NASA Technical Paper 1271

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AUGUST 1978

NASA

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NASA
National Aeronautics
and Space Administration

Scientific and Technical
Information Office

1978

CONTENTS

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by Raymond E. Gaugler

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SUMMARY

A FORTRAN IV computer program to calculate transient and steady-state temperatures, pressures, and flows in a cooled turbine blade or vane with an impingement insert has been developed and is described in this report. Coolant-side heat-transfer coefficients are calculated internally in the program, with the user specifying one of three modes of heat transfer at each station: (1) impingement, including the effect of crossflow; (2) forced-convection channel flow; or (3) forced convection over pin fins. Additionally, a limited capability to handle film cooling is available in the program. It is assumed that spent impingement air flows in a chordwise direction and is discharged through a split or drilled trailing edge and through film-cooling holes. The program does not allow for radial flow of the spent impingement air. The use of film cooling is restricted by a numerical model requirement for a continuous crossflow.

Input to the program includes a description of the blade geometry, coolant-supply conditions, outside thermal boundary conditions, and wheel speed. The user can divide the blade by chordwise cuts into as many as 15 slices and can divide each slice into as many as 79 stations around the blade. Each station in turn consists of four calculational nodes through the wall and one in the coolant channel. The blade wall can have two layers of different materials, such as a ceramic thermal-barrier coating over a metallic substrate. Program output includes the temperature at each node, the coolant pressures and flow rates, and the coolant-side heat-transfer coefficients.

INTRODUCTION

As core turbine-engine operating conditions become more severe, it becomes more difficult to effectively cool blades and vanes. Advanced transient thermal calculational techniques are needed to design reliable turbine blades. There appears to be no generally available computer program that uses these advanced techniques in combining the required heat-transfer and coolant-flow-distribution calculations. Thus, it was decided to create a computer program that would perform transient and steady-state heat-transfer and coolant-flow analyses for a cooled blade, given the outside hot-gas boundary conditions, the coolant-inlet pressure or flow rate, the geometry of the blade shell, and the cooling configuration.

The resulting program, TACT1, can handle a turbine blade or vane that is equipped with a central coolant-plenum insert from which coolant air flows through holes to impinge on the inner surface of the blade shell. It is assumed that the spent impingement air then flows chordwise and is dumped through a split or drilled trailing edge and through film-cooling holes. The blade is modeled by dividing it by chordwise planes into as many as 15 slices, with each slice having as many as 79 chordwise calculational stations. Temperatures at each station are calculated for four points through the wall and one in the coolant channel. Included in this model is the capability to analyze a blade with a ceramic thermal-barrier coating. The ability of the program to handle film cooling is limited by the numerical modeling of the coolant crossflow.

The TACT1 program is used at the NASA Lewis Research Center on an IBM TSS/360-67 computer. The source program consists of approximately 6200 lines of code and the program requires about 60 000 words of storage. Typical running times for the program are 1.4 seconds of central processing unit (CPU) time per calculational station for a steady-state run, and 0.4 second of CPU time per station per time step for a transient run.

The TACT1 program is reported in two parts. This report, part I, is a users manual and contains all the information necessary to run the program: a detailed description of the input, the method of solution, and the output and a sample problem. Part II is a programmers manual and includes a complete program listing and a detailed description of the procedure.

METHOD OF ANALYSIS

Blade Geometric Model

The key to creating a usable computer program is the geometric model of the system being analyzed. For this program, since the emphasis is on a blade or vane with a central coolant plenum and chordwise flow of the coolant after impingement, it was decided that the primary calculational direction would also be chordwise. Thus, the blade is divided into layers, or slices, that are bounded by chordwise cuts, or planes, through the blade. Figure 1 shows the chordwise cuts on a blade dividing it into slices, numbered 1 to N. The number of slices is limited to 15.

The program allows for mixed radial-axial flow of the hot gas stream, so the cutting planes do not have to be at a constant radius. However, the distance between cuts, or the thickness of the slice, must be constant. Each slice is treated separately in the program, with radial heat conduction in the wall the only communication between slices.

Figure 2 shows the model of the blade slice that is used in TACT1. Figure 2 is a cross-sectional view through a typical slice and shows the geometrical breakdown of the blade or vane into calculational stations and through-the-wall nodes. Chordwise, the blade is split into two regions: the forward region, and the trailing-edge region. The forward region ends at the end of the impingement insert.

The numbering system used to identify the stations around the blade is important, and a few basic rules must be followed in assigning station numbers. To begin with, stations on the pressure side must have odd numbers and stations on the suction side must have even numbers. This is required to minimize the bandwidth of the coefficient matrices in the solution procedure. Station 1 must be near the hot-gas stagnation point and must coincide with an internal row of impingement holes. The number of stations on either side of the blade must be the same, but the spacing between stations can vary arbitrarily. In the trailing-edge region, corresponding suction-side and pressure-side stations must share a common coolant-channel node. The maximum number of stations is set at 79.

Figure 2 shows how an individual station is divided into five calculational nodes. These are physically located (1) at the wall outer surface, (2) at the interface between the coating and the blade metal, (3) at a point midway through the wall metal, (4) at the wall inner surface, and (5) in the middle of the coolant channel.

For input to the program, the following basic elements of the geometry are needed for each station: (1) the thicknesses of the wall coating and wall metal and the coolant-channel width, (2) the chordwise distance of each node from the adjacent upstream node, and (3) the radial span for this slice. In addition, depending on the mode of heat transfer specified, the user must supply diameter and spacing for impingement holes or pin fins and data for film-cooling holes. All input values except the radial span are assumed to be the values at the midspan of the slice. The input is described fully in this report.

Numerical Model

The numerical solution for the temperatures throughout the blade involves writing a transient energy equation for each node and forming a set of equations to be solved for the temperature distribution. The nodal energy balances are linearized, one-dimensional, heat-conduction equations at the wall-outer-surface node, at the junction of the cladding and the metal node, and at the wall-inner-surface node. At the mid-metal node a linear, three-dimensional, heat-conduction equation is used.

Similarly, the coolant pressure distribution is determined by writing the transient momentum equation for one-dimensional flow between adjacent fluid nodes and solving the resulting set of equations for static pressures. In the coolant channel, energy and momentum equations for one-dimensional compressible flow including friction and heat transfer are written for the elemental channel length between two coolant nodes. The equations used are detailed in appendix A. Symbols are defined in appendix B.

Solution Technique

The method of solution can be shown by describing what is involved in doing a steady-state calculation for a multislice blade. There are three basic, nested calculational loops that must converge for a solution to be reached. The innermost loop results in stable temperatures at all nodes and stable pressures at the coolant-channel nodes. The intermediate loop results in a stable coolant-flow split between the suction and pressure sides of the blade. And the outermost loop is an overall coolant mass balance between the coolant supply and the coolant discharge to the main stream.

The program starts with the coolant supply pressure and total coolant flow fixed. The impingement flow is initially assumed to split uniformly at the leading-edge stagnation station, station 1. All coolant flows for the slice under consideration are calculated first, based on the latest pressure distribution. Then the temperatures at each node are calculated by solving simultaneously the energy equations presented in appendix A, and the pressures at all coolant nodes are calculated by solving simultaneously the momentum equations presented in appendix A. This cycle of calculating coolant flows, all temperatures, and coolant-channel pressures is repeated until the pressures converge. Then the flow split between suction- and pressure-side coolant channels is checked by comparing the pressures at the entrance to the trailing-edge region. If they do not match, the impingement flow split at the leading edge is adjusted and the inner-loop calculations are repeated. Once the proper flow split is achieved, the program moves up the blade to the next slice and repeats the preceding sequence. After all N slices have converged, the total coolant flow used is compared with the inlet value. If there is an imbalance, either the inlet flow or the supply pressure is adjusted, as specified by the user, and the calculations start over again. Once the overall coolant balance is satisfied, the steady-state solution is satisfied and the transient calculations begin.

