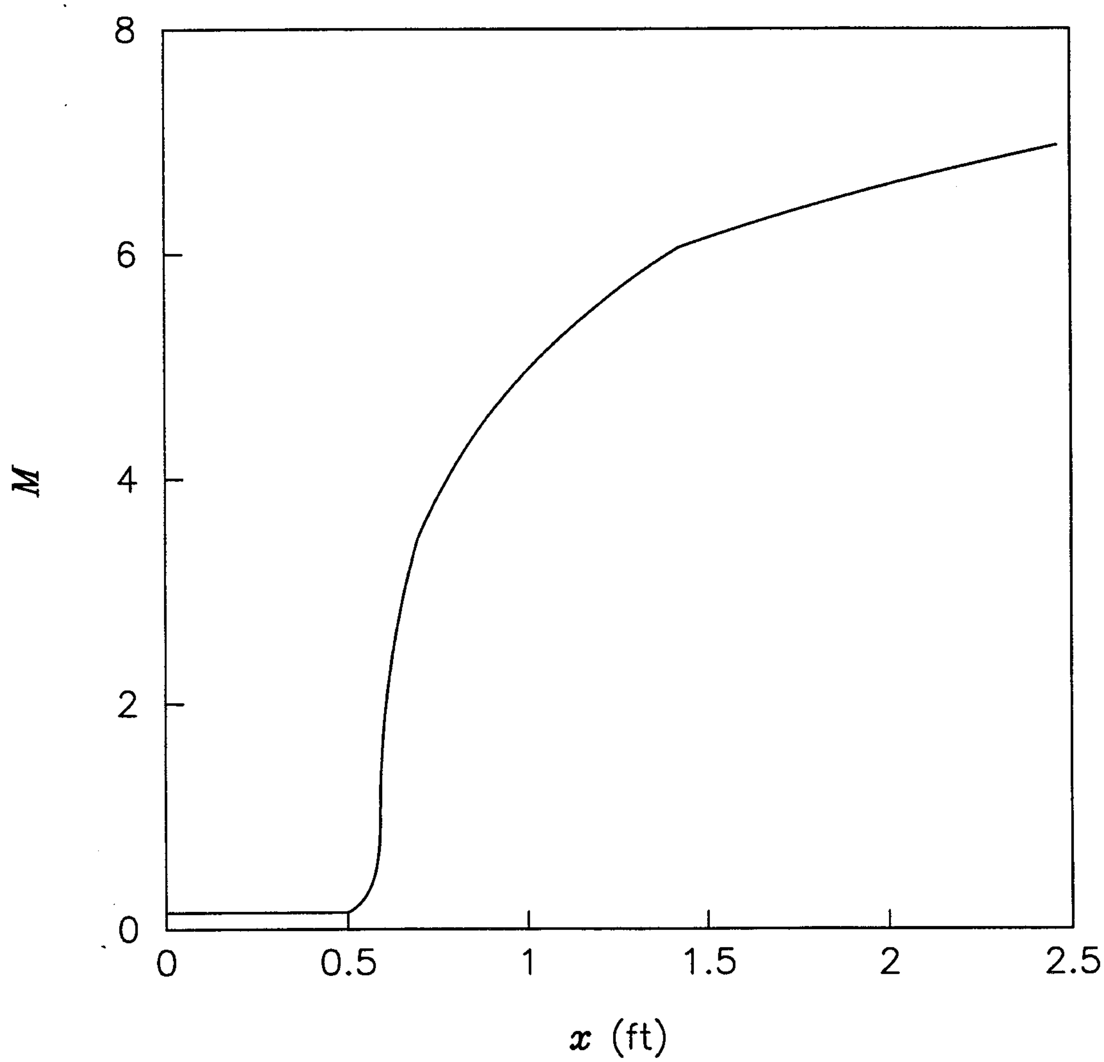


Figure III.1 Mach Number Distribution

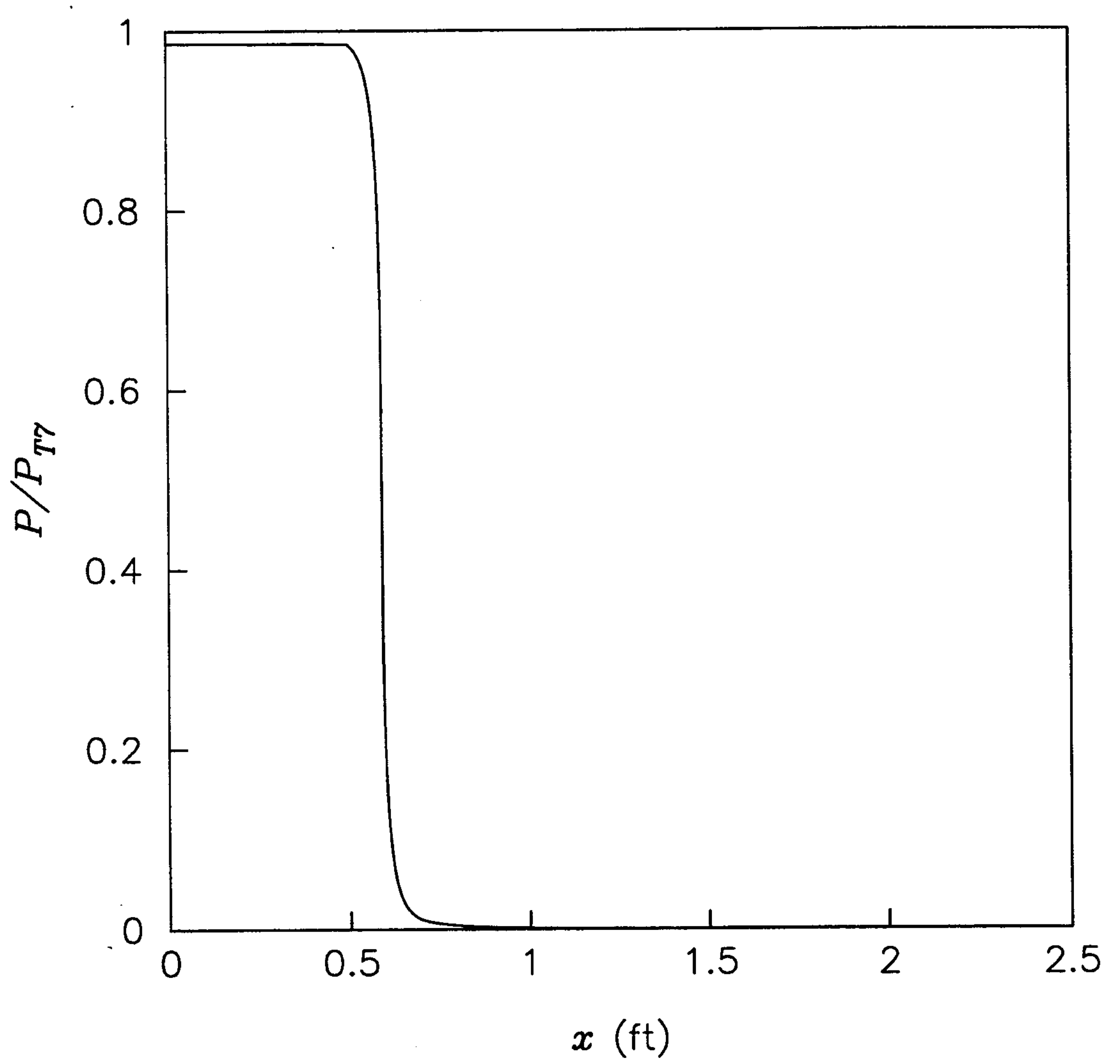


Figure III.2 Normalized Pressure Distribution

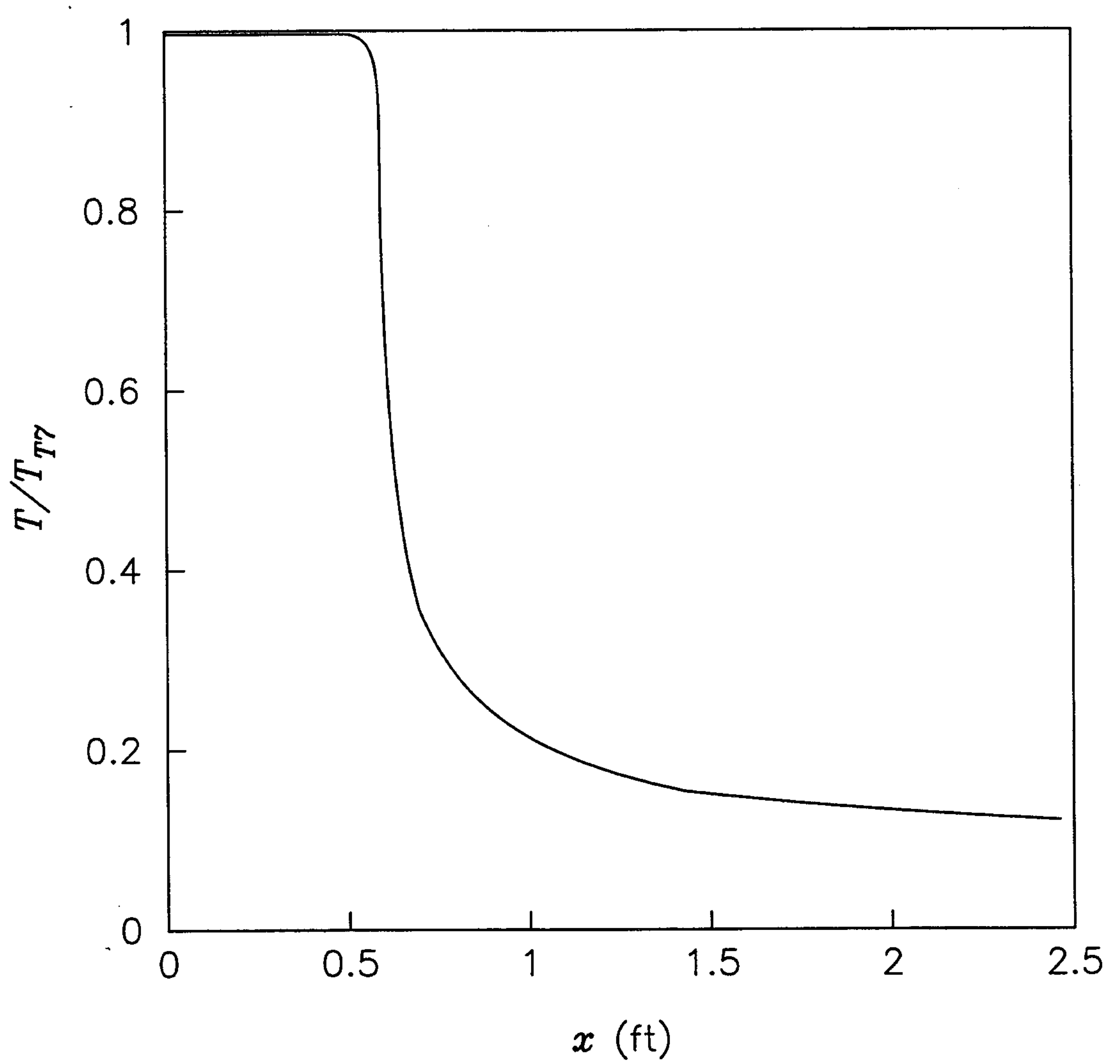


Figure III.3 Normalized Temperature Distribution

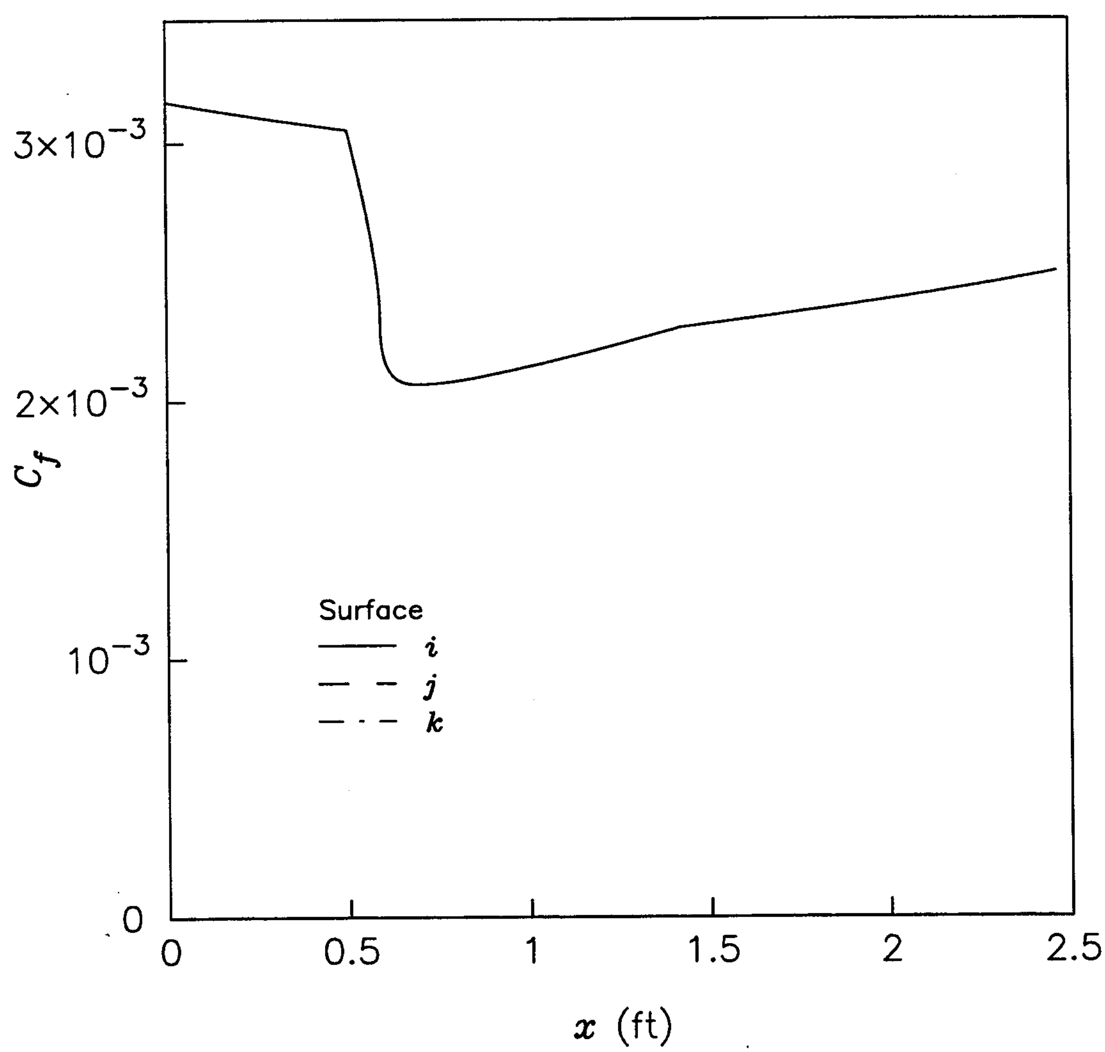


Figure III.4 Skin Friction Distribution

```
&npac
 echo=1,
 title='Rocket Nozzle NASA-TP 3576 reading 601',
 table='npac.dat',
 iout=1,0,0,1,0,
 ni=5,                                          waddi= 0.000,
 xri=  0.000,  1.000,  0,  0,  7,  0.000,  0.000,  0.000,  0.000,  0.0,
       6.000,  1.000,  0,  1,  0, -1.000,  0.000,  0.000,  0.000,  0.0,
       7.070,  0.500,  0,  1,  8, -1.000,  0.000,  0.000,  0.000,  0.0,
       8.330,  1.520,  0,  1,  0, -1.000,  0.000,  0.000,  0.000,  0.0,
      17.100,  6.360,  0,  1,  0, -1.000,  0.000,  0.000,  0.000,  0.0,
      29.560, 10.490,  0,  1,  9, -1.000,  0.000,  0.000,  0.000,  0.0,
 nj=5,                                          waddj= 0.000,
 xrj=  0.000,  0.000,  0,  0,  7,  0.000,  0.000,  0.000,  0.000,  0.0,
       6.000,  0.000,  0, -1,  0, -1.000,  0.000,  0.000,  0.000,  0.0,
       7.070,  0.000,  0, -1,  8, -1.000,  0.000,  0.000,  0.000,  0.0,
       8.330,  0.000,  0, -1,  0, -1.000,  0.000,  0.000,  0.000,  0.0,
      17.100,  0.000,  0, -1,  0, -1.000,  0.000,  0.000,  0.000,  0.0,
      29.560,  0.000,  0, -1,  9, -1.000,  0.000,  0.000,  0.000,  0.0,
 npts=101,nspl=50,
 idim=1,ar=1.0,scale=0.08333,
 w7=0.0,    pt7=2.699e+5,tt7=6589,
 p0=0.0001, xm8=1.0,rei=1.0E+7,gamma=1.30,rgas=113.3,
 eps=1.0E-3,tol=1.0E-6,del=1.0E-2,con=1.0E-6,
&end

NPAC   Rocket Nozzle NASA-TP 3576 reading 601


i surface, ni =  5, geometry input values follow, scale =  8.3330E-02

         x           r        flags    Tw/Tt7     w/w7      Pt/Pt7    Tt/Tt7      phi

 0  0.000E+00  8.333E-02  0  0  7  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 1  5.000E-01  8.333E-02  0  1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 2  5.891E-01  4.166E-02  0  1  8 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 3  6.941E-01  1.267E-01  0  1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 4  1.425E+00  5.300E-01  0  1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 5  2.463E+00  8.741E-01  0  1  9 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00

j surface, nj =  5, geometry input values follow, scale =  8.3330E-02

         x           r        flags    Tw/Tt7     w/w7      Pt/Pt7    Tt/Tt7      phi

 0  0.000E+00  0.000E+00  0  0  7  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 1  5.000E-01  0.000E+00  0 -1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
```

```
 2  5.891E-01  0.000E+00  0 -1  8 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 3  6.941E-01  0.000E+00  0 -1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 4  1.425E+00  0.000E+00  0 -1  0 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 5  2.463E+00  0.000E+00  0 -1  9 -1.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