Heat-Transfer Correlations

Three different modes of coolant-side heat transfer are built into the program. The user must indicate the mode to be used at each station. The built-in correlations, which appear to be the best available at this time, are (1) for impingement, including separate correlations for the stagnation point under station 1 and for stations where crossflow is present; (2) for forced-convection channel flow; and (3) for forced convection over an equilateral triangular array of pin fins.

For the impingement-with-crossflow cooled region of the blade, there is a choice between a specific correlation and a general correlation for which the user supplies constants. If the user specifies that internal heat transfer is by impingement cooling but does not specify correlation constants, the correlation of Kercher and Tabakoff (ref. 1), which includes the effects of crossflow, is used. If the user also specifies the constants for a general correlation, that correlation is used rather than the Kercher-Tabakoff correlation. The Kercher-Tabakoff correlation is of the form

$$(Nu)_j = \varphi_1 \varphi_2 (Re)_j^m (Pr)^{0.33} \left(\frac{Z}{D_j}\right)^{0.091} \tag{1}$$

where φ_1 and m are functions of the ratio of jet spacing to jet diameter and φ_2 is a function of the ratio of coolant crossflow to jet flow.

The functions φ_1, φ_2, and m used in this program are the result of a least-squares fit to the data of reference 1 by G. James Van Fossen in unpublished work done at the NASA Lewis Research Center. The expressions used and the applicable range of jet Reynolds number are

For $300 < (Re)_j < 3000$:

$$m = -0.00145\left(\frac{X}{D_j}\right)^2 + 0.04284\left(\frac{X}{D_j}\right) + 0.51655 \tag{2}$$

$$\varphi_1 = \exp\left[0.0126\left(\frac{X}{D_j}\right)^2 - 0.5106\left(\frac{X}{D_j}\right) - 0.2057\right] \tag{3}$$

$$\varphi_2 = \frac{1.0}{1.0 + 0.4215\left(\frac{W_c}{W_j}\frac{Z}{D_j}\right)^{0.580}} \tag{4}$$

And for $3000 < (Re)_j < 30\ 000$:

$$m = -0.00252\left(\frac{X}{D_j}\right)^2 + 0.06849\left(\frac{X}{D_j}\right) + 0.50699 \tag{5}$$

$$\varphi_1 = \exp\left[0.0260\left(\frac{X}{D_j}\right)^2 - 0.8259\left(\frac{X}{D_j}\right) - 0.3985\right] \tag{6}$$

$$\varphi_2 = \frac{1.0}{1.0 + 0.4696\left(\frac{W_c}{W_j}\frac{Z}{D_j}\right)^{0.965}} \tag{7}$$

The alternative general correlation is of the form

$$St = C1\left(\frac{\rho_c U_c}{\rho_j U_j}\right)^{C2}\left(\frac{\rho_c U_c^2}{\rho_j U_j^2}\right)^{C3}\left(\frac{Z}{D_j}\right)^{C4}\left(\frac{X}{D_j}\right)^{C5}(Re)_j^{C6}\ (Pr)^{C7} \tag{8}$$

where the constants C1 to C7 are specified by the user in the input. If a nonzero C1 is specified, the program automatically switches to this correlation.

If station 1, at the leading edge, is the impingement stagnation point, that is, if the spent impingement flow from the holes at station 1 splits between the suction- and pressure-side coolant channels, a correlation specifically for impingement into a concave surface is used to calculate the coolant-side heat-transfer coefficient. Here again, the user has a choice between a specific built-in correlation and a general correlation requiring constants. The built-in correlation is that of Metzger, Yamashita. and Jenkins (ref. 2) and has the form

$$St = 0.355\ (Re)_j^{-0.27}\left(\frac{l}{b}\right)^{-0.52} \tag{9}$$

where the Reynolds number is based on the equivalent slot width b and l is the surface half-length over which the heat transfer is averaged.

The alternative general correlation is of the form

$$St = D1\ (Re)^{D2}\ (Pr)^{D3}\left(\frac{Z}{D_j}\right)^{D4}\left(\frac{X}{D_j}\right)^{D5}\left(\frac{l}{D_j}\right)^{D6} \tag{10}$$

where the constants D1 to D6 are specified by the user in the input if this correlation is to be used.

The correlation used for turbulent forced-convection channel flow is taken from reference 3:

$$(Nu)_D = 0.023\ (Re)_D^{0.8}\ (Pr)^{0.333} \tag{11}$$

where the subscript D indicates that the channel hydraulic diameter is to be used as the reference length.

The correlation for forced convection in an equilateral triangular array of pin fins is taken from reference 4:

$$(Nu)_D = \left\{ 0.023 + \frac{4.143 \exp\left[-3.094\left(\frac{D_p}{S_p}\right) - 0.89\left(\frac{S_p}{L_p}\right)^{0.5075}\right]}{(Re)_D^{0.2946}} \right\} (Re)_D^{0.8}\ (Pr)^{0.33} \tag{12}$$

If local film cooling is included, the user may specify the wall-outer-surface heat-transfer coefficient for the film-cooled case directly or he may specify an unblown heat-transfer coefficient and let the program calculate an effectiveness. Effectiveness is calculated from the following correlation, taken from reference 5:

$$\eta = \left\{ \frac{x}{Ms}\left[(Re)_j \frac{\mu_c}{\mu_g}\right]^{-0.25} + 4.1 \right\}^{-0.8} \tag{13}$$

where s is an equivalent slot height, x is the distance from the row of holes, M is the coolant-to-free-stream mass velocity ratio, Re_j is the coolant Reynolds number, and μ_c and μ_g are the coolant and free-stream viscosities.

The air properties needed in the various correlations are evaluated in the program at a local reference temperature defined as the mean temperature between the surface and the bulk fluid. A table of air properties as a function of temperature at 20 atmospheres pressure, from reference 6, is included in TACT1.

DESCRIPTION OF INPUT AND OUTPUT

Program Input

Input data to TACT1 must be entered in NAMELIST format. Six NAMELIST names make up the input to TACT1: NAMELIST/TITL/, NAMELIST/CHANLS/, NAMELIST /BC/, NAMELIST/CONTRL/, NAMELIST/PROPS/, and NAMELIST/GEO/.

In the input data set, each NAMELIST data group begins with a blank character. The second character is an ampersand (&), immediately followed by the NAMELIST name, which must be followed by a blank. This is followed by any combination of the data items, separated by commas. The end of the data group is signaled by & END.

A number of input variables are initialized in the program to commonly used values. These variables are identified in the following definitions by the inclusion of a default value. If, for any variable, the specified default value meets the user's requirements, that variable need not be specified in the user's input.

Most of the input variables must be in real form; that is, they must include a decimal point. Those variables that must be in integer form, that is, with no decimal point, are noted in the following descriptions.

NAMELISTS /TITL/, /CHANLS/, and /BC/ pertain to the overall job and are entered in order at the beginning of the data set. These NAMELISTS are followed by NSLICE groups of input lines, where each group begins with a /CONTRL/NAMELIST, followed by NGEO/GEO/ entries. Schematically, the data set will look like this.

```
                      & TITL . . . . . & END
                      & CHANLS . . . & END
                      & BC . . . . . . & END

                     { & CONTRL . . . . & END
                     { & PROPS . . . . . & END
                     { & GEO  . . . . . . & END
Slice 1              { & GEO  . . . . . . & END
                     {   .
                     {   .
                     {   .
                     { & GEO  . . . . . . & END

                         .
                         .
                         .

                     { & CONTRL . . . . & END
                     { & PROPS . . . . . & END
                     { & GEO  . . . . . . & END
Slice NSLICE         { & GEO  . . . . . . & END
                     {   .
                     {   .
                     {   .
                     { & GEO  . . . . . . & END
```

The following sections describe in detail the variables involved in each NAMELIST.

NAMELIST/TITL/. - NAMELIST/TITL/ is used to input the variable TITLE, a descriptive title line that is printed in the output. The input for /TITL/ is a quoted string of up to 120 characters. For example,

&TITL TITLE='...THIS IS THE TITLE LINE...' &END

In addition to being printed in the output, the title line is printed as the top label on all microfilm plots.

NAMELIST/CHANLS/. - NAMELIST/CHANLS/ consists of a group of integer indicators - NSLICE, NSTA, INEDIT, IPLOT, IWRITE, IUNITS, IFILM, and IADJIN - that are defined as follows:

NSLICE number of chordwise slices that make up the blade for this problem, limited to 15

NSTA total number of calculational stations in each slice (fig. 2), limited to 79

INEDIT integer indicator of whether user wants listing of input data presented in output. If INEDIT = 0, the input is not printed. If INEDIT > 0, the input is printed. The default value is INEDIT = 0.

IPLOT integer indicator that turns on output-plotting features of program. The plots are created using a TSS/360 graphics package, and are thus only available if the user has a TSS/360 operating system. The default value is IPLOT = 0; no plots are made. If the plotting package is available, IPLOT = 1 causes plots of temperature and pressure versus surface position to be made of the final, converged solution. IPLOT = 2 causes the same plots - but after every temperature-pressure iteration. IPLOT = 3 results in a pair of summary plots of surface temperatures and midmetal temperatures, with all slices of the blade on the same plot. This option is used mainly for transient runs to minimize the number of plots produced.

IWRITE integer indicator that controls amount of printed output. IWRITE = 0 is the default value and causes output to be printed only for the final, converged solution. If the user wants intermediate output, IWRITE = 1 causes output printing after each flow-split iteration and IWRITE = 2 causes output after each temperature-pressure iteration.

IUNITS integer indicator that indicates which system of units the user is working with. IUNITS = 1 requires input and output in SI units, IUNITS = 2 requires input and output in U.S. customary units. The default value is 2.

The input must be consistent, either all SI units or all U.S. customary units, and the units must be as specified in the following descriptions of input parameters.

IFILM integer indicator that indicates the presence of film cooling on the blade and controls the method of handling the hot-gas boundary conditions. IFILM = 0 is the default value and means that there is no film cooling on this blade. IFILM = 1 indicates that film cooling is present somewhere on the blade but that the specified hot-gas heat-flux or heat-transfer coefficient is to be used directly with no corrections for film-cooling effectiveness. IFILM = 2 indicates the presence of film cooling and turns on the internal calculation of film-cooling effectiveness.

IADJIN integer indicator that indicates whether coolant-supply pressure or coolant-inlet flow rate is to be adjusted in the outermost iteration loop. IADJIN = 0, the default value, means that the coolant-supply pressure is fixed and the coolant-inlet flow rate is to be adjusted. IADJIN > 0 indicates that the coolant-inlet flow rate is to be fixed and the coolant-supply pressure is adjusted.

NAMELIST/BC/. - NAMELIST/BC/ contains specifications of the boundary conditions of the problem. The variables are NBCS, NBCP, BCXS, BCXP, BCHGS, BCHGP, BCTGS, BCTGP, BCQGS, BCQGP, BCPGS, BCPGP, THUBIN, QHUBIN, TTIPIN, QTIPIN, RHOVG, PEX, BCTIME, TTIO, PTIO, WPLEN, WSVST, AKCTBL, AKWTBL, RHOC, RHOM, SPHTC, SPHTM, DLTYME, TEPS, and TYMMAX. The first group of boundary conditions consists of tables of the hot-gas-side heat-transfer-coefficient distribution and hot-gas effective temperature distribution or tables of the hot-gas-side heat-flux distribution and, if there is film cooling present, the static-pressure distribution around the blade. The entries in these tables correspond to blade-wall-outer-surface positions, measured from the forward stagnation point, that are listed in the arrays BCXS and BCXP. The locations at which the boundary conditions are specified are completely at the discretion of the user. The program will perform linear interpolation in the tables to determine boundary conditions at the calculational stations. The specific entries in this group are

NBCS, NBCP number of boundary condition locations on suction and pressure sides, respectively, of each slice of the blade, input as integers. Each slice must have its own boundary conditions specified, and the number of boundary condition points must be the same for each slice. The boundary condition point at the forward stagnation point is the only one that must coincide with a calculational station,

station 1. This point is shared by the suction- and pressure-side boundary condition sets, so it is counted in both NBCS and NBCP and is the zero point in the location arrays, BCXS and BCXP.

BCXS, BCXP — tables that specify location in cm (in.), of hot-gas-side boundary condition points along the surface relative to the forward stagnation point for suction and pressure sides, respectively. The first value, for each slice, in each array must be 0.0 and must coincide with the location of calculational station 1 as shown in figure 2. There must be at least two entries in the tables for each slice to allow the use of linear interpolation. If the boundary condition locations do not extend to the end of the blade, the program will extrapolate beyond the table. The entries for different slices are listed sequentially; that is, the first NBCS values in BCXS are for the first slice and the next NBCS entries are for the second slice, continuing to the final slice - for a total of NBCS*NSLICE entries in BCXS and a total of NBCP*NSLICE entries in BCXP. BCXS and BCXP are dimensioned for a maximum of 400 entries each.

BCHGS, BCHGP — tables of hot-gas-side heat-transfer coefficients, in $W/m^2 \cdot K$ ($Btu/hr \cdot ft^2 \cdot {}^oF$), at the corresponding boundary condition locations specified in BCXS and BCXP, respectively. Thus, for a steady-state problem, there are NBCS*NSLICE entries in BCHGS and NBCP*NSLICE entries in BCHGP. If the case being run is a transient, there will be additional sets of entries in the BCHGS and BCHGP arrays, one additional set for each of the transient times specified in BCTIME. Each set consists of NBCS*NSLICE or NBCP*NSLICE entries, ordered in the same way as the steady-state values. The only limit on the number of time-dependent entries is the maximum size of BCHGS and BCHGP, which are dimensioned for 1000 entries each in the program. These arrays are initialized to all zeros, and if no entries are found in the input, the program assumes that the user is specifying directly the heat flux to the blade rather than the heat-transfer coefficient and gas temperature.

BCTGS, BCTGP — tables of suction- and pressure-side hot-gas reference temperature, in K(^{o}F), to be used in conjunction with input heat-transfer coefficients. They are input at the corresponding boundary condition locations specified in BCXS and BCXP, respectively. Thus, for a steady-state problem, there are NBCS*NSLICE entries in

BCTGP. If the case being run is a transient, there will be additional sets of entries in the BCTGS and BCTGP arrays, one additional set for each of the transient times specified in BCTIME. Each set consists of NBCS*NSLICE or NBCP*NSLICE entries, ordered in the same way as the steady-state values. The only limit on the number of time-dependent entries is the maximum size of BCTGS and BCTGP, which are dimensioned for 1000 entries each in the program.

BCQGS, BCQGP tables of hot-gas-side heat flux, in W/m^2 ($Btu/hr \cdot ft^2$), which may be input instead of the heat-transfer coefficient and temperature arrays. The fluxes specified in BCQGS and BCQGP are at the corresponding boundary condition locations specified in BCXS and BCXP, respectively. Thus, for a steady-state problem, there are NBCS*NSLICE entries in BCQGS and NBCP*NSLICE entries in BCQGP. If the case being run is a transient, there will be additional sets of entries in the BCQGS and BCQGP arrays, one additional set for each of the transient times specified in BCTIME. Each set consists of NBCS*NSLICE or NBCP*NSLICE entries, ordered in the same way as the steady-state values. The only limit on the number of time-dependent entries is the maximum size of BCQGS and BCQGP, which are dimensioned for 1000 entries each in the program.