```

geometric a8 is 5.4537E-03, nozzle entrance weight flow is 6.4479E+00

nozzle entrance Mach number is 1.4816E-01, inviscid flow model

nozzle throat total pressure is 2.6956E+05, pass number 1, in full model

nozzle entrance Mach number is 1.4797E-01, viscous flow model

nozzle throat total pressure is 2.6956E+05, pass number 2, in full model

full-equations viscous flow model

	x	M	P	T	rho	U	Pt	Tt
1	0.0000E+00	1.4797E-01	2.6609E+05	6.5674E+03	1.1115E-02	8.2549E+02	2.6990E+05	6.5890E+03
2	4.9998E-03	1.4797E-01	2.6609E+05	6.5674E+03	1.1115E-02	8.2550E+02	2.6990E+05	6.5890E+03
3	9.9996E-03	1.4797E-01	2.6609E+05	6.5674E+03	1.1115E-02	8.2550E+02	2.6990E+05	6.5890E+03
4	1.4999E-02	1.4797E-01	2.6609E+05	6.5674E+03	1.1115E-02	8.2551E+02	2.6990E+05	6.5890E+03
5	1.9999E-02	1.4797E-01	2.6609E+05	6.5674E+03	1.1115E-02	8.2551E+02	2.6989E+05	6.5890E+03
6	2.4999E-02	1.4797E-01	2.6608E+05	6.5674E+03	1.1114E-02	8.2551E+02	2.6989E+05	6.5890E+03
7	2.9999E-02	1.4798E-01	2.6608E+05	6.5674E+03	1.1114E-02	8.2552E+02	2.6989E+05	6.5890E+03
8	3.4999E-02	1.4798E-01	2.6608E+05	6.5674E+03	1.1114E-02	8.2552E+02	2.6989E+05	6.5890E+03
9	3.9998E-02	1.4798E-01	2.6608E+05	6.5674E+03	1.1114E-02	8.2553E+02	2.6989E+05	6.5890E+03
10	4.4998E-02	1.4798E-01	2.6608E+05	6.5674E+03	1.1114E-02	8.2553E+02	2.6989E+05	6.5890E+03
11	4.9998E-02	1.4798E-01	2.6608E+05	6.5674E+03	1.1114E-02	8.2554E+02	2.6989E+05	6.5890E+03
12	5.4998E-02	1.4798E-01	2.6608E+05	6.5674E+03	1.1114E-02	8.2554E+02	2.6988E+05	6.5890E+03
13	5.9998E-02	1.4798E-01	2.6607E+05	6.5674E+03	1.1114E-02	8.2555E+02	2.6988E+05	6.5890E+03
14	6.4997E-02	1.4798E-01	2.6607E+05	6.5674E+03	1.1114E-02	8.2555E+02	2.6988E+05	6.5890E+03
15	6.9997E-02	1.4798E-01	2.6607E+05	6.5674E+03	1.1114E-02	8.2555E+02	2.6988E+05	6.5890E+03
16	7.4997E-02	1.4798E-01	2.6607E+05	6.5674E+03	1.1114E-02	8.2556E+02	2.6988E+05	6.5890E+03
17	7.9997E-02	1.4798E-01	2.6607E+05	6.5674E+03	1.1114E-02	8.2556E+02	2.6988E+05	6.5890E+03
18	8.4997E-02	1.4798E-01	2.6607E+05	6.5674E+03	1.1114E-02	8.2557E+02	2.6988E+05	6.5890E+03
19	8.9996E-02	1.4799E-01	2.6607E+05	6.5674E+03	1.1114E-02	8.2557E+02	2.6987E+05	6.5890E+03
20	9.4996E-02	1.4799E-01	2.6606E+05	6.5674E+03	1.1114E-02	8.2558E+02	2.6987E+05	6.5890E+03
21	9.9996E-02	1.4799E-01	2.6606E+05	6.5674E+03	1.1114E-02	8.2558E+02	2.6987E+05	6.5890E+03
22	1.0500E-01	1.4799E-01	2.6606E+05	6.5674E+03	1.1114E-02	8.2559E+02	2.6987E+05	6.5890E+03
23	1.1000E-01	1.4799E-01	2.6606E+05	6.5674E+03	1.1113E-02	8.2559E+02	2.6987E+05	6.5890E+03
24	1.1500E-01	1.4799E-01	2.6606E+05	6.5674E+03	1.1113E-02	8.2560E+02	2.6987E+05	6.5890E+03
25	1.2000E-01	1.4799E-01	2.6606E+05	6.5674E+03	1.1113E-02	8.2560E+02	2.6986E+05	6.5890E+03
26	1.2499E-01	1.4799E-01	2.6606E+05	6.5674E+03	1.1113E-02	8.2560E+02	2.6986E+05	6.5890E+03
27	1.2999E-01	1.4799E-01	2.6605E+05	6.5674E+03	1.1113E-02	8.2561E+02	2.6986E+05	6.5890E+03

93	28	1.3499E-01	1.4799E-01	2.6605E+05	6.5674E+03	1.1113E-02	8.2561E+02	2.6986E+05	6.5890E+03
94	29	1.3999E-01	1.4799E-01	2.6605E+05	6.5674E+03	1.1113E-02	8.2562E+02	2.6986E+05	6.5890E+03
95	30	1.4499E-01	1.4799E-01	2.6605E+05	6.5674E+03	1.1113E-02	8.2562E+02	2.6986E+05	6.5890E+03
96	31	1.4999E-01	1.4799E-01	2.6605E+05	6.5674E+03	1.1113E-02	8.2563E+02	2.6986E+05	6.5890E+03
97	32	1.5499E-01	1.4800E-01	2.6605E+05	6.5674E+03	1.1113E-02	8.2563E+02	2.6985E+05	6.5890E+03
98	33	1.5999E-01	1.4800E-01	2.6605E+05	6.5674E+03	1.1113E-02	8.2564E+02	2.6985E+05	6.5890E+03
99	34	1.6499E-01	1.4800E-01	2.6604E+05	6.5674E+03	1.1113E-02	8.2564E+02	2.6985E+05	6.5890E+03
100	35	1.6999E-01	1.4800E-01	2.6604E+05	6.5674E+03	1.1113E-02	8.2564E+02	2.6985E+05	6.5890E+03
101	36	1.7499E-01	1.4800E-01	2.6604E+05	6.5674E+03	1.1113E-02	8.2565E+02	2.6985E+05	6.5890E+03
102	37	1.7999E-01	1.4800E-01	2.6604E+05	6.5674E+03	1.1113E-02	8.2565E+02	2.6985E+05	6.5890E+03
103	38	1.8499E-01	1.4800E-01	2.6604E+05	6.5674E+03	1.1113E-02	8.2566E+02	2.6985E+05	6.5890E+03
104	39	1.8999E-01	1.4800E-01	2.6604E+05	6.5674E+03	1.1112E-02	8.2566E+02	2.6984E+05	6.5890E+03
105	40	1.9499E-01	1.4800E-01	2.6603E+05	6.5674E+03	1.1112E-02	8.2567E+02	2.6984E+05	6.5890E+03
106	41	1.9999E-01	1.4800E-01	2.6603E+05	6.5674E+03	1.1112E-02	8.2567E+02	2.6984E+05	6.5890E+03
107	42	2.0499E-01	1.4800E-01	2.6603E+05	6.5674E+03	1.1112E-02	8.2568E+02	2.6984E+05	6.5890E+03
108	43	2.0999E-01	1.4800E-01	2.6603E+05	6.5674E+03	1.1112E-02	8.2568E+02	2.6984E+05	6.5890E+03
109	44	2.1499E-01	1.4801E-01	2.6603E+05	6.5674E+03	1.1112E-02	8.2569E+02	2.6984E+05	6.5890E+03
110	45	2.1999E-01	1.4801E-01	2.6603E+05	6.5674E+03	1.1112E-02	8.2569E+02	2.6984E+05	6.5890E+03
111	46	2.2499E-01	1.4801E-01	2.6603E+05	6.5674E+03	1.1112E-02	8.2569E+02	2.6983E+05	6.5890E+03
112	47	2.2999E-01	1.4801E-01	2.6602E+05	6.5674E+03	1.1112E-02	8.2570E+02	2.6983E+05	6.5890E+03
113	48	2.3499E-01	1.4801E-01	2.6602E+05	6.5674E+03	1.1112E-02	8.2570E+02	2.6983E+05	6.5890E+03
114	49	2.3999E-01	1.4801E-01	2.6602E+05	6.5674E+03	1.1112E-02	8.2571E+02	2.6983E+05	6.5890E+03
115	50	2.4499E-01	1.4801E-01	2.6602E+05	6.5674E+03	1.1112E-02	8.2571E+02	2.6983E+05	6.5890E+03
116	51	2.4999E-01	1.4801E-01	2.6602E+05	6.5674E+03	1.1112E-02	8.2572E+02	2.6983E+05	6.5890E+03
117	52	2.5499E-01	1.4801E-01	2.6602E+05	6.5674E+03	1.1112E-02	8.2572E+02	2.6983E+05	6.5890E+03
118	53	2.5999E-01	1.4801E-01	2.6602E+05	6.5674E+03	1.1112E-02	8.2573E+02	2.6982E+05	6.5890E+03
119	54	2.6499E-01	1.4801E-01	2.6601E+05	6.5674E+03	1.1112E-02	8.2573E+02	2.6982E+05	6.5890E+03
120	55	2.6999E-01	1.4801E-01	2.6601E+05	6.5674E+03	1.1112E-02	8.2573E+02	2.6982E+05	6.5890E+03
121	56	2.7499E-01	1.4801E-01	2.6601E+05	6.5674E+03	1.1111E-02	8.2574E+02	2.6982E+05	6.5890E+03
122	57	2.7999E-01	1.4802E-01	2.6601E+05	6.5674E+03	1.1111E-02	8.2574E+02	2.6982E+05	6.5890E+03
123	58	2.8499E-01	1.4802E-01	2.6601E+05	6.5674E+03	1.1111E-02	8.2575E+02	2.6982E+05	6.5890E+03
124	59	2.8999E-01	1.4802E-01	2.6601E+05	6.5674E+03	1.1111E-02	8.2575E+02	2.6982E+05	6.5890E+03
125	60	2.9499E-01	1.4802E-01	2.6601E+05	6.5674E+03	1.1111E-02	8.2576E+02	2.6981E+05	6.5890E+03
126	61	2.9999E-01	1.4802E-01	2.6600E+05	6.5674E+03	1.1111E-02	8.2576E+02	2.6981E+05	6.5890E+03
127	62	3.0499E-01	1.4802E-01	2.6600E+05	6.5674E+03	1.1111E-02	8.2577E+02	2.6981E+05	6.5890E+03
128	63	3.0999E-01	1.4802E-01	2.6600E+05	6.5674E+03	1.1111E-02	8.2577E+02	2.6981E+05	6.5890E+03
129	64	3.1499E-01	1.4802E-01	2.6600E+05	6.5674E+03	1.1111E-02	8.2577E+02	2.6981E+05	6.5890E+03
130	65	3.1999E-01	1.4802E-01	2.6600E+05	6.5674E+03	1.1111E-02	8.2578E+02	2.6981E+05	6.5890E+03
131	66	3.2499E-01	1.4802E-01	2.6600E+05	6.5674E+03	1.1111E-02	8.2578E+02	2.6981E+05	6.5890E+03
132	67	3.2999E-01	1.4802E-01	2.6600E+05	6.5674E+03	1.1111E-02	8.2579E+02	2.6980E+05	6.5890E+03
133	68	3.3499E-01	1.4802E-01	2.6599E+05	6.5674E+03	1.1111E-02	8.2579E+02	2.6980E+05	6.5890E+03
134	69	3.3999E-01	1.4803E-01	2.6599E+05	6.5674E+03	1.1111E-02	8.2580E+02	2.6980E+05	6.5890E+03
135	70	3.4499E-01	1.4803E-01	2.6599E+05	6.5674E+03	1.1111E-02	8.2580E+02	2.6980E+05	6.5890E+03
136	71	3.4999E-01	1.4803E-01	2.6599E+05	6.5674E+03	1.1111E-02	8.2581E+02	2.6980E+05	6.5890E+03
137	72	3.5499E-01	1.4803E-01	2.6599E+05	6.5674E+03	1.1110E-02	8.2581E+02	2.6980E+05	6.5890E+03
138	73	3.5999E-01	1.4803E-01	2.6599E+05	6.5674E+03	1.1110E-02	8.2581E+02	2.6980E+05	6.5890E+03

139	74	3.6499E-01	1.4803E-01	2.6599E+05	6.5674E+03	1.1110E-02	8.2582E+02	2.6979E+05	6.5890E+03
140	75	3.6999E-01	1.4803E-01	2.6598E+05	6.5674E+03	1.1110E-02	8.2582E+02	2.6979E+05	6.5890E+03
141	76	3.7498E-01	1.4803E-01	2.6598E+05	6.5674E+03	1.1110E-02	8.2583E+02	2.6979E+05	6.5890E+03
142	77	3.7998E-01	1.4803E-01	2.6598E+05	6.5674E+03	1.1110E-02	8.2583E+02	2.6979E+05	6.5890E+03
143	78	3.8498E-01	1.4803E-01	2.6598E+05	6.5674E+03	1.1110E-02	8.2584E+02	2.6979E+05	6.5890E+03
144	79	3.8998E-01	1.4803E-01	2.6598E+05	6.5674E+03	1.1110E-02	8.2584E+02	2.6979E+05	6.5890E+03
145	80	3.9498E-01	1.4803E-01	2.6598E+05	6.5674E+03	1.1110E-02	8.2585E+02	2.6979E+05	6.5890E+03
146	81	3.9998E-01	1.4803E-01	2.6598E+05	6.5674E+03	1.1110E-02	8.2585E+02	2.6978E+05	6.5890E+03
147	82	4.0498E-01	1.4804E-01	2.6597E+05	6.5674E+03	1.1110E-02	8.2585E+02	2.6978E+05	6.5890E+03
148	83	4.0998E-01	1.4804E-01	2.6597E+05	6.5674E+03	1.1110E-02	8.2586E+02	2.6978E+05	6.5890E+03
149	84	4.1498E-01	1.4804E-01	2.6597E+05	6.5674E+03	1.1110E-02	8.2586E+02	2.6978E+05	6.5890E+03
150	85	4.1998E-01	1.4804E-01	2.6597E+05	6.5674E+03	1.1110E-02	8.2587E+02	2.6978E+05	6.5890E+03
151	86	4.2498E-01	1.4804E-01	2.6597E+05	6.5674E+03	1.1110E-02	8.2587E+02	2.6978E+05	6.5890E+03
152	87	4.2998E-01	1.4804E-01	2.6597E+05	6.5674E+03	1.1110E-02	8.2588E+02	2.6978E+05	6.5890E+03
153	88	4.3498E-01	1.4804E-01	2.6597E+05	6.5674E+03	1.1110E-02	8.2588E+02	2.6977E+05	6.5890E+03
154	89	4.3998E-01	1.4804E-01	2.6596E+05	6.5674E+03	1.1109E-02	8.2588E+02	2.6977E+05	6.5890E+03
155	90	4.4498E-01	1.4804E-01	2.6596E+05	6.5674E+03	1.1109E-02	8.2589E+02	2.6977E+05	6.5890E+03
156	91	4.4998E-01	1.4804E-01	2.6596E+05	6.5674E+03	1.1109E-02	8.2589E+02	2.6977E+05	6.5890E+03
157	92	4.5498E-01	1.4804E-01	2.6596E+05	6.5674E+03	1.1109E-02	8.2590E+02	2.6977E+05	6.5890E+03
158	93	4.5998E-01	1.4804E-01	2.6596E+05	6.5674E+03	1.1109E-02	8.2590E+02	2.6977E+05	6.5890E+03
159	94	4.6498E-01	1.4805E-01	2.6596E+05	6.5674E+03	1.1109E-02	8.2591E+02	2.6977E+05	6.5890E+03
160	95	4.6998E-01	1.4805E-01	2.6596E+05	6.5674E+03	1.1109E-02	8.2591E+02	2.6976E+05	6.5890E+03
161	96	4.7498E-01	1.4805E-01	2.6595E+05	6.5674E+03	1.1109E-02	8.2592E+02	2.6976E+05	6.5890E+03
162	97	4.7998E-01	1.4805E-01	2.6595E+05	6.5674E+03	1.1109E-02	8.2592E+02	2.6976E+05	6.5890E+03
163	98	4.8498E-01	1.4805E-01	2.6595E+05	6.5674E+03	1.1109E-02	8.2592E+02	2.6976E+05	6.5890E+03
164	99	4.8998E-01	1.4805E-01	2.6595E+05	6.5674E+03	1.1109E-02	8.2593E+02	2.6976E+05	6.5890E+03
165	100	4.9498E-01	1.4805E-01	2.6595E+05	6.5674E+03	1.1109E-02	8.2593E+02	2.6976E+05	6.5890E+03
166	101	4.9998E-01	1.4805E-01	2.6595E+05	6.5674E+03	1.1109E-02	8.2594E+02	2.6976E+05	6.5890E+03
167	102	5.0087E-01	1.4958E-01	2.6587E+05	6.5670E+03	1.1106E-02	8.3445E+02	2.6976E+05	6.5890E+03
168	103	5.0176E-01	1.5114E-01	2.6579E+05	6.5665E+03	1.1104E-02	8.4310E+02	2.6976E+05	6.5890E+03
169	104	5.0265E-01	1.5272E-01	2.6570E+05	6.5660E+03	1.1101E-02	8.5188E+02	2.6976E+05	6.5890E+03
170	105	5.0355E-01	1.5432E-01	2.6562E+05	6.5655E+03	1.1098E-02	8.6081E+02	2.6975E+05	6.5890E+03
171	106	5.0444E-01	1.5596E-01	2.6553E+05	6.5650E+03	1.1095E-02	8.6988E+02	2.6975E+05	6.5890E+03
172	107	5.0533E-01	1.5761E-01	2.6544E+05	6.5645E+03	1.1093E-02	8.7910E+02	2.6975E+05	6.5890E+03
173	108	5.0622E-01	1.5930E-01	2.6535E+05	6.5640E+03	1.1090E-02	8.8847E+02	2.6975E+05	6.5890E+03
174	109	5.0711E-01	1.6102E-01	2.6525E+05	6.5635E+03	1.1086E-02	8.9800E+02	2.6975E+05	6.5890E+03
175	110	5.0800E-01	1.6276E-01	2.6516E+05	6.5629E+03	1.1083E-02	9.0768E+02	2.6975E+05	6.5890E+03
176	111	5.0890E-01	1.6453E-01	2.6506E+05	6.5624E+03	1.1080E-02	9.1753E+02	2.6975E+05	6.5890E+03
177	112	5.0979E-01	1.6633E-01	2.6496E+05	6.5618E+03	1.1077E-02	9.2754E+02	2.6975E+05	6.5890E+03
178	113	5.1068E-01	1.6817E-01	2.6485E+05	6.5612E+03	1.1073E-02	9.3772E+02	2.6975E+05	6.5890E+03
179	114	5.1157E-01	1.7003E-01	2.6474E+05	6.5606E+03	1.1070E-02	9.4808E+02	2.6975E+05	6.5890E+03
180	115	5.1246E-01	1.7193E-01	2.6463E+05	6.5599E+03	1.1066E-02	9.5861E+02	2.6975E+05	6.5890E+03
181	116	5.1335E-01	1.7386E-01	2.6451E+05	6.5593E+03	1.1063E-02	9.6932E+02	2.6975E+05	6.5890E+03
182	117	5.1425E-01	1.7582E-01	2.6440E+05	6.5586E+03	1.1059E-02	9.8022E+02	2.6975E+05	6.5890E+03
183	118	5.1514E-01	1.7782E-01	2.6428E+05	6.5579E+03	1.1055E-02	9.9132E+02	2.6975E+05	6.5890E+03
184	119	5.1603E-01	1.7986E-01	2.6415E+05	6.5572E+03	1.1051E-02	1.0026E+03	2.6975E+05	6.5890E+03