BCPGS, BCPGP tables of suction- and pressure-surface hot-gas-side static pressures, in kPa (psia), specified at corresponding boundary condition locations listed in BCXS and BCXP, respectively. The pressure distributions are required only if film cooling is present somewhere on the blade. If there is no film cooling, BCPGS and BCPGP are not needed in the input. If the pressure distributions are required, they are arranged just as the BCHGS and BCHGP arrays containing NBCS*NSLICE and NBCP*NSLICE entries, respectively, for the steady state. If the case being run is a transient, there will be additional sets of entries in the BCPGS and BCPGP arrays, one additional set for each of the transient times specified in BCTIME. Each set consists of NBCS*NSLICE or NBCP*NSLICE entries, ordered in the same way as the steady-state values. The only limit on the number of time-dependent entries is the maximum size of BCPGS and BCPGP, which are dimensioned for 1000 entries each in the program.

The next group of boundary conditions contains arrays where the quantities are specified at the calculational stations rather than at the boundary condition points specified in BCXS and BCXP. These consist of blade hub and tip thermal boundary conditions - THUBIN, QHUBIN, TTIPIN, QTIPIN - and the hot-gas-side mass velocity, RHOVG, used for film-cooling purposes. The blade hub and tip conditions are used to specify midwall temperatures or spanwise heat fluxes at the ends of the blade. The user has three options available at each end of the blade:

(1) The blade is considered insulated at the hub (tip), in which case THUBIN and QHUBIN (TTIPIN and QTIPIN) are not input.

(2) There is a specified midwall temperature distribution around the hub (tip) end of the blade, in which case THUBIN (TTIPIN) is specified and QHUBIN (QTIPIN) is not input.

(3) There is a specified spanwise heat flux to or from the blade at the hub (tip) end, in which case QHUBIN (QTIPIN) is specified and THUBIN (TTIPIN) is not input. The input variables in this group are defined as follows:

THUBIN — temperature distribution, in K(^{o}F), at hub end of blade, with entries ordered in a one-to-one correspondence with calculational station numbers, for a total of NSTA entries for a steady-state problem. For a transient case, there will be additional sets of NSTA entries each, one additional set for each transient time specified in the BCTIME array. The only limit on the number of entries is the maximum size of the array, which is dimensioned for 400 entries.

QHUBIN — spanwise heat-flux distribution, in W/m^2 (Btu/hr · ft^2), at hub end of blade, considered positive if directed from the hub into the blade. The entries are ordered in a one-to-one correspondence with the calculational station numbers, for a total of NSTA entries for a steady-state problem. For a transient case, there will be additional sets of NSTA entries each, one additional set for each transient time specified in the BCTIME array. The only limit on the number of entries is the maximum size of the array, which is dimensioned for 400 entries.

TTIPIN — temperature distribution, in K(^{o}F), at tip end of blade, with entries ordered in a one-to-one correspondence with calculational station numbers, for a total of NSTA entries for a steady-state problem. For a transient case, there will be additional sets of NSTA entries each, one additional set for each transient time specified in the BCTIME array. The only limit on the number of entries is the maximum size of the array, which is dimensioned for 400 entries.

QTIPIN — spanwise heat-flux distribution, in W/m^2 ($Btu/hr \cdot ft^2$), at tip end of blade, considered positive if the flux is leaving the blade. The entries are ordered in a one-to-one correspondence with the calculational station numbers, for a total of NSTA entries for a steady-state problem. For a transient case, there will be additional sets of NSTA entries each, one additional set for each transient time specified in the BCTIME array. The only limit on the number of entries is the maximum size of the array, which is dimensioned for 400 entries.

RHOVG — table of hot-gas-side, free-stream mass velocity, in $kg/m^2 \cdot sec$ ($lbm/ft^2 \cdot sec$). If there is no film cooling on the blade, RHOVG need not be specified. However, if film cooling is present and the user wants the program to calculate an effectiveness, RHOVG must be specified. The entries in RHOVG are ordered in a one-to-one correspondence with the calculational station numbers, for a total of NSTA entries for a steady-state problem. For a transient case, there will be additional sets of NSTA entries each, one additional set for each transient time specified in the BCTIME array. The only limit on the number of entries is the maximum size of the array, which is dimensioned for 400 entries. There is no provision for RHOVG to vary in the spanwise direction. The one set of entries is used for all slices of the blade. Also nonzero values for RHOVG are only required for calculational stations that contain specified film-cooling holes. All other entries in RHOVG may be zero.

One additional variable in the /BC/NAMELIST includes a spatial variation as well as a time variation. That is the specified static-pressure distribution at the blade trailing edge PEX.

PEX — table of hot-gas static pressure, in kPa (psia), one value for each slice at the location of coolant exhaust in trailing-edge region of blade. For a steady-state problem, there are NSLICE entries in PEX, ordered in a one-to-one correspondence with the slice numbers. For a transient, there must be additional sets of NSLICE entries each, one additional set for each transient time specified in the BCTIME array. The only limit on the number of entries in PEX is the maximum size of the array, which is dimensioned for 400 entries.

BCTIME — array containing time values in seconds, which is required if run contains a transient. For a steady-state case, BCTIME need not be specified. When used, the entries are the times at which the transient boundary conditions are tabulated. The first entry in BCTIME must be 0.0 to correspond to the initial steady-state solution. During the transient calculations, the program will perform linear interpolation in the boundary condition tables, based on the current time value and the time points specified in BCTIME BCTIME is dimensioned for a maximum of 50 entries.

The next group of boundary conditions specifies the coolant-supply conditions, which may also vary with time during a transient.

TTIO — table of coolant-supply total temperature, in K(^{o}F), versus time, in seconds, input as alternating values of temperature and time, where an odd-numbered subscript refers to temperature and the following even-numbered subscript refers to the corresponding time. For a steady-state run, no time entries are needed.

PTIO — table of coolant-supply total pressure, in kPa (psia), versus time, in seconds, input as alternating values of pressure and time. For a steady-state run, no time entries are needed; and if the overall iteration loop is on coolant-supply pressure, the value of PTIO input is an initial estimate only, with the final value being determined in the program.

WPLEN — initial estimate of total coolant mass flow rate, in kg/hr (lbm/hr). If IADJIN > 0, this value is held fixed and supply pressure is variable.

WSVST — table of rotor speed in rpm versus time in seconds, input as alternating values of speed and time. For a steady-state run, no time entries are needed.

AKCTBL — table of wall-cladding thermal conductivity versus temperature. The entries are alternating values of temperature, in K(^{o}F), and thermal conductivity, in W/m · K (Btu/hr · ft · ^{o}F) - to a maximum of 10 temperatures. If the blade does not have a cladding, AKCTBL must still be specified, and the entries must be identical to the AKWTBL entries.

AKWTBL — table of wall-metal thermal conductivity versus temperature - arranged as for AKCTBL

RHOC — density of wall cladding, in kg/m^3 (lbm/ft^3), assumed to be constant. If the problem is steady state, it is not necessary to specify RHOC.

RHOM — density of wall metal, in kg/m^3 (lbm/ft^3), assumed to be constant. If the problem is steady state, it is not necessary to specify RHOM.

SPHTC, SPHTM — specific heats of outer cladding and wall metal, respectively, in J/kg · K (Btu/lbm · ^oF) - assumed to be constant. If the problem is steady state, it is not necessary to specify SPHTC and SPHTM.

DLTYME — time-step size, in seconds, to be used in transient calculations. If the problem is steady state, DLTYME must not be specified.

TEPS — factor to be used in time-marching solution, to define time mean properties (ϵ in the equations of appendix A). If TEPS = 0.0, the solution is purely explicit; and if TEPS = 1.0, the solution is implicit. For stability, it is recommended that a value of 1.0 be used. If the problem is steady state, it is not necessary to specify TEPS.

TYMMAX — maximum time, in seconds, to which the transient calculation is carried. If the problem is steady state, it is not necessary to specify TYMMAX.