185	120	5.1692E-01	1.8193E-01	2.6402E+05	6.5565E+03	1.1047E-02	1.0141E+03	2.6975E+05	6.5890E+03
186	121	5.1781E-01	1.8404E-01	2.6389E+05	6.5557E+03	1.1043E-02	1.0258E+03	2.6975E+05	6.5890E+03
187	122	5.1870E-01	1.8619E-01	2.6375E+05	6.5549E+03	1.1038E-02	1.0377E+03	2.6975E+05	6.5890E+03
188	123	5.1960E-01	1.8837E-01	2.6361E+05	6.5541E+03	1.1034E-02	1.0498E+03	2.6975E+05	6.5890E+03
189	124	5.2049E-01	1.9060E-01	2.6347E+05	6.5533E+03	1.1029E-02	1.0622E+03	2.6975E+05	6.5890E+03
190	125	5.2138E-01	1.9287E-01	2.6332E+05	6.5524E+03	1.1024E-02	1.0747E+03	2.6975E+05	6.5890E+03
191	126	5.2227E-01	1.9518E-01	2.6317E+05	6.5516E+03	1.1019E-02	1.0875E+03	2.6975E+05	6.5890E+03
192	127	5.2316E-01	1.9753E-01	2.6301E+05	6.5507E+03	1.1014E-02	1.1006E+03	2.6975E+05	6.5890E+03
193	128	5.2405E-01	1.9993E-01	2.6285E+05	6.5497E+03	1.1009E-02	1.1139E+03	2.6975E+05	6.5890E+03
194	129	5.2495E-01	2.0238E-01	2.6268E+05	6.5488E+03	1.1004E-02	1.1274E+03	2.6974E+05	6.5890E+03
195	130	5.2584E-01	2.0487E-01	2.6251E+05	6.5478E+03	1.0998E-02	1.1412E+03	2.6974E+05	6.5890E+03
196	131	5.2673E-01	2.0741E-01	2.6233E+05	6.5468E+03	1.0992E-02	1.1553E+03	2.6974E+05	6.5890E+03
197	132	5.2762E-01	2.1000E-01	2.6215E+05	6.5457E+03	1.0986E-02	1.1696E+03	2.6974E+05	6.5890E+03
198	133	5.2851E-01	2.1265E-01	2.6196E+05	6.5446E+03	1.0980E-02	1.1843E+03	2.6974E+05	6.5890E+03
199	134	5.2940E-01	2.1535E-01	2.6176E+05	6.5435E+03	1.0974E-02	1.1992E+03	2.6974E+05	6.5890E+03
200	135	5.3030E-01	2.1810E-01	2.6156E+05	6.5423E+03	1.0967E-02	1.2144E+03	2.6974E+05	6.5890E+03
201	136	5.3119E-01	2.2090E-01	2.6135E+05	6.5411E+03	1.0961E-02	1.2299E+03	2.6974E+05	6.5890E+03
202	137	5.3208E-01	2.2377E-01	2.6113E+05	6.5399E+03	1.0954E-02	1.2457E+03	2.6974E+05	6.5890E+03
203	138	5.3297E-01	2.2669E-01	2.6091E+05	6.5386E+03	1.0946E-02	1.2619E+03	2.6974E+05	6.5890E+03
204	139	5.3386E-01	2.2968E-01	2.6068E+05	6.5373E+03	1.0939E-02	1.2784E+03	2.6974E+05	6.5890E+03
205	140	5.3475E-01	2.3273E-01	2.6044E+05	6.5359E+03	1.0931E-02	1.2952E+03	2.6974E+05	6.5890E+03
206	141	5.3565E-01	2.3585E-01	2.6020E+05	6.5345E+03	1.0923E-02	1.3124E+03	2.6974E+05	6.5890E+03
207	142	5.3654E-01	2.3903E-01	2.5994E+05	6.5330E+03	1.0915E-02	1.3300E+03	2.6974E+05	6.5890E+03
208	143	5.3743E-01	2.4228E-01	2.5968E+05	6.5315E+03	1.0907E-02	1.3479E+03	2.6973E+05	6.5890E+03
209	144	5.3832E-01	2.4560E-01	2.5941E+05	6.5299E+03	1.0898E-02	1.3662E+03	2.6973E+05	6.5890E+03
210	145	5.3921E-01	2.4900E-01	2.5913E+05	6.5283E+03	1.0889E-02	1.3850E+03	2.6973E+05	6.5890E+03
211	146	5.4010E-01	2.5248E-01	2.5884E+05	6.5266E+03	1.0879E-02	1.4041E+03	2.6973E+05	6.5890E+03
212	147	5.4100E-01	2.5603E-01	2.5853E+05	6.5248E+03	1.0870E-02	1.4237E+03	2.6973E+05	6.5890E+03
213	148	5.4189E-01	2.5967E-01	2.5822E+05	6.5230E+03	1.0859E-02	1.4437E+03	2.6973E+05	6.5890E+03
214	149	5.4278E-01	2.6339E-01	2.5790E+05	6.5211E+03	1.0849E-02	1.4642E+03	2.6973E+05	6.5890E+03
215	150	5.4367E-01	2.6719E-01	2.5756E+05	6.5192E+03	1.0838E-02	1.4851E+03	2.6973E+05	6.5890E+03
216	151	5.4456E-01	2.7109E-01	2.5721E+05	6.5172E+03	1.0827E-02	1.5066E+03	2.6973E+05	6.5890E+03
217	152	5.4545E-01	2.7509E-01	2.5685E+05	6.5151E+03	1.0815E-02	1.5285E+03	2.6973E+05	6.5890E+03
218	153	5.4634E-01	2.7918E-01	2.5648E+05	6.5129E+03	1.0803E-02	1.5510E+03	2.6972E+05	6.5890E+03
219	154	5.4724E-01	2.8337E-01	2.5609E+05	6.5106E+03	1.0790E-02	1.5740E+03	2.6972E+05	6.5890E+03
220	155	5.4813E-01	2.8767E-01	2.5568E+05	6.5082E+03	1.0777E-02	1.5976E+03	2.6972E+05	6.5890E+03
221	156	5.4902E-01	2.9207E-01	2.5526E+05	6.5058E+03	1.0764E-02	1.6217E+03	2.6972E+05	6.5890E+03
222	157	5.4991E-01	2.9659E-01	2.5483E+05	6.5032E+03	1.0749E-02	1.6465E+03	2.6972E+05	6.5890E+03
223	158	5.5080E-01	3.0123E-01	2.5437E+05	6.5005E+03	1.0735E-02	1.6719E+03	2.6972E+05	6.5890E+03
224	159	5.5169E-01	3.0599E-01	2.5390E+05	6.4978E+03	1.0719E-02	1.6980E+03	2.6972E+05	6.5890E+03
225	160	5.5259E-01	3.1088E-01	2.5341E+05	6.4949E+03	1.0703E-02	1.7247E+03	2.6971E+05	6.5890E+03
226	161	5.5348E-01	3.1590E-01	2.5290E+05	6.4918E+03	1.0687E-02	1.7522E+03	2.6971E+05	6.5890E+03
227	162	5.5437E-01	3.2106E-01	2.5236E+05	6.4887E+03	1.0669E-02	1.7804E+03	2.6971E+05	6.5890E+03
228	163	5.5526E-01	3.2637E-01	2.5181E+05	6.4854E+03	1.0651E-02	1.8093E+03	2.6971E+05	6.5890E+03
229	164	5.5615E-01	3.3182E-01	2.5123E+05	6.4820E+03	1.0632E-02	1.8391E+03	2.6971E+05	6.5890E+03
230	165	5.5704E-01	3.3744E-01	2.5062E+05	6.4784E+03	1.0613E-02	1.8697E+03	2.6971E+05	6.5890E+03

231	166	5.5794E-01	3.4322E-01	2.4999E+05	6.4746E+03	1.0592E-02	1.9012E+03	2.6970E+05	6.5890E+03
232	167	5.5883E-01	3.4918E-01	2.4933E+05	6.4707E+03	1.0570E-02	1.9336E+03	2.6970E+05	6.5890E+03
233	168	5.5972E-01	3.5532E-01	2.4864E+05	6.4665E+03	1.0548E-02	1.9670E+03	2.6970E+05	6.5890E+03
234	169	5.6061E-01	3.6165E-01	2.4792E+05	6.4622E+03	1.0524E-02	2.0013E+03	2.6970E+05	6.5890E+03
235	170	5.6150E-01	3.6819E-01	2.4717E+05	6.4577E+03	1.0500E-02	2.0368E+03	2.6970E+05	6.5890E+03
236	171	5.6239E-01	3.7493E-01	2.4638E+05	6.4529E+03	1.0474E-02	2.0733E+03	2.6969E+05	6.5890E+03
237	172	5.6329E-01	3.8190E-01	2.4555E+05	6.4479E+03	1.0447E-02	2.1111E+03	2.6969E+05	6.5890E+03
238	173	5.6418E-01	3.8911E-01	2.4468E+05	6.4427E+03	1.0418E-02	2.1501E+03	2.6969E+05	6.5890E+03
239	174	5.6507E-01	3.9657E-01	2.4377E+05	6.4372E+03	1.0388E-02	2.1903E+03	2.6969E+05	6.5890E+03
240	175	5.6596E-01	4.0430E-01	2.4281E+05	6.4313E+03	1.0357E-02	2.2320E+03	2.6968E+05	6.5890E+03
241	176	5.6685E-01	4.1231E-01	2.4181E+05	6.4252E+03	1.0324E-02	2.2751E+03	2.6968E+05	6.5890E+03
242	177	5.6774E-01	4.2062E-01	2.4074E+05	6.4187E+03	1.0289E-02	2.3198E+03	2.6968E+05	6.5890E+03
243	178	5.6864E-01	4.2925E-01	2.3963E+05	6.4118E+03	1.0252E-02	2.3661E+03	2.6967E+05	6.5890E+03
244	179	5.6953E-01	4.3822E-01	2.3845E+05	6.4045E+03	1.0213E-02	2.4142E+03	2.6967E+05	6.5890E+03
245	180	5.7042E-01	4.4756E-01	2.3720E+05	6.3968E+03	1.0172E-02	2.4642E+03	2.6967E+05	6.5890E+03
246	181	5.7131E-01	4.5730E-01	2.3588E+05	6.3886E+03	1.0129E-02	2.5162E+03	2.6966E+05	6.5890E+03
247	182	5.7220E-01	4.6747E-01	2.3449E+05	6.3799E+03	1.0083E-02	2.5704E+03	2.6966E+05	6.5890E+03
248	183	5.7309E-01	4.7810E-01	2.3301E+05	6.3706E+03	1.0034E-02	2.6269E+03	2.6966E+05	6.5890E+03
249	184	5.7399E-01	4.8923E-01	2.3143E+05	6.3607E+03	9.9814E-03	2.6860E+03	2.6965E+05	6.5890E+03
250	185	5.7488E-01	5.0091E-01	2.2976E+05	6.3500E+03	9.9257E-03	2.7478E+03	2.6965E+05	6.5890E+03
251	186	5.7577E-01	5.1320E-01	2.2797E+05	6.3386E+03	9.8662E-03	2.8127E+03	2.6964E+05	6.5890E+03
252	187	5.7666E-01	5.2615E-01	2.2606E+05	6.3263E+03	9.8024E-03	2.8809E+03	2.6964E+05	6.5890E+03
253	188	5.7755E-01	5.3984E-01	2.2401E+05	6.3131E+03	9.7338E-03	2.9527E+03	2.6963E+05	6.5890E+03
254	189	5.7844E-01	5.5436E-01	2.2180E+05	6.2987E+03	9.6599E-03	3.0287E+03	2.6963E+05	6.5890E+03
255	190	5.7934E-01	5.6981E-01	2.1942E+05	6.2830E+03	9.5800E-03	3.1092E+03	2.6962E+05	6.5890E+03
256	191	5.8023E-01	5.8633E-01	2.1683E+05	6.2659E+03	9.4931E-03	3.1950E+03	2.6962E+05	6.5890E+03
257	192	5.8112E-01	6.0408E-01	2.1402E+05	6.2471E+03	9.3981E-03	3.2868E+03	2.6961E+05	6.5890E+03
258	193	5.8201E-01	6.2327E-01	2.1093E+05	6.2262E+03	9.2937E-03	3.3856E+03	2.6960E+05	6.5890E+03
259	194	5.8290E-01	6.4419E-01	2.0753E+05	6.2029E+03	9.1780E-03	3.4926E+03	2.6960E+05	6.5890E+03
260	195	5.8379E-01	6.6721E-01	2.0373E+05	6.1766E+03	9.0485E-03	3.6097E+03	2.6959E+05	6.5890E+03
261	196	5.8468E-01	6.9289E-01	1.9945E+05	6.1464E+03	8.9017E-03	3.7395E+03	2.6958E+05	6.5890E+03
262	197	5.8558E-01	7.2207E-01	1.9452E+05	6.1111E+03	8.7321E-03	3.8858E+03	2.6957E+05	6.5890E+03
263	198	5.8647E-01	7.5616E-01	1.8872E+05	6.0685E+03	8.5308E-03	4.0551E+03	2.6957E+05	6.5890E+03
264	199	5.8736E-01	7.9792E-01	1.8155E+05	6.0146E+03	8.2805E-03	4.2600E+03	2.6956E+05	6.5890E+03
265	200	5.8825E-01	8.5440E-01	1.7183E+05	5.9387E+03	7.9373E-03	4.5326E+03	2.6956E+05	6.5890E+03
266	201	5.8914E-01	1.0000E+00	1.4683E+05	5.7296E+03	7.0302E-03	5.2203E+03	2.6956E+05	6.5890E+03
267	202	5.9019E-01	1.2300E+00	1.1100E+05	5.3702E+03	5.6699E-03	6.2166E+03	2.6978E+05	6.5890E+03
268	203	5.9124E-01	1.3282E+00	9.7319E+04	5.2103E+03	5.1239E-03	6.6119E+03	2.6966E+05	6.5890E+03
269	204	5.9229E-01	1.4055E+00	8.7373E+04	5.0828E+03	4.7156E-03	6.9109E+03	2.6953E+05	6.5890E+03
270	205	5.9334E-01	1.4719E+00	7.9446E+04	4.9730E+03	4.3825E-03	7.1584E+03	2.6941E+05	6.5890E+03
271	206	5.9439E-01	1.5310E+00	7.2846E+04	4.8750E+03	4.0992E-03	7.3722E+03	2.6929E+05	6.5890E+03
272	207	5.9544E-01	1.5850E+00	6.7208E+04	4.7857E+03	3.8525E-03	7.5618E+03	2.6916E+05	6.5890E+03
273	208	5.9649E-01	1.6349E+00	6.2305E+04	4.7032E+03	3.6340E-03	7.7327E+03	2.6904E+05	6.5890E+03
274	209	5.9754E-01	1.6817E+00	5.7987E+04	4.6264E+03	3.4384E-03	7.8887E+03	2.6892E+05	6.5890E+03
275	210	5.9859E-01	1.7258E+00	5.4147E+04	4.5543E+03	3.2615E-03	8.0323E+03	2.6880E+05	6.5890E+03
276	211	5.9964E-01	1.7677E+00	5.0705E+04	4.4863E+03	3.1005E-03	8.1655E+03	2.6868E+05	6.5890E+03

277	212	6.0069E-01	1.8076E+00	4.7601E+04	4.4218E+03	2.9531E-03	8.2897E+03	2.6856E+05	6.5890E+03
278	213	6.0174E-01	1.8459E+00	4.4785E+04	4.3605E+03	2.8175E-03	8.4062E+03	2.6844E+05	6.5890E+03
279	214	6.0279E-01	1.8826E+00	4.2221E+04	4.3020E+03	2.6923E-03	8.5158E+03	2.6831E+05	6.5890E+03
280	215	6.0384E-01	1.9180E+00	3.9875E+04	4.2461E+03	2.5762E-03	8.6193E+03	2.6819E+05	6.5890E+03
281	216	6.0489E-01	1.9522E+00	3.7722E+04	4.1925E+03	2.4683E-03	8.7173E+03	2.6807E+05	6.5890E+03
282	217	6.0594E-01	1.9852E+00	3.5740E+04	4.1410E+03	2.3677E-03	8.8104E+03	2.6795E+05	6.5890E+03
283	218	6.0699E-01	2.0173E+00	3.3910E+04	4.0915E+03	2.2736E-03	8.8990E+03	2.6783E+05	6.5890E+03
284	219	6.0804E-01	2.0484E+00	3.2216E+04	4.0438E+03	2.1855E-03	8.9836E+03	2.6771E+05	6.5890E+03
285	220	6.0909E-01	2.0787E+00	3.0645E+04	3.9978E+03	2.1028E-03	9.0644E+03	2.6759E+05	6.5890E+03
286	221	6.1014E-01	2.1082E+00	2.9184E+04	3.9534E+03	2.0250E-03	9.1417E+03	2.6747E+05	6.5890E+03
287	222	6.1119E-01	2.1369E+00	2.7822E+04	3.9105E+03	1.9518E-03	9.2159E+03	2.6735E+05	6.5890E+03
288	223	6.1224E-01	2.1650E+00	2.6552E+04	3.8689E+03	1.8826E-03	9.2871E+03	2.6723E+05	6.5890E+03
289	224	6.1329E-01	2.1924E+00	2.5364E+04	3.8287E+03	1.8173E-03	9.3556E+03	2.6711E+05	6.5890E+03
290	225	6.1434E-01	2.2191E+00	2.4252E+04	3.7897E+03	1.7555E-03	9.4215E+03	2.6699E+05	6.5890E+03
291	226	6.1539E-01	2.2453E+00	2.3209E+04	3.7518E+03	1.6970E-03	9.4850E+03	2.6687E+05	6.5890E+03
292	227	6.1644E-01	2.2710E+00	2.2229E+04	3.7150E+03	1.6414E-03	9.5462E+03	2.6675E+05	6.5890E+03
293	228	6.1749E-01	2.2961E+00	2.1308E+04	3.6793E+03	1.5887E-03	9.6054E+03	2.6663E+05	6.5890E+03
294	229	6.1854E-01	2.3208E+00	2.0440E+04	3.6446E+03	1.5385E-03	9.6625E+03	2.6651E+05	6.5890E+03
295	230	6.1959E-01	2.3450E+00	1.9623E+04	3.6108E+03	1.4908E-03	9.7178E+03	2.6639E+05	6.5890E+03
296	231	6.2064E-01	2.3687E+00	1.8851E+04	3.5779E+03	1.4454E-03	9.7714E+03	2.6627E+05	6.5890E+03
297	232	6.2169E-01	2.3920E+00	1.8122E+04	3.5458E+03	1.4020E-03	9.8233E+03	2.6615E+05	6.5890E+03
298	233	6.2274E-01	2.4149E+00	1.7432E+04	3.5146E+03	1.3607E-03	9.8735E+03	2.6603E+05	6.5890E+03
299	234	6.2379E-01	2.4374E+00	1.6780E+04	3.4841E+03	1.3212E-03	9.9223E+03	2.6591E+05	6.5890E+03
300	235	6.2484E-01	2.4596E+00	1.6161E+04	3.4544E+03	1.2834E-03	9.9697E+03	2.6579E+05	6.5890E+03
301	236	6.2589E-01	2.4814E+00	1.5574E+04	3.4254E+03	1.2473E-03	1.0016E+04	2.6567E+05	6.5890E+03
302	237	6.2694E-01	2.5028E+00	1.5017E+04	3.3971E+03	1.2127E-03	1.0060E+04	2.6556E+05	6.5890E+03
303	238	6.2799E-01	2.5239E+00	1.4488E+04	3.3694E+03	1.1796E-03	1.0104E+04	2.6544E+05	6.5890E+03
304	239	6.2904E-01	2.5447E+00	1.3985E+04	3.3424E+03	1.1478E-03	1.0146E+04	2.6532E+05	6.5890E+03
305	240	6.3009E-01	2.5652E+00	1.3506E+04	3.3160E+03	1.1173E-03	1.0187E+04	2.6520E+05	6.5890E+03
306	241	6.3114E-01	2.5854E+00	1.3050E+04	3.2901E+03	1.0881E-03	1.0228E+04	2.6508E+05	6.5890E+03
307	242	6.3219E-01	2.6054E+00	1.2615E+04	3.2648E+03	1.0600E-03	1.0267E+04	2.6496E+05	6.5890E+03
308	243	6.3324E-01	2.6250E+00	1.2201E+04	3.2401E+03	1.0330E-03	1.0305E+04	2.6485E+05	6.5890E+03
309	244	6.3429E-01	2.6444E+00	1.1805E+04	3.2159E+03	1.0070E-03	1.0342E+04	2.6473E+05	6.5890E+03
310	245	6.3534E-01	2.6635E+00	1.1427E+04	3.1921E+03	9.8203E-04	1.0378E+04	2.6461E+05	6.5890E+03
311	246	6.3639E-01	2.6824E+00	1.1066E+04	3.1689E+03	9.5798E-04	1.0414E+04	2.6449E+05	6.5890E+03
312	247	6.3744E-01	2.7010E+00	1.0721E+04	3.1461E+03	9.3482E-04	1.0448E+04	2.6438E+05	6.5890E+03
313	248	6.3849E-01	2.7194E+00	1.0391E+04	3.1238E+03	9.1250E-04	1.0482E+04	2.6426E+05	6.5890E+03
314	249	6.3954E-01	2.7376E+00	1.0075E+04	3.1020E+03	8.9098E-04	1.0515E+04	2.6414E+05	6.5890E+03
315	250	6.4059E-01	2.7555E+00	9.7720E+03	3.0805E+03	8.7022E-04	1.0548E+04	2.6402E+05	6.5890E+03
316	251	6.4164E-01	2.7733E+00	9.4818E+03	3.0595E+03	8.5018E-04	1.0579E+04	2.6391E+05	6.5890E+03
317	252	6.4269E-01	2.7908E+00	9.2035E+03	3.0388E+03	8.3084E-04	1.0610E+04	2.6379E+05	6.5890E+03
318	253	6.4374E-01	2.8081E+00	8.9366E+03	3.0185E+03	8.1216E-04	1.0640E+04	2.6368E+05	6.5890E+03
319	254	6.4479E-01	2.8253E+00	8.6804E+03	2.9987E+03	7.9411E-04	1.0670E+04	2.6356E+05	6.5890E+03
320	255	6.4584E-01	2.8422E+00	8.4343E+03	2.9791E+03	7.7665E-04	1.0699E+04	2.6344E+05	6.5890E+03
321	256	6.4689E-01	2.8590E+00	8.1979E+03	2.9599E+03	7.5978E-04	1.0727E+04	2.6333E+05	6.5890E+03
322	257	6.4794E-01	2.8756E+00	7.9707E+03	2.9411E+03	7.4345E-04	1.0755E+04	2.6321E+05	6.5890E+03

323	258	6.4899E-01	2.8920E+00	7.7522E+03	2.9226E+03	7.2765E-04	1.0782E+04	2.6310E+05	6.5890E+03
324	259	6.5004E-01	2.9082E+00	7.5419E+03	2.9044E+03	7.1235E-04	1.0809E+04	2.6298E+05	6.5890E+03
325	260	6.5109E-01	2.9243E+00	7.3396E+03	2.8865E+03	6.9753E-04	1.0835E+04	2.6287E+05	6.5890E+03
326	261	6.5214E-01	2.9402E+00	7.1447E+03	2.8689E+03	6.8317E-04	1.0861E+04	2.6275E+05	6.5890E+03
327	262	6.5319E-01	2.9559E+00	6.9570E+03	2.8517E+03	6.6926E-04	1.0886E+04	2.6264E+05	6.5890E+03
328	263	6.5424E-01	2.9715E+00	6.7761E+03	2.8347E+03	6.5576E-04	1.0911E+04	2.6252E+05	6.5890E+03
329	264	6.5529E-01	2.9869E+00	6.6018E+03	2.8179E+03	6.4268E-04	1.0935E+04	2.6241E+05	6.5890E+03
330	265	6.5634E-01	3.0022E+00	6.4336E+03	2.8015E+03	6.2998E-04	1.0959E+04	2.6229E+05	6.5890E+03
331	266	6.5739E-01	3.0173E+00	6.2713E+03	2.7853E+03	6.1766E-04	1.0982E+04	2.6218E+05	6.5890E+03
332	267	6.5844E-01	3.0323E+00	6.1147E+03	2.7694E+03	6.0570E-04	1.1005E+04	2.6207E+05	6.5890E+03
333	268	6.5949E-01	3.0472E+00	5.9635E+03	2.7537E+03	5.9409E-04	1.1028E+04	2.6195E+05	6.5890E+03
334	269	6.6054E-01	3.0619E+00	5.8174E+03	2.7382E+03	5.8281E-04	1.1050E+04	2.6184E+05	6.5890E+03
335	270	6.6159E-01	3.0765E+00	5.6763E+03	2.7230E+03	5.7184E-04	1.1072E+04	2.6173E+05	6.5890E+03
336	271	6.6264E-01	3.0910E+00	5.5399E+03	2.7081E+03	5.6119E-04	1.1093E+04	2.6161E+05	6.5890E+03
337	272	6.6369E-01	3.1053E+00	5.4081E+03	2.6933E+03	5.5083E-04	1.1114E+04	2.6150E+05	6.5890E+03
338	273	6.6474E-01	3.1195E+00	5.2805E+03	2.6788E+03	5.4076E-04	1.1135E+04	2.6139E+05	6.5890E+03
339	274	6.6579E-01	3.1336E+00	5.1572E+03	2.6645E+03	5.3096E-04	1.1155E+04	2.6128E+05	6.5890E+03
340	275	6.6684E-01	3.1475E+00	5.0378E+03	2.6504E+03	5.2143E-04	1.1175E+04	2.6116E+05	6.5890E+03
341	276	6.6789E-01	3.1614E+00	4.9222E+03	2.6365E+03	5.1215E-04	1.1195E+04	2.6105E+05	6.5890E+03
342	277	6.6894E-01	3.1751E+00	4.8103E+03	2.6228E+03	5.0312E-04	1.1214E+04	2.6094E+05	6.5890E+03
343	278	6.6999E-01	3.1887E+00	4.7019E+03	2.6093E+03	4.9432E-04	1.1234E+04	2.6083E+05	6.5890E+03
344	279	6.7104E-01	3.2022E+00	4.5968E+03	2.5960E+03	4.8576E-04	1.1252E+04	2.6072E+05	6.5890E+03
345	280	6.7209E-01	3.2156E+00	4.4950E+03	2.5829E+03	4.7742E-04	1.1271E+04	2.6060E+05	6.5890E+03
346	281	6.7314E-01	3.2289E+00	4.3963E+03	2.5699E+03	4.6929E-04	1.1289E+04	2.6049E+05	6.5890E+03
347	282	6.7419E-01	3.2421E+00	4.3006E+03	2.5571E+03	4.6136E-04	1.1307E+04	2.6038E+05	6.5890E+03
348	283	6.7524E-01	3.2552E+00	4.2078E+03	2.5445E+03	4.5364E-04	1.1325E+04	2.6027E+05	6.5890E+03
349	284	6.7629E-01	3.2682E+00	4.1178E+03	2.5321E+03	4.4611E-04	1.1342E+04	2.6016E+05	6.5890E+03
350	285	6.7734E-01	3.2811E+00	4.0304E+03	2.5199E+03	4.3876E-04	1.1359E+04	2.6005E+05	6.5890E+03
351	286	6.7839E-01	3.2939E+00	3.9455E+03	2.5078E+03	4.3160E-04	1.1376E+04	2.5994E+05	6.5890E+03
352	287	6.7944E-01	3.3066E+00	3.8631E+03	2.4958E+03	4.2461E-04	1.1393E+04	2.5983E+05	6.5890E+03
353	288	6.8049E-01	3.3192E+00	3.7831E+03	2.4840E+03	4.1779E-04	1.1409E+04	2.5972E+05	6.5890E+03
354	289	6.8154E-01	3.3317E+00	3.7054E+03	2.4724E+03	4.1113E-04	1.1425E+04	2.5961E+05	6.5890E+03
355	290	6.8259E-01	3.3441E+00	3.6299E+03	2.4609E+03	4.0463E-04	1.1441E+04	2.5950E+05	6.5890E+03
356	291	6.8364E-01	3.3564E+00	3.5565E+03	2.4496E+03	3.9828E-04	1.1457E+04	2.5939E+05	6.5890E+03
357	292	6.8469E-01	3.3687E+00	3.4852E+03	2.4384E+03	3.9209E-04	1.1472E+04	2.5928E+05	6.5890E+03
358	293	6.8574E-01	3.3808E+00	3.4158E+03	2.4274E+03	3.8603E-04	1.1487E+04	2.5918E+05	6.5890E+03
359	294	6.8679E-01	3.3929E+00	3.3483E+03	2.4164E+03	3.8012E-04	1.1502E+04	2.5907E+05	6.5890E+03
360	295	6.8784E-01	3.4049E+00	3.2827E+03	2.4057E+03	3.7434E-04	1.1517E+04	2.5896E+05	6.5890E+03
361	296	6.8889E-01	3.4168E+00	3.2188E+03	2.3950E+03	3.6869E-04	1.1532E+04	2.5885E+05	6.5890E+03
362	297	6.8994E-01	3.4286E+00	3.1567E+03	2.3845E+03	3.6316E-04	1.1546E+04	2.5874E+05	6.5890E+03
363	298	6.9099E-01	3.4403E+00	3.0962E+03	2.3741E+03	3.5776E-04	1.1561E+04	2.5863E+05	6.5890E+03
364	299	6.9204E-01	3.4520E+00	3.0373E+03	2.3638E+03	3.5249E-04	1.1575E+04	2.5853E+05	6.5890E+03
365	300	6.9309E-01	3.4636E+00	2.9800E+03	2.3537E+03	3.4732E-04	1.1589E+04	2.5842E+05	6.5890E+03
366	301	6.9414E-01	3.4751E+00	2.9241E+03	2.3437E+03	3.4227E-04	1.1602E+04	2.5831E+05	6.5890E+03
367	302	7.0145E-01	3.5283E+00	2.6785E+03	2.2979E+03	3.1976E-04	1.1665E+04	2.5769E+05	6.5890E+03
368	303	7.0875E-01	3.5800E+00	2.4607E+03	2.2546E+03	2.9939E-04	1.1723E+04	2.5708E+05	6.5890E+03