NAMELIST/CONTRL/. - The fourth NAMELIST, /CONTRL/, is a list of integer controls - NFWD, ICOR, and NGEO - where

NFWD — number of calculational stations in forward region of blade, an odd number. The forward region is that part of the blade where separate suction-side and pressure-side coolant crossflow channels are formed by the clearance between the blade shell and the impingement insert.

ICOR — calculational station number at which impingement-with-crossflow correlation is first used. Forward of this station, a correlation for impingement into a concave surface is used. The program requires that there be only one row of impingement jets forward of station ICOR. The default value of ICOR is 1.

NGEO — number of NAMELIST/GEO/ entries that are going to be read for this slice

NAMELIST/PROPS/. - The fifth NAMELIST, /PROPS/, includes the variables CD, SPAN, ADUMP, DHYD, APLEN, RI, RO, CIMP1, CIMP2, CIMP3, CIMP4, CIMP5, CIMP6, CIMP7, DIMP1, DIMP2, DIMP3, DIMP4, DIMP5, and DIMP6, which are defined as

CD	discharge coefficient for an impingement hole. A default value of 0.8 is included in the program.
SPAN	radial length of this chordwise slice, cm (in.)
ADUMP	flow area that dumps coolant directly from coolant-supply plenum into trailing-edge channel, cm^2 (in^2)
DHYD	hydraulic diameter of coolant plenum for this slice, cm (in.)
APLEN	mean cross-sectional area of coolant plenum for this slice, cm^2 (in^2)
RI, RO	radial locations of coolant-plenum inlet and outlet for this slice, cm (in.)
CIMP1, . . . CIMP7	user-supplied constants for impingement-with-crossflow heat-transfer correlation defined by equation (8). If they are not specified, the Kercher-Tabakoff correlation (ref. 1) is used.
DIMP1, . . . DIMP6	user-supplied constants for impingement-onto-a-concave-surface heat-transfer correlation defined by equation (10). If they are not specified, the Metzger correlation (ref. 2) is used.

NAMELIST/GEO/. - The sixth NAMELIST, /GEO/, describes the blade geometry at each calculational station, through the variables ISTA, ISTB, THK, TDLX, TDHJ, TXN, TDHF, TRR, IHCT, TDP, and TSP. Figure 3 illustrates the location of the variables that describe the geometry. The definitions of the variables are

ISTA	number of first station at which this /GEO/ data applies, an integer
ISTB	number of last station that has identical input, also an integer. That is, if two or more adjacent stations have the same input, they can be lumped together on one /GEO/ line. If station ISTA is unique, ISTB need not be specified.
THK	array of dimension (3), where THK(1) is cladding thickness, THK(2) is metal-wall thickness, and THK(3) is coolant-channel width, all in cm (in.)
TDLX	array of dimension (5), representing distance, in cm (in.), from adjacent upstream station, where TDLX(1) is the distance along the wall outside surface, TDLX(2) is the distance along the interface

of blade cladding and blade metal, TDLX(3) is the distance along a midmetal line, TDLX(4) is the distance along the wall inside surface, and, TDLX(5) is the distance along a mid-coolant-channel line. If TDLX(2), TDLX(3) and TDLX(5) are put in as 0.0, the program will interpolate values for them, based on a linear fit to TDLX(1) and TDLX(4) versus THK.

TDHJ — hydraulic diameter, in cm (in.), of an impingement jet at this station. It is not necessary that there be impingement holes at every station in the impingement-cooled region, but the holes that are present must aline with calculational stations.

TXN — radial center-to-center spacing, in cm (in.), of impingement holes at this station. To avoid fractional holes, TXN should be an integral fraction of SPAN.

TDHF — effective diameter, in cm (in.), of a film-cooling hole at this station, defined as the hydraulic diameter of one hole multiplied by the square root of the number of holes at this station in this slice

TRR — mean radial location of this station, cm (in.)

IHCT — integer indicator of what type of internal heat transfer is used at this station:
- = 1, impingement with crossflow
- = 2, forced-convection channel flow
- = 3, pin fins

TDP — diameter of pin fins, if there are any, cm (in.)

TSP — pin-fin center-to-center spacing, assuming an equilateral triangular array, cm (in.)

Program Output

The output of the program is available both in printed form and as microfilm plots of temperatures and pressures. The printed output comes in two parts, both of which are controlled by the user. The first part is a listing of the input, which is controlled by the input parameter INEDIT. If an input listing is wanted, INEDIT must be set equal to 1 in the input. Otherwise, no input listing will be printed.

The other part of the printed output is the results of calculations. The user has three options available for the amount of output. The controlling variable is IWRITE. The user can specify a printout after each pressure-temperature iteration loop

(IWRITE = 2), after each coolant-flow-split loop (IWRITE = 1), or only after the flow split has converged (IWRITE = 0). The normal default case is IWRITE = 0, which produces minimum output. If this is all that the user needs, it is not necessary to specify IWRITE. Included in the output is the temperature at each node, the coolant pressure and heat-transfer coefficient at each coolant node, and all coolant flow rates and Reynolds numbers. Examples of the output are included in the section SAMPLE PROBLEMS.

Microfilm plots of the output are controlled by the input parameter IPLOT. The plots are created by using a TSS/360 graphics package and are thus only available if the user has a TSS/360 operating system. The default value is IPLOT = 0, which indicates that no plots are to be filmed. If IPLOT = 1, only final results are filmed; if IPLOT = 2, the results of each pressure-temperature iteration are plotted on film; and if IPLOT = 3, summary plots, one per time step, are produced.

When plots are requested, they will consist of, first, a layout of impingement hole spacings; then plots of temperature and coolant total pressure versus distance from the leading edge; and finally, if the blade consists of more than one slice, a set of summary plots comparing temperatures from all slices to show spanwise variations.

SAMPLE PROBLEMS

A conceptual design of an impingement-cooled blade for an advanced high-pressure turbine is used to demonstrate the use of the program. Two cases are shown: hot steady state, and acceleration from idle to takeoff conditions.

The blade considered has a span of 3.81 centimeters and is divided into three slices. Figure 4 is a cross-sectional view of the blade showing the locations of the computational stations and the impingement holes. Table I is a listing of the input data for the sample steady-state problem as it was run in TACT1, and table II is a listing of the input data for the sample transient problem. The entries in table I and II are all defined in the section Program Input.

For these problems, the hot-gas-side heat-transfer coefficients were based on a relative total temperature of 1810 K and a relative total pressure of 2940 kilopascals. The heat-transfer coefficients were calculated by using STAN5, a two-dimensional, finite difference, boundary-layer program (ref. 7).

Table III is a selection of pages from the output of the steady-state problem presented in table I. The first part of the table gives the hot-gas boundary conditions and the input listing for slice 1. Similar input listings for slices 2 and 3 have been left out of table III. The second part of the table shows the final output of TACT1 for each of the three slices of this sample problem. The temperature at every node is presented, along with the pressure and heat-transfer-coefficient results for the coolant-channel nodes. Coolant flow information is also presented for each station.

Portions of the output for the sample transient problem are shown in table IV. This problem was run for 5 seconds, in 0.25-second steps. Table IV contains program output for the initial steady state, at 2.5 seconds, and at 5.0 seconds. Figure 5 shows the transient behavior of the blade temperatures during the acceleration transient. The three curves represent the midspan, wall-outer-surface, leading-edge point; the midspan, wall-outer-surface cold spot; and the overall bulk-metal temperature.

Lewis Research Center,
National Aeronautics and Space Administration,
Cleveland, Ohio, April 10, 1978,
505-04.

APPENDIX A

FINITE-DIFFERENCE EQUATIONS

The layout and nomenclature of the nodal system at a given station, IS, for a given slice, i, of the blade are shown in figure 6. Time-dependent, finite-difference equations are written for the heat transfer at each node. The superscript refers to time and the subscript refers to spatial node. The third dimension is the radial span of the blade slices, defined by S_{i-1}, S_i, and S_{i+1}. Also, the temperatures used in the equations $\overline{T}$ are evaluated as some intermediate value between time t^j and t^{j-1}, where this value is defined by the parameter ϵ.

$$\overline{T} = \epsilon T^j + (1 - \epsilon) T^{j-1} \tag{A1}$$

For $\epsilon = 0$, the equations become fully explicit; and for $\epsilon = 1$, the equations are fully implicit.

At the wall-outer-surface node, LOUT, the hot-gas heat flux is matched to that conducted in the wall between nodes LOUT and LJ. The hot-gas heat flux is specified by the user either as the heat flux q directly or as a heat-transfer coefficient h and the gas recovery temperature TG. The program sets an indicator, β, to specify the type of boundary condition. For heat flux, $\beta = 1.0$; and for heat-transfer coefficient, $\beta = 0.0$.

The basic transient equation at node LOUT is

$$\beta q_{IS} A_{LOUT} + (1 - \beta) h_{IS} A_{LOUT} \left[(1 - \eta)(TG)_{IS} + \eta \overline{T}_{LCOOL} - \overline{T}_{LOUT} \right]$$

$$- k_{LOUT} A_{LOUT} \left(\frac{\overline{T}_{LOUT} - \overline{T}_{LJ}}{\tau_{LOUT}} \right) - (\rho c V)_{LOUT} \left(\frac{T^j_{LOUT} + T^j_{LJ} - T^{j-1}_{LOUT} - T^{j-1}_{LJ}}{2\,\Delta t} \right) = 0.0 \tag{A2}$$

where η is the film-cooling effectiveness; A_{LOUT} is the wall-outer-surface area associated with node LOUT and equals $S_i(DX3 + DX4)/2$; τ_{LOUT} is the thickness of the outer coating; k_{LOUT} is the thermal conductivity; $(\rho c V)_{LOUT}$ is the heat capacity; and Δt is the time interval between $j - 1$ and j.

Dividing through by $k_{LOUT} A_{LOUT} / \tau_{LOUT}$ gives

$$\frac{\beta q_{IS}\tau_{LOUT}}{k_{LOUT}} + (1 - \beta)\frac{h_{IS}\tau_{LOUT}}{k_{LOUT}}\left[(1-\eta)(TG)_{IS} + \eta\overline{T}_{LCOOL} - \overline{T}_{LOUT}\right] - (\overline{T}_{LOUT} - \overline{T}_{LJ})$$

$$- \frac{(\rho cV)_{LOUT}}{k_{LOUT}A_{LOUT}}\frac{\tau_{LOUT}}{2\,\Delta t}\left(T^{j}_{LOUT} + T^{j}_{LJ} - T^{j-1}_{LOUT} - T^{j-1}_{LJ}\right) = 0.0 \qquad \text{(A3)}$$

To simplify, rename the coefficients in equation (A3) and write it as

$$QF + QH\left[(1 - \eta)(TG)_{IS} + \eta\overline{T}_{LCOOL} - \overline{T}_{LOUT}\right] - (\overline{T}_{LOUT} - \overline{T}_{LJ})$$

$$- QT\left(T^{j}_{LOUT} + T^{j}_{LJ} - T^{j-1}_{LOUT} - T^{j-1}_{LJ}\right) = 0.0 \qquad \text{(A4)}$$

And finally, using equation (A1) in (A4) and rearranging gives

$$T^{j}_{LOUT}\left[\epsilon(-QH - 1.0) - QT\right] + T^{j}_{LJ}(\epsilon - QT) + T^{j}_{LCOOL}(\eta\epsilon QH)$$

$$= -QF - QH(1.0 - \eta)(TG)_{IS} + T^{j-1}_{LOUT}\left[(1.0 - \epsilon)(1.0 + QH) - QT\right]$$

$$+ T^{j-1}_{LJ}\left[-(1.0 - \epsilon) - QT\right] + T^{j-1}_{LCOOL}\left[-\eta(1.0 - \epsilon)QH\right] \qquad \text{(A5)}$$

At node LJ, which may be at the junction between dissimilar materials, the heat flow from node LOUT is set equal to the heat flow to node L.

The basic energy-balance equation is

$$k_{LOUT}A_{LOUT}\left(\frac{\overline{T}_{LOUT} - \overline{T}_{LJ}}{\tau_{LOUT}}\right) = k_L\left(\frac{A_{LJ} + A_L}{2}\right)\left(\frac{\overline{T}_{LJ} - \overline{T}_L}{\tau_L/2}\right) \qquad \text{(A6)}$$

where A_{LJ} is the heat-transfer area at node LJ and equals $S_i(DX9 + DX10)/2$; A_L is the heat-transfer area at node L and equals $S_i(DX1 + DX2)/2$; and τ_L is the thickness of the metal wall. Using equation (A1) in equation (A6) and rearranging give

$$T^{j}_{LOUT}(\epsilon) - T^{j}_{LJ}\left[\epsilon(1 + \varphi)\right] + T^{j}_{L}(\epsilon\varphi) = -(1 - \epsilon)\left[T^{j-1}_{LOUT} - T^{j-1}_{LJ}(1 + \varphi) + T^{j-1}_{L}\varphi\right]$$

(A7)

where

$$\varphi = \left(\frac{k_L}{k_{LOUT}}\right)\left(\frac{A_{LJ} + A_L}{A_{LOUT}}\right)\left(\frac{\tau_{LOUT}}{\tau_L}\right)$$

Next, consider the midwall node, L, and its surrounding nodes as shown in figure 6.

A three-dimensional, transient, finite-difference heat balance is written at this point, allowing spanwise conduction between this slice, i, and the adjacent slices, i - 1 and i + 1. The basic equation is

$$k_L A_{LJ,L}\left(\frac{\overline{T}_{LJ} - \overline{T}_L}{\tau_L/2}\right) - k_L A_{L,LIN}\left(\frac{\overline{T}_L - \overline{T}_{LIN}}{\tau_L/2}\right)$$
$$+ k_L A_{LUP,L}\left(\frac{\overline{T}_{LUP} - \overline{T}_L}{DX1}\right) - k_L A_{L,LDN}\left(\frac{\overline{T}_L - \overline{T}_{LDN}}{DX2}\right)$$
$$+ k_L A_R\left[\frac{T_B - \overline{T}_L}{(S_{i-1} + S_i)/2}\right] - k_L A_R\left[\frac{\overline{T}_L - T_A}{(S_i + S_{i+1})/2}\right]$$
$$= (\rho c V)_L\left(\frac{T_L^j - T_L^{j-1}}{\Delta t}\right) \qquad \text{(A8)}$$

where the A's are mean cross-sectional areas for heat conduction between nodes and are defined as follows:

$$\left.\begin{aligned}
A_{LJ,L} &= \frac{S_i(DX9 + DX10 + DX1 + DX2)}{4} \\
A_{L,LIN} &= \frac{S_i(DX1 + DX2 + DX5 + DX6)}{4} \\
A_{LUP,L} &= \frac{S_i(\tau_{LUP} + \tau_L)}{2} \\
A_{L,LDN} &= \frac{S_i(\tau_L + \tau_{LDN})}{2} \\
A_R &= \frac{\tau_L(DX1 + DX2)}{2}
\end{aligned}\right\} \qquad \text{(A9)}$$

The two temperatures, T_B and T_A, are defined as the most recently calculated temperatures at node L for the slice immediately below slice i and the slice immediately above slice i, respectively.