369	304	7.1606E-01	3.6301E+00	2.2667E+03	2.2135E+03	2.8091E-04	1.1779E+04	2.5647E+05	6.5890E+03
370	305	7.2337E-01	3.6789E+00	2.0933E+03	2.1745E+03	2.6409E-04	1.1831E+04	2.5586E+05	6.5890E+03
371	306	7.3068E-01	3.7264E+00	1.9379E+03	2.1372E+03	2.4873E-04	1.1881E+04	2.5525E+05	6.5890E+03
372	307	7.3799E-01	3.7727E+00	1.7980E+03	2.1018E+03	2.3468E-04	1.1928E+04	2.5465E+05	6.5890E+03
373	308	7.4530E-01	3.8178E+00	1.6718E+03	2.0679E+03	2.2178E-04	1.1973E+04	2.5406E+05	6.5890E+03
374	309	7.5260E-01	3.8619E+00	1.5576E+03	2.0355E+03	2.0992E-04	1.2016E+04	2.5346E+05	6.5890E+03
375	310	7.5991E-01	3.9049E+00	1.4539E+03	2.0045E+03	1.9898E-04	1.2057E+04	2.5287E+05	6.5890E+03
376	311	7.6722E-01	3.9469E+00	1.3596E+03	1.9747E+03	1.8887E-04	1.2096E+04	2.5228E+05	6.5890E+03
377	312	7.7453E-01	3.9880E+00	1.2736E+03	1.9462E+03	1.7951E-04	1.2133E+04	2.5170E+05	6.5890E+03
378	313	7.8184E-01	4.0282E+00	1.1949E+03	1.9188E+03	1.7084E-04	1.2169E+04	2.5112E+05	6.5890E+03
379	314	7.8914E-01	4.0675E+00	1.1229E+03	1.8925E+03	1.6277E-04	1.2203E+04	2.5055E+05	6.5890E+03
380	315	7.9645E-01	4.1061E+00	1.0567E+03	1.8671E+03	1.5526E-04	1.2236E+04	2.4997E+05	6.5890E+03
381	316	8.0376E-01	4.1438E+00	9.9589E+02	1.8427E+03	1.4826E-04	1.2268E+04	2.4941E+05	6.5890E+03
382	317	8.1107E-01	4.1809E+00	9.3980E+02	1.8192E+03	1.4172E-04	1.2298E+04	2.4884E+05	6.5890E+03
383	318	8.1838E-01	4.2172E+00	8.8801E+02	1.7965E+03	1.3560E-04	1.2327E+04	2.4828E+05	6.5890E+03
384	319	8.2568E-01	4.2529E+00	8.4010E+02	1.7745E+03	1.2987E-04	1.2356E+04	2.4772E+05	6.5890E+03
385	320	8.3299E-01	4.2879E+00	7.9571E+02	1.7534E+03	1.2449E-04	1.2383E+04	2.4717E+05	6.5890E+03
386	321	8.4030E-01	4.3223E+00	7.5452E+02	1.7329E+03	1.1945E-04	1.2409E+04	2.4662E+05	6.5890E+03
387	322	8.4761E-01	4.3561E+00	7.1623E+02	1.7131E+03	1.1470E-04	1.2434E+04	2.4607E+05	6.5890E+03
388	323	8.5492E-01	4.3893E+00	6.8060E+02	1.6939E+03	1.1022E-04	1.2459E+04	2.4553E+05	6.5890E+03
389	324	8.6222E-01	4.4220E+00	6.4738E+02	1.6753E+03	1.0601E-04	1.2482E+04	2.4499E+05	6.5890E+03
390	325	8.6953E-01	4.4541E+00	6.1637E+02	1.6572E+03	1.0203E-04	1.2505E+04	2.4445E+05	6.5890E+03
391	326	8.7684E-01	4.4858E+00	5.8740E+02	1.6398E+03	9.8270E-05	1.2527E+04	2.4391E+05	6.5890E+03
392	327	8.8415E-01	4.5169E+00	5.6028E+02	1.6228E+03	9.4713E-05	1.2549E+04	2.4338E+05	6.5890E+03
393	328	8.9146E-01	4.5475E+00	5.3488E+02	1.6063E+03	9.1346E-05	1.2570E+04	2.4285E+05	6.5890E+03
394	329	8.9876E-01	4.5777E+00	5.1104E+02	1.5903E+03	8.8155E-05	1.2590E+04	2.4233E+05	6.5890E+03
395	330	9.0607E-01	4.6074E+00	4.8867E+02	1.5747E+03	8.5128E-05	1.2609E+04	2.4181E+05	6.5890E+03
396	331	9.1338E-01	4.6367E+00	4.6763E+02	1.5596E+03	8.2254E-05	1.2628E+04	2.4129E+05	6.5890E+03
397	332	9.2069E-01	4.6656E+00	4.4783E+02	1.5449E+03	7.9523E-05	1.2647E+04	2.4077E+05	6.5890E+03
398	333	9.2800E-01	4.6940E+00	4.2918E+02	1.5305E+03	7.6925E-05	1.2665E+04	2.4026E+05	6.5890E+03
399	334	9.3530E-01	4.7221E+00	4.1159E+02	1.5166E+03	7.4452E-05	1.2682E+04	2.3975E+05	6.5890E+03
400	335	9.4261E-01	4.7498E+00	3.9499E+02	1.5029E+03	7.2096E-05	1.2699E+04	2.3924E+05	6.5890E+03
401	336	9.4992E-01	4.7771E+00	3.7931E+02	1.4897E+03	6.9850E-05	1.2716E+04	2.3874E+05	6.5890E+03
402	337	9.5723E-01	4.8040E+00	3.6448E+02	1.4768E+03	6.7707E-05	1.2732E+04	2.3824E+05	6.5890E+03
403	338	9.6454E-01	4.8306E+00	3.5045E+02	1.4641E+03	6.5661E-05	1.2748E+04	2.3774E+05	6.5890E+03
404	339	9.7184E-01	4.8569E+00	3.3716E+02	1.4518E+03	6.3706E-05	1.2763E+04	2.3724E+05	6.5890E+03
405	340	9.7915E-01	4.8828E+00	3.2456E+02	1.4398E+03	6.1837E-05	1.2778E+04	2.3675E+05	6.5890E+03
406	341	9.8646E-01	4.9084E+00	3.1260E+02	1.4281E+03	6.0049E-05	1.2792E+04	2.3626E+05	6.5890E+03
407	342	9.9377E-01	4.9337E+00	3.0125E+02	1.4166E+03	5.8337E-05	1.2807E+04	2.3577E+05	6.5890E+03
408	343	1.0011E+00	4.9587E+00	2.9047E+02	1.4054E+03	5.6697E-05	1.2820E+04	2.3528E+05	6.5890E+03
409	344	1.0084E+00	4.9833E+00	2.8022E+02	1.3945E+03	5.5125E-05	1.2834E+04	2.3480E+05	6.5890E+03
410	345	1.0157E+00	5.0077E+00	2.7046E+02	1.3838E+03	5.3617E-05	1.2847E+04	2.3432E+05	6.5890E+03
411	346	1.0230E+00	5.0318E+00	2.6117E+02	1.3733E+03	5.2170E-05	1.2860E+04	2.3384E+05	6.5890E+03
412	347	1.0303E+00	5.0556E+00	2.5232E+02	1.3631E+03	5.0781E-05	1.2873E+04	2.3337E+05	6.5890E+03
413	348	1.0376E+00	5.0792E+00	2.4389E+02	1.3531E+03	4.9447E-05	1.2885E+04	2.3289E+05	6.5890E+03
414	349	1.0449E+00	5.1025E+00	2.3584E+02	1.3432E+03	4.8164E-05	1.2897E+04	2.3242E+05	6.5890E+03

415	350	1.0522E+00	5.1255E+00	2.2815E+02	1.3336E+03	4.6931E-05	1.2909E+04	2.3195E+05	6.5890E+03
416	351	1.0595E+00	5.1483E+00	2.2081E+02	1.3242E+03	4.5744E-05	1.2921E+04	2.3149E+05	6.5890E+03
417	352	1.0668E+00	5.1708E+00	2.1380E+02	1.3150E+03	4.4601E-05	1.2932E+04	2.3102E+05	6.5890E+03
418	353	1.0742E+00	5.1931E+00	2.0709E+02	1.3060E+03	4.3501E-05	1.2943E+04	2.3056E+05	6.5890E+03
419	354	1.0815E+00	5.2152E+00	2.0068E+02	1.2971E+03	4.2441E-05	1.2954E+04	2.3010E+05	6.5890E+03
420	355	1.0888E+00	5.2370E+00	1.9453E+02	1.2884E+03	4.1419E-05	1.2964E+04	2.2964E+05	6.5890E+03
421	356	1.0961E+00	5.2586E+00	1.8865E+02	1.2799E+03	4.0433E-05	1.2975E+04	2.2919E+05	6.5890E+03
422	357	1.1034E+00	5.2800E+00	1.8301E+02	1.2716E+03	3.9482E-05	1.2985E+04	2.2874E+05	6.5890E+03
423	358	1.1107E+00	5.3012E+00	1.7760E+02	1.2634E+03	3.8564E-05	1.2995E+04	2.2828E+05	6.5890E+03
424	359	1.1180E+00	5.3222E+00	1.7242E+02	1.2553E+03	3.7678E-05	1.3005E+04	2.2784E+05	6.5890E+03
425	360	1.1253E+00	5.3429E+00	1.6744E+02	1.2474E+03	3.6822E-05	1.3014E+04	2.2739E+05	6.5890E+03
426	361	1.1326E+00	5.3635E+00	1.6266E+02	1.2397E+03	3.5994E-05	1.3024E+04	2.2694E+05	6.5890E+03
427	362	1.1399E+00	5.3838E+00	1.5807E+02	1.2321E+03	3.5195E-05	1.3033E+04	2.2650E+05	6.5890E+03
428	363	1.1472E+00	5.4040E+00	1.5366E+02	1.2246E+03	3.4421E-05	1.3042E+04	2.2606E+05	6.5890E+03
429	364	1.1545E+00	5.4240E+00	1.4942E+02	1.2173E+03	3.3673E-05	1.3051E+04	2.2562E+05	6.5890E+03
430	365	1.1619E+00	5.4438E+00	1.4534E+02	1.2101E+03	3.2948E-05	1.3060E+04	2.2518E+05	6.5890E+03
431	366	1.1692E+00	5.4634E+00	1.4141E+02	1.2030E+03	3.2247E-05	1.3068E+04	2.2475E+05	6.5890E+03
432	367	1.1765E+00	5.4828E+00	1.3763E+02	1.1960E+03	3.1568E-05	1.3077E+04	2.2432E+05	6.5890E+03
433	368	1.1838E+00	5.5020E+00	1.3399E+02	1.1892E+03	3.0910E-05	1.3085E+04	2.2389E+05	6.5890E+03
434	369	1.1911E+00	5.5211E+00	1.3048E+02	1.1824E+03	3.0272E-05	1.3093E+04	2.2346E+05	6.5890E+03
435	370	1.1984E+00	5.5400E+00	1.2710E+02	1.1758E+03	2.9654E-05	1.3101E+04	2.2303E+05	6.5890E+03
436	371	1.2057E+00	5.5588E+00	1.2384E+02	1.1693E+03	2.9055E-05	1.3109E+04	2.2260E+05	6.5890E+03
437	372	1.2130E+00	5.5774E+00	1.2070E+02	1.1629E+03	2.8473E-05	1.3117E+04	2.2218E+05	6.5890E+03
438	373	1.2203E+00	5.5958E+00	1.1767E+02	1.1566E+03	2.7909E-05	1.3125E+04	2.2176E+05	6.5890E+03
439	374	1.2276E+00	5.6141E+00	1.1474E+02	1.1504E+03	2.7361E-05	1.3132E+04	2.2134E+05	6.5890E+03
440	375	1.2349E+00	5.6322E+00	1.1191E+02	1.1443E+03	2.6830E-05	1.3139E+04	2.2092E+05	6.5890E+03
441	376	1.2422E+00	5.6501E+00	1.0918E+02	1.1383E+03	2.6313E-05	1.3147E+04	2.2050E+05	6.5890E+03
442	377	1.2495E+00	5.6679E+00	1.0654E+02	1.1324E+03	2.5811E-05	1.3154E+04	2.2009E+05	6.5890E+03
443	378	1.2569E+00	5.6856E+00	1.0399E+02	1.1265E+03	2.5324E-05	1.3161E+04	2.1967E+05	6.5890E+03
444	379	1.2642E+00	5.7031E+00	1.0153E+02	1.1208E+03	2.4850E-05	1.3168E+04	2.1926E+05	6.5890E+03
445	380	1.2715E+00	5.7205E+00	9.9144E+01	1.1151E+03	2.4389E-05	1.3175E+04	2.1885E+05	6.5890E+03
446	381	1.2788E+00	5.7377E+00	9.6837E+01	1.1096E+03	2.3941E-05	1.3181E+04	2.1844E+05	6.5890E+03
447	382	1.2861E+00	5.7548E+00	9.4605E+01	1.1041E+03	2.3505E-05	1.3188E+04	2.1804E+05	6.5890E+03
448	383	1.2934E+00	5.7718E+00	9.2443E+01	1.0987E+03	2.3081E-05	1.3194E+04	2.1763E+05	6.5890E+03
449	384	1.3007E+00	5.7886E+00	9.0350E+01	1.0934E+03	2.2669E-05	1.3201E+04	2.1723E+05	6.5890E+03
450	385	1.3080E+00	5.8054E+00	8.8323E+01	1.0881E+03	2.2267E-05	1.3207E+04	2.1683E+05	6.5890E+03
451	386	1.3153E+00	5.8219E+00	8.6359E+01	1.0830E+03	2.1876E-05	1.3213E+04	2.1643E+05	6.5890E+03
452	387	1.3226E+00	5.8384E+00	8.4456E+01	1.0779E+03	2.1495E-05	1.3219E+04	2.1603E+05	6.5890E+03
453	388	1.3299E+00	5.8547E+00	8.2610E+01	1.0728E+03	2.1123E-05	1.3225E+04	2.1563E+05	6.5890E+03
454	389	1.3372E+00	5.8709E+00	8.0821E+01	1.0679E+03	2.0762E-05	1.3231E+04	2.1524E+05	6.5890E+03
455	390	1.3446E+00	5.8870E+00	7.9085E+01	1.0630E+03	2.0409E-05	1.3237E+04	2.1484E+05	6.5890E+03
456	391	1.3519E+00	5.9030E+00	7.7401E+01	1.0582E+03	2.0066E-05	1.3243E+04	2.1445E+05	6.5890E+03
457	392	1.3592E+00	5.9188E+00	7.5767E+01	1.0534E+03	1.9731E-05	1.3249E+04	2.1406E+05	6.5890E+03
458	393	1.3665E+00	5.9345E+00	7.4181E+01	1.0487E+03	1.9404E-05	1.3254E+04	2.1367E+05	6.5890E+03
459	394	1.3738E+00	5.9501E+00	7.2641E+01	1.0441E+03	1.9085E-05	1.3260E+04	2.1328E+05	6.5890E+03
460	395	1.3811E+00	5.9657E+00	7.1145E+01	1.0395E+03	1.8775E-05	1.3265E+04	2.1289E+05	6.5890E+03

461	396	1.3884E+00	5.9810E+00	6.9692E+01	1.0350E+03	1.8471E-05	1.3271E+04	2.1250E+05	6.5890E+03
462	397	1.3957E+00	5.9963E+00	6.8281E+01	1.0306E+03	1.8175E-05	1.3276E+04	2.1212E+05	6.5890E+03
463	398	1.4030E+00	6.0115E+00	6.6909E+01	1.0262E+03	1.7886E-05	1.3281E+04	2.1174E+05	6.5890E+03
464	399	1.4103E+00	6.0266E+00	6.5575E+01	1.0219E+03	1.7604E-05	1.3286E+04	2.1135E+05	6.5890E+03
465	400	1.4176E+00	6.0416E+00	6.4278E+01	1.0176E+03	1.7328E-05	1.3291E+04	2.1097E+05	6.5890E+03
466	401	1.4249E+00	6.0564E+00	6.3017E+01	1.0134E+03	1.7059E-05	1.3296E+04	2.1060E+05	6.5890E+03
467	402	1.4353E+00	6.0682E+00	6.1985E+01	1.0101E+03	1.6835E-05	1.3300E+04	2.1011E+05	6.5890E+03
468	403	1.4457E+00	6.0798E+00	6.0976E+01	1.0068E+03	1.6615E-05	1.3304E+04	2.0962E+05	6.5890E+03
469	404	1.4561E+00	6.0914E+00	5.9990E+01	1.0035E+03	1.6399E-05	1.3308E+04	2.0914E+05	6.5890E+03
470	405	1.4665E+00	6.1029E+00	5.9026E+01	1.0003E+03	1.6187E-05	1.3312E+04	2.0866E+05	6.5890E+03
471	406	1.4769E+00	6.1144E+00	5.8085E+01	9.9715E+02	1.5980E-05	1.3316E+04	2.0818E+05	6.5890E+03
472	407	1.4872E+00	6.1258E+00	5.7164E+01	9.9400E+02	1.5776E-05	1.3320E+04	2.0770E+05	6.5890E+03
473	408	1.4976E+00	6.1371E+00	5.6264E+01	9.9089E+02	1.5576E-05	1.3323E+04	2.0722E+05	6.5890E+03
474	409	1.5080E+00	6.1483E+00	5.5383E+01	9.8781E+02	1.5380E-05	1.3327E+04	2.0675E+05	6.5890E+03
475	410	1.5184E+00	6.1595E+00	5.4522E+01	9.8477E+02	1.5188E-05	1.3331E+04	2.0628E+05	6.5890E+03
476	411	1.5288E+00	6.1706E+00	5.3680E+01	9.8175E+02	1.5000E-05	1.3334E+04	2.0581E+05	6.5890E+03
477	412	1.5392E+00	6.1817E+00	5.2856E+01	9.7877E+02	1.4814E-05	1.3338E+04	2.0534E+05	6.5890E+03
478	413	1.5495E+00	6.1926E+00	5.2050E+01	9.7581E+02	1.4633E-05	1.3341E+04	2.0488E+05	6.5890E+03
479	414	1.5599E+00	6.2035E+00	5.1261E+01	9.7289E+02	1.4454E-05	1.3345E+04	2.0441E+05	6.5890E+03
480	415	1.5703E+00	6.2144E+00	5.0489E+01	9.6999E+02	1.4279E-05	1.3348E+04	2.0395E+05	6.5890E+03
481	416	1.5807E+00	6.2252E+00	4.9733E+01	9.6713E+02	1.4107E-05	1.3352E+04	2.0349E+05	6.5890E+03
482	417	1.5911E+00	6.2359E+00	4.8993E+01	9.6429E+02	1.3938E-05	1.3355E+04	2.0303E+05	6.5890E+03
483	418	1.6015E+00	6.2466E+00	4.8268E+01	9.6148E+02	1.3772E-05	1.3358E+04	2.0258E+05	6.5890E+03
484	419	1.6118E+00	6.2572E+00	4.7559E+01	9.5869E+02	1.3609E-05	1.3362E+04	2.0212E+05	6.5890E+03
485	420	1.6222E+00	6.2677E+00	4.6864E+01	9.5594E+02	1.3449E-05	1.3365E+04	2.0167E+05	6.5890E+03
486	421	1.6326E+00	6.2782E+00	4.6183E+01	9.5321E+02	1.3291E-05	1.3368E+04	2.0122E+05	6.5890E+03
487	422	1.6430E+00	6.2887E+00	4.5517E+01	9.5051E+02	1.3137E-05	1.3371E+04	2.0077E+05	6.5890E+03
488	423	1.6534E+00	6.2990E+00	4.4864E+01	9.4783E+02	1.2985E-05	1.3374E+04	2.0032E+05	6.5890E+03
489	424	1.6638E+00	6.3093E+00	4.4224E+01	9.4518E+02	1.2835E-05	1.3378E+04	1.9987E+05	6.5890E+03
490	425	1.6741E+00	6.3196E+00	4.3596E+01	9.4255E+02	1.2689E-05	1.3381E+04	1.9943E+05	6.5890E+03
491	426	1.6845E+00	6.3298E+00	4.2982E+01	9.3995E+02	1.2544E-05	1.3384E+04	1.9899E+05	6.5890E+03
492	427	1.6949E+00	6.3399E+00	4.2379E+01	9.3737E+02	1.2402E-05	1.3387E+04	1.9855E+05	6.5890E+03
493	428	1.7053E+00	6.3500E+00	4.1788E+01	9.3482E+02	1.2263E-05	1.3390E+04	1.9811E+05	6.5890E+03
494	429	1.7157E+00	6.3601E+00	4.1209E+01	9.3229E+02	1.2126E-05	1.3393E+04	1.9767E+05	6.5890E+03
495	430	1.7260E+00	6.3700E+00	4.0642E+01	9.2978E+02	1.1991E-05	1.3396E+04	1.9724E+05	6.5890E+03
496	431	1.7364E+00	6.3800E+00	4.0085E+01	9.2730E+02	1.1858E-05	1.3399E+04	1.9680E+05	6.5890E+03
497	432	1.7468E+00	6.3898E+00	3.9539E+01	9.2483E+02	1.1728E-05	1.3402E+04	1.9637E+05	6.5890E+03
498	433	1.7572E+00	6.3997E+00	3.9003E+01	9.2240E+02	1.1600E-05	1.3405E+04	1.9594E+05	6.5890E+03
499	434	1.7676E+00	6.4094E+00	3.8478E+01	9.1998E+02	1.1474E-05	1.3407E+04	1.9551E+05	6.5890E+03
500	435	1.7780E+00	6.4191E+00	3.7963E+01	9.1759E+02	1.1349E-05	1.3410E+04	1.9508E+05	6.5890E+03
501	436	1.7883E+00	6.4288E+00	3.7457E+01	9.1521E+02	1.1227E-05	1.3413E+04	1.9466E+05	6.5890E+03
502	437	1.7987E+00	6.4384E+00	3.6961E+01	9.1286E+02	1.1107E-05	1.3416E+04	1.9423E+05	6.5890E+03
503	438	1.8091E+00	6.4480E+00	3.6474E+01	9.1053E+02	1.0989E-05	1.3419E+04	1.9381E+05	6.5890E+03
504	439	1.8195E+00	6.4575E+00	3.5996E+01	9.0821E+02	1.0873E-05	1.3421E+04	1.9339E+05	6.5890E+03
505	440	1.8299E+00	6.4670E+00	3.5527E+01	9.0592E+02	1.0758E-05	1.3424E+04	1.9297E+05	6.5890E+03
506	441	1.8403E+00	6.4764E+00	3.5066E+01	9.0365E+02	1.0645E-05	1.3427E+04	1.9255E+05	6.5890E+03