Equation (A8) is simplified by dividing through by $(2k_L A_{LJ,L}/\tau_L)$. Then it becomes

$$
\begin{aligned}
(\overline{T}_{LJ} - \overline{T}_L) &- \frac{A_{L,LIN}}{A_{LJ,L}} (\overline{T}_L - \overline{T}_{LIN}) \\
&+ \frac{A_{LUP,L}}{A_{LJ,L}} \frac{\tau_L}{2DX1} (\overline{T}_{LUP} - \overline{T}_L) - \frac{A_{L,LDN}}{A_{LJ,L}} \frac{\tau_L}{2DX2} (\overline{T}_L - \overline{T}_{LDN}) \\
&+ \frac{A_R}{A_{LJ,L}} \frac{\tau_L}{S_{i-1} + S_i} (T_B - \overline{T}_L) - \frac{A_R}{A_{LJ,L}} \frac{\tau_L}{S_i + S_{i+1}} (\overline{T}_L - T_A) \\
&= \frac{(\rho cV)_L}{\Delta t} \frac{\tau_L}{2k_L A_{LJ,L}} \left(T_L^j - T_L^{j-1}\right) \qquad \text{(A10)}
\end{aligned}
$$

Next, to simplify, the coefficients of the temperature terms in equation (A10) are renamed:

$$
\begin{aligned}
(\overline{T}_{LJ} - \overline{T}_L) &- \theta_1 (\overline{T}_L - \overline{T}_{LIN}) + \theta_2 (\overline{T}_{LUP} - \overline{T}_L) \\
&- \theta_3 (\overline{T}_L - \overline{T}_{LDN}) + \theta_4 (T_B - \overline{T}_L) - \theta_5 (\overline{T}_L - T_A) \\
&= \theta_9 \left(T_L^j - T_L^{j-1}\right) \qquad \text{(A11)}
\end{aligned}
$$

Then equation (A1) is used in equation (A11). The terms involving the new time step are gathered on the left; the terms involving the old time step are gathered on the right. The final version to solve for the temperatures is then

$$T^j_{LUP}(\epsilon\theta_2) + T^j_{LJ}(\epsilon) + T^j_L\left[-\epsilon(1.0 + \theta_1 + \theta_2 + \theta_3 + \theta_4 + \theta_5) - \theta_9\right] + T^j_{LIN}(\epsilon\theta_1) + T^j_{LDN}(\epsilon\theta_3)$$

$$= T^{j-1}_{LUP}\left[-(1 - \epsilon)\theta_2\right] + T^{j-1}_{LJ}\left[-(1 - \epsilon)\right] + T^{j-1}_{LDN}\left[-(1 - \epsilon)\theta_3\right]$$

$$+ T^{j-1}_L\left[(1 - \epsilon)(1.0 + \theta_1 + \theta_2 + \theta_3 + \theta_4 + \theta_5) - \theta_9\right]$$

$$+ T^{j-1}_{LIN}\left[-(1 - \epsilon)\theta_1\right] - \theta_4 T_B - \theta_5 T_A \tag{A12}$$

For a steady-state problem, $\epsilon = 1.0$ and $\theta_9 = 0.0$.

In the preceding equations, radial conduction is taken into account by treating the corresponding nodal temperatures for the adjacent slices as constants for each time step. The term T_A refers to the slice immediately above the current slice, and the term T_B refers to the slice immediately below it.

Finally, the heat balance is written for node LIN, the boundary between the wall and the coolant channel. In general terms, this equation has the form

$$k_L\left(\frac{A_L + A_{LIN}}{2}\right)\left(\frac{\overline{T}_L - \overline{T}_{LIN}}{\tau_L/2}\right) = (HC)(AC)\Delta\overline{T}_c \tag{A13}$$

where HC, AC, and ΔT_c will depend on the mode of internal heat transfer; HC being the heat-transfer coefficient calculated in the program, AC being the effective area for heat transfer, and the ΔT term involving either the coolant crossflow recovery temperature for convection or the coolant-supply total temperature TC for impingement. In the program, the ΔT term is written out, in general, with multiplying factors included to handle the special cases. The form of the expression is

$$\Delta\overline{T}_c = \overline{T}_{LIN} - (YC + YF)\overline{T}_{LCOOL} - (YI)(TC) \tag{A14}$$

where only one of the coefficients - YC, YF, or YI - is nonzero depending on the mode of internal heat transfer specified for the station in question: YC is nonzero for forced-convection channel flow, YF is nonzero for flow over pin fins, and YI is nonzero for impingement with crossflow.

Then, using equation (A14) in equation (A13), dividing through by $k_L(A_L + A_{LIN})/\tau_L$ and rearranging result in

$$T_L^j(\epsilon) + T_{LIN}^j\left[-\epsilon(1+\theta_8)\right] + T_{LCOOL}^j\left[\epsilon\theta_8(YC+YF)\right] =$$

$$= -(1-\epsilon)\left\{T_L^{j-1} - T_{LIN}^{j-1} - \theta_8\left[T_{LIN}^{j-1} - (YC+YF)T_{LCOOL}^{j-1}\right]\right\} - \theta_8(YI)(TC) \tag{A15}$$

where

$$\theta_8 = \frac{(HC)(AC)\tau_L}{k_L\ (A_L + A_{LIN})}$$

In the coolant channel, the flow is treated as one-dimensional, compressible flow with friction, heat transfer, and mass addition. And conservation equations are written for mass, energy, and momentum. Figure 7 illustrates the control volume considered for coolant flow between two adjacent stations. A mass balance requires that the flow leaving the control volume at a given time be

$$WCROS(IS) = WCROS(IS-2) + WJ(IS-2) - WFC(IS) \tag{A16}$$

where WCROS is mass flow rate crossing the station lines, WJ is the total impingement-jet mass flow at the specified station, and WFC is the total film-cooling mass flow leaving the control volume.

The transient energy balance for the control volume shown in figure 7 is given by

$$\begin{aligned}
&WCROS(IS-2)(CP)\overline{T}_{LCUP}\left(1+\frac{\gamma-1}{2}M_{IS-2}^2\right)\\
&\qquad + HC(IS-2)(A1)\left[\overline{T}_{LCUPS} - (YC+YF)\overline{T}_{LCUP} - (YI)(TC)\right]\\
&\qquad + HC(IS)(A2)\left[\overline{T}_{LIN} - (YC+YF)\overline{T}_{LCOOL} - (YI)(TC)\right]\\
&\qquad - WCROS(IS)(CP)\overline{T}_{LCOOL}\left(1+\frac{\gamma-1}{2}M_{IS}^2\right)\\
&\qquad + WJ(IS-2)(CP)(TC) - WFC(IS)(CP)\overline{T}_{LCOOL}\\
&\qquad - (\overline{\rho cV})\frac{T_{LCOOL}^j + T_{LCUP}^j - T_{LCOOL}^{j-1} - T_{LCUP}^{j-1}}{2\ \Delta t} = 0.0
\end{aligned} \tag{A17}$$

where the term ρcV is averaged between nodes LCUP and LCOOL, CP is the specific heat of the coolant, and A1 and A2 are effective heat-transfer areas as shown in figure 7. Dividing equation (A17) by WCROS(IS)(CP), using the definition of equation (A1), and rearranging yield the working form of the transient energy equation for the coolant channel:

$$T^{j}_{LCUPS}\,\epsilon\left[\frac{HC(IS-2)A1}{WCROS(IS)CP}\right] + T^{j}_{LIN}\,\epsilon\left[\frac{HC(IS)A2}{WCROS(IS)CP}\right]$$

$$+ T^{j}_{LCUP}\left[\frac{\epsilon \times WCROS(IS-2)CP\left(1+\frac{\gamma-1}{2}M^{2}_{IS-2}\right)}{WCROS(IS)CP} - \frac{\epsilon \times HC(IS-2)A1(YC+YF)+\frac{\rho cV}{2\,\Delta t}}{WCROS(IS)CP}\right]$$

$$+ T^{j}_{LCOOL}\left[\epsilon\left(-1-\frac{\gamma-1}{2}M^{2}_{IS}\right) - \frac{\epsilon \times WFC(IS)CP}{WCROS(IS)CP} - \frac{\epsilon \times HC(IS)A2(YC+YF)+\frac{\rho cV}{2\,\Delta t}}{WCROS(IS)CP}\right]$$

$$= -T^{j-1}_{LCUPS}(1-\epsilon)\frac{HC(IS-2)A1}{WCROS(IS)CP} - T^{j-1}_{LIN}(1-\epsilon)\frac{HC(IS)A2}{WCROS(IS)CP}$$

$$- T^{j-1}_{LCUP}\left[\frac{(1-\epsilon)WCROS(IS-2)CP\left(1+\frac{\gamma-1}{2}M^{2}_{IS-2}\right)}{WCROS(IS)CP} - \frac{(1-\epsilon)HC(IS-2)A1(YC+YF)+\frac{\rho cV}{2\,\Delta t}}{WCROS(IS)CP}\right]$$

$$- T^{j-1}_{LCOOL}\left[(1-\epsilon)\left(-1-\frac{\gamma-1}{2}M^{2}_{IS}\right) - \frac{(1-\epsilon)WFC(IS)CP}{WCROS(IS)CP} - \frac{(1-\epsilon)HC(IS)A2(YC+YF)-\frac{\rho cV}{2\,\Delta t}}{WCROS(IS)CP}\right]$$

$$- TC\,\frac{WJ(IS-2)CP - YI \times HC(IS-2)A1 - YI \times HC(IS)A2}{WCROS(IS)CP} \qquad \text{(A18)}$$

Finally, the transient momentum equation is written for the coolant-channel control volume, assuming one-dimensional, compressible flow with friction, heat transfer, and mass addition. As with temperature, an intermediate pressure between time j and j-1 is defined as

$$\bar{p} = \epsilon p^{j} + (1 - \epsilon) p^{j-1} \tag{A19}$$

Then, the momentum equation for flow between nodes LCUP and LCOOL is

$$\bar{p}_{LCUP}\tau_{LCUP}S_i - \bar{p}_{LCOOL}\tau_{LCOOL}S_i + \frac{\bar{p}_{LCOOL} - \bar{p}_{LCUP}}{2}(\tau_{LCOOL} - \tau_{LCUP})S_i$$

$$- \left(\frac{4 \times f \times DLX}{D_h}\right)\left(\frac{\gamma M_{IS}^2}{2}\right)\bar{p}_{LCOOL}\tau_{LCOOL}S_i$$

$$= \gamma M_{IS}^2 \bar{p}_{LCOOL}\tau_{LCOOL}S_i - \gamma M_{IS-2}^2 \bar{p}_{LCUP}\tau_{LCUP}S_i$$

$$+ \frac{WFC(IS)}{WCROS(IS)}\gamma M_{IS}^2 \bar{p}_{LCOOL}\tau_{LCOOL}S_i + DLX\frac{WCROS^{j}(IS) - WCROS^{j-1}(IS)}{\Delta t} \tag{A20}$$

where f is the friction factor and D_h is the coolant-channel hydraulic diameter.

Dividing equation (A20) by the upstream area $\tau_{LCUP}S_i$, using equation (A19), and rearranging yield the equation that is programmed:

$$p^{j}_{LCUP}\,\epsilon\left(1+\frac{\tau_{LCOOL}-\tau_{LCUP}}{2\tau_{LCUP}}+\gamma M^{2}_{IS-2}\right)-p^{j}_{LCOOL}$$

$$\times\,\epsilon\left\{\frac{\tau_{LCOOL}}{\tau_{LCUP}}-\frac{\tau_{LCOOL}-\tau_{LCUP}}{2\tau_{LCUP}}+\frac{\tau_{LCOOL}}{\tau_{LCUP}}\,\frac{\gamma M^{2}_{IS}}{2}\left[\frac{4\times f\times DLX}{D_h}+2+2\,\frac{WFC(IS)}{WCROS(IS)}\right]\right\}$$

$$=\frac{DLX}{\tau_{LCUP}S_i}\left(\frac{WCROS^{j}(IS)-WCROS^{j-1}(IS)}{\Delta t}\right)$$

$$-(1-\epsilon)\,p^{j-1}_{LCUP}\left(1+\frac{\tau_{LCOOL}-\tau_{LCUP}}{2\tau_{LCUP}}+\gamma M^{2}_{IS-2}\right)-p^{j-1}_{LCOOL}$$

$$\times\left\{\frac{\tau_{LCOOL}}{\tau_{LCUP}}-\left(\frac{\tau_{LCOOL}-\tau_{LCUP}}{2\tau_{LCUP}}\right)+\frac{\tau_{LCOOL}}{\tau_{LCUP}}\,\frac{\gamma M^{2}_{IS}}{2}\left[\frac{4\times f\times DLX}{D_h}+2+2\,\frac{WFC(IS)}{WCROS(IS)}\right]\right\}$$

(A21)

APPENDIX B

SYMBOLS

A	area
AC	effective heat-transfer area
A1	area defined in fig. 7
A2	area defined in fig. 7
b	equivalent impingement slot width for leading-edge region
c	specific heat
CP	coolant specific heat
C1 - C7	user-supplied constants in general impingement correlation
D	diameter
D_h	hydraulic diameter
DLX	incremental length for friction calculation (fig. 7)
DX1	midwall length defined in fig. 6
DX2	midwall length defined in fig. 6
DX3	wall-outer-surface distance defined in fig. 6
DX4	wall-outer-surface distance defined in fig. 6
DX5	wall-inner-surface distance defined in fig. 6
DX6	wall-inner-surface distance defined in fig. 6
DX9	distance along junction of cladding and wall, defined in fig. 6
DX10	distance along junction of cladding and wall, defined in fig. 6
D1 - D6	user-supplied constants in general leading-edge impingement correlation
f	friction factor
HC	coolant-side heat-transfer coefficient, calculated in program
h	hot-gas-side heat-transfer coefficient, input as a boundary condition
k	thermal conductivity
L	pin fin length
l	surface half-length over which leading-edge impingement is averaged

M	film-cooling mass velocity ratio, coolant to free stream, in eq. (13); Mach number in appendix A
m	constant in eq. (1)
Nu	Nusselt number
Pr	Prandtl number
p	coolant-channel static pressure
QF, QH, QT	coefficients defined in eq. (A3)
q	hot-gas-side heat flux, input as a boundary condition
Re	Reynolds number
S	pin-fin spacing in eq. (12); span of slice in appendix A
St	Stanton number
s	equivalent slot height for film cooling
T	temperature
ΔT	temperature difference
TC	impingement-jet supply total temperature
TG	hot-gas-side reference temperature
t	time
Δt	time increment
U	velocity
V	volume element
W	mass flow rate per unit area
WCROS	coolant-channel crossflow rate
WFC	film-cooling flow rate
WJ	impingement-jet flow rate
X	impingement-jet, spanwise, center-to-center spacing
x	surface distance from row of film-cooling holes
YC	factor that is nonzero only if internal heat transfer is by forced-convection channel flow
YF	factor that is nonzero only if internal heat transfer is by forced convection over pin fins

YI	factor that is nonzero only if internal heat transfer is by impingement jets
Z	impingement channel width
β	internal indicator of type of hot-gas-side boundary condition
γ	isentropic exponent
ϵ	factor for defining time-weighted quantities
η	film-cooling effectiveness, defined as difference between adiabatic wall temperature and hot gas, divided by difference between coolant temperature and hot gas
$\theta_1 - \theta_5, \theta_9$	coefficients defined in eq. (A11)
θ_8	coefficient defined in eq. (A15)
μ	viscosity
ρ	density
τ	thickness
φ	coefficient defined in eq. (A7)
φ_1, φ_2	constants in eq. (1)

Subscripts:

A	slice above current slice
B	slice below current slice
c	coolant channel
D	channel hydraulic diameter
g	hot gas
i	current slice number
IS	current calculational station number (fig. 6)
j	jet, impingement, or film cooling
L	midmetal node of station IS (fig. 6)
LCOOL	coolant-channel node of station IS (fig. 6)
LCUP	upstream coolant-channel node of station IS - 2 (fig. 7)
LCUPS	upstream wall-inner-surface node of station IS - 2 (fig