507	442	1.8506E+00	6.4857E+00	3.4614E+01	9.0140E+02	1.0534E-05	1.3429E+04	1.9213E+05	6.5890E+03
508	443	1.8610E+00	6.4951E+00	3.4170E+01	8.9917E+02	1.0425E-05	1.3432E+04	1.9172E+05	6.5890E+03
509	444	1.8714E+00	6.5043E+00	3.3734E+01	8.9695E+02	1.0317E-05	1.3435E+04	1.9131E+05	6.5890E+03
510	445	1.8818E+00	6.5136E+00	3.3306E+01	8.9476E+02	1.0211E-05	1.3437E+04	1.9089E+05	6.5890E+03
511	446	1.8922E+00	6.5227E+00	3.2886E+01	8.9259E+02	1.0107E-05	1.3440E+04	1.9048E+05	6.5890E+03
512	447	1.9026E+00	6.5319E+00	3.2473E+01	8.9043E+02	1.0004E-05	1.3442E+04	1.9007E+05	6.5890E+03
513	448	1.9129E+00	6.5409E+00	3.2068E+01	8.8829E+02	9.9033E-06	1.3445E+04	1.8967E+05	6.5890E+03
514	449	1.9233E+00	6.5500E+00	3.1669E+01	8.8617E+02	9.8036E-06	1.3447E+04	1.8926E+05	6.5890E+03
515	450	1.9337E+00	6.5590E+00	3.1278E+01	8.8407E+02	9.7055E-06	1.3450E+04	1.8885E+05	6.5890E+03
516	451	1.9441E+00	6.5679E+00	3.0893E+01	8.8198E+02	9.6088E-06	1.3452E+04	1.8845E+05	6.5890E+03
517	452	1.9545E+00	6.5768E+00	3.0515E+01	8.7992E+02	9.5136E-06	1.3455E+04	1.8805E+05	6.5890E+03
518	453	1.9649E+00	6.5857E+00	3.0144E+01	8.7786E+02	9.4197E-06	1.3457E+04	1.8765E+05	6.5890E+03
519	454	1.9752E+00	6.5945E+00	2.9779E+01	8.7583E+02	9.3273E-06	1.3459E+04	1.8725E+05	6.5890E+03
520	455	1.9856E+00	6.6033E+00	2.9420E+01	8.7381E+02	9.2362E-06	1.3462E+04	1.8685E+05	6.5890E+03
521	456	1.9960E+00	6.6120E+00	2.9067E+01	8.7181E+02	9.1464E-06	1.3464E+04	1.8646E+05	6.5890E+03
522	457	2.0064E+00	6.6207E+00	2.8721E+01	8.6983E+02	9.0579E-06	1.3467E+04	1.8606E+05	6.5890E+03
523	458	2.0168E+00	6.6294E+00	2.8380E+01	8.6786E+02	8.9707E-06	1.3469E+04	1.8567E+05	6.5890E+03
524	459	2.0272E+00	6.6380E+00	2.8045E+01	8.6590E+02	8.8848E-06	1.3471E+04	1.8527E+05	6.5890E+03
525	460	2.0375E+00	6.6465E+00	2.7715E+01	8.6397E+02	8.8001E-06	1.3473E+04	1.8488E+05	6.5890E+03
526	461	2.0479E+00	6.6550E+00	2.7391E+01	8.6205E+02	8.7165E-06	1.3476E+04	1.8449E+05	6.5890E+03
527	462	2.0583E+00	6.6635E+00	2.7072E+01	8.6014E+02	8.6342E-06	1.3478E+04	1.8410E+05	6.5890E+03
528	463	2.0687E+00	6.6720E+00	2.6759E+01	8.5825E+02	8.5530E-06	1.3480E+04	1.8371E+05	6.5890E+03
529	464	2.0791E+00	6.6804E+00	2.6450E+01	8.5637E+02	8.4730E-06	1.3482E+04	1.8333E+05	6.5890E+03
530	465	2.0894E+00	6.6887E+00	2.6147E+01	8.5451E+02	8.3941E-06	1.3485E+04	1.8294E+05	6.5890E+03
531	466	2.0998E+00	6.6970E+00	2.5849E+01	8.5266E+02	8.3163E-06	1.3487E+04	1.8256E+05	6.5890E+03
532	467	2.1102E+00	6.7053E+00	2.5555E+01	8.5083E+02	8.2395E-06	1.3489E+04	1.8218E+05	6.5890E+03
533	468	2.1206E+00	6.7136E+00	2.5266E+01	8.4901E+02	8.1638E-06	1.3491E+04	1.8180E+05	6.5890E+03
534	469	2.1310E+00	6.7218E+00	2.4982E+01	8.4720E+02	8.0892E-06	1.3493E+04	1.8142E+05	6.5890E+03
535	470	2.1414E+00	6.7300E+00	2.4702E+01	8.4541E+02	8.0155E-06	1.3495E+04	1.8104E+05	6.5890E+03
536	471	2.1517E+00	6.7381E+00	2.4427E+01	8.4363E+02	7.9429E-06	1.3497E+04	1.8066E+05	6.5890E+03
537	472	2.1621E+00	6.7462E+00	2.4156E+01	8.4187E+02	7.8712E-06	1.3499E+04	1.8029E+05	6.5890E+03
538	473	2.1725E+00	6.7542E+00	2.3889E+01	8.4012E+02	7.8005E-06	1.3501E+04	1.7991E+05	6.5890E+03
539	474	2.1829E+00	6.7623E+00	2.3626E+01	8.3838E+02	7.7308E-06	1.3504E+04	1.7954E+05	6.5890E+03
540	475	2.1933E+00	6.7702E+00	2.3368E+01	8.3665E+02	7.6620E-06	1.3506E+04	1.7917E+05	6.5890E+03
541	476	2.2037E+00	6.7782E+00	2.3113E+01	8.3494E+02	7.5941E-06	1.3508E+04	1.7879E+05	6.5890E+03
542	477	2.2140E+00	6.7861E+00	2.2863E+01	8.3324E+02	7.5271E-06	1.3510E+04	1.7842E+05	6.5890E+03
543	478	2.2244E+00	6.7940E+00	2.2616E+01	8.3155E+02	7.4609E-06	1.3512E+04	1.7806E+05	6.5890E+03
544	479	2.2348E+00	6.8018E+00	2.2373E+01	8.2988E+02	7.3957E-06	1.3514E+04	1.7769E+05	6.5890E+03
545	480	2.2452E+00	6.8096E+00	2.2134E+01	8.2822E+02	7.3313E-06	1.3515E+04	1.7732E+05	6.5890E+03
546	481	2.2556E+00	6.8174E+00	2.1898E+01	8.2657E+02	7.2677E-06	1.3517E+04	1.7696E+05	6.5890E+03
547	482	2.2660E+00	6.8251E+00	2.1666E+01	8.2493E+02	7.2050E-06	1.3519E+04	1.7659E+05	6.5890E+03
548	483	2.2763E+00	6.8328E+00	2.1438E+01	8.2330E+02	7.1430E-06	1.3521E+04	1.7623E+05	6.5890E+03
549	484	2.2867E+00	6.8405E+00	2.1212E+01	8.2169E+02	7.0819E-06	1.3523E+04	1.7587E+05	6.5890E+03
550	485	2.2971E+00	6.8481E+00	2.0991E+01	8.2009E+02	7.0215E-06	1.3525E+04	1.7551E+05	6.5890E+03
551	486	2.3075E+00	6.8557E+00	2.0772E+01	8.1850E+02	6.9619E-06	1.3527E+04	1.7515E+05	6.5890E+03
552	487	2.3179E+00	6.8633E+00	2.0557E+01	8.1692E+02	6.9031E-06	1.3529E+04	1.7479E+05	6.5890E+03

488	2.3283E+00	6.8708E+00	2.0345E+01	8.1535E+02	6.8450E-06	1.3531E+04	1.7443E+05	6.5890E+03
489	2.3386E+00	6.8783E+00	2.0136E+01	8.1379E+02	6.7876E-06	1.3532E+04	1.7407E+05	6.5890E+03
490	2.3490E+00	6.8857E+00	1.9930E+01	8.1225E+02	6.7310E-06	1.3534E+04	1.7372E+05	6.5890E+03
491	2.3594E+00	6.8932E+00	1.9727E+01	8.1071E+02	6.6750E-06	1.3536E+04	1.7336E+05	6.5890E+03
492	2.3698E+00	6.9006E+00	1.9527E+01	8.0919E+02	6.6198E-06	1.3538E+04	1.7301E+05	6.5890E+03
493	2.3802E+00	6.9079E+00	1.9329E+01	8.0768E+02	6.5652E-06	1.3540E+04	1.7266E+05	6.5890E+03
494	2.3906E+00	6.9153E+00	1.9135E+01	8.0617E+02	6.5113E-06	1.3541E+04	1.7231E+05	6.5890E+03
495	2.4009E+00	6.9226E+00	1.8943E+01	8.0468E+02	6.4581E-06	1.3543E+04	1.7196E+05	6.5890E+03
496	2.4113E+00	6.9299E+00	1.8755E+01	8.0320E+02	6.4055E-06	1.3545E+04	1.7161E+05	6.5890E+03
497	2.4217E+00	6.9371E+00	1.8568E+01	8.0173E+02	6.3535E-06	1.3546E+04	1.7126E+05	6.5890E+03
498	2.4321E+00	6.9443E+00	1.8385E+01	8.0027E+02	6.3022E-06	1.3548E+04	1.7091E+05	6.5890E+03
499	2.4425E+00	6.9515E+00	1.8204E+01	7.9881E+02	6.2515E-06	1.3550E+04	1.7057E+05	6.5890E+03
500	2.4529E+00	6.9586E+00	1.8025E+01	7.9737E+02	6.2014E-06	1.3552E+04	1.7022E+05	6.5890E+03
501	2.4632E+00	6.9657E+00	1.7849E+01	7.9594E+02	6.1519E-06	1.3553E+04	1.6988E+05	6.5890E+03

nozzle pressure ratio (NPR) 2.6990E+09

nozzle area ratio (a9/a8) 4.4016E+02

flow station number		7	8	9
flow area	(ft**2)	2.181E-02	5.454E-03	2.401E+00
Mach number		1.480E-01	1.000E+00	6.966E+00
pressure	(lbf/ft**2)	2.661E+05	1.468E+05	1.785E+01
temperature	(R)	6.567E+03	5.730E+03	7.959E+02
density	(slg/ft**3)	1.111E-02	7.030E-03	6.152E-06
velocity	(ft/s)	8.255E+02	5.220E+03	1.355E+04
total pressure	(lbf/ft**2)	2.699E+05	2.696E+05	1.699E+05
total temperature	(R)	6.589E+03	6.589E+03	6.589E+03
mass flux	(lbm/s)	6.440E+00	6.440E+00	6.440E+00
momentum flux	(lbf)	1.652E+02	1.045E+03	2.713E+03
pressure*area	(lbf)	5.805E+03	8.008E+02	4.285E+01

segment: surface i	momentum flux	pressure*area	shear*area
1	0.000E+00	0.000E+00	-3.083E+00
2	0.000E+00	-4.120E+03	-1.551E+00
3	0.000E+00	6.301E+02	-5.645E+00
4	0.000E+00	2.632E+02	-1.403E+01
5	0.000E+00	4.886E+01	-9.700E+00

segment: surface j	momentum flux	pressure*area	shear*area
1	0.000E+00	0.000E+00	0.000E+00
2	0.000E+00	0.000E+00	0.000E+00
3	0.000E+00	0.000E+00	0.000E+00
4	0.000E+00	0.000E+00	0.000E+00
5	0.000E+00	0.000E+00	0.000E+00

segment: surface k	momentum flux	pressure*area	shear*area
1	0.000E+00	0.000E+00	0.000E+00
2	0.000E+00	0.000E+00	0.000E+00
3	0.000E+00	0.000E+00	0.000E+00
4	0.000E+00	0.000E+00	0.000E+00
5	0.000E+00	0.000E+00	0.000E+00

divergence factor		.9746
nozzle gross thrust	(lbf)	2.689E+03
ideal gross thrust	(lbf)	2.882E+03
thrust coefficient		.9332

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13. ABSTRACT ***(Maximum 200 words)***

A simple and accurate nozzle performance analysis methodology has been developed. The geometry modeling requirements are minimal and very flexible, thus allowing rapid design evaluations. The solution techniques accurately couple: continuity, momentum, energy, state, and other relations which permit fast and accurate calculations of nozzle gross thrust. The control volume and internal flow analyses are capable of accounting for the effects of: over/under expansion, flow divergence, wall friction, heat transfer, and mass addition/loss across surfaces. The results from the nozzle performance methodology are shown to be in excellent agreement with experimental data for a variety of nozzle designs over a range of operating conditions.

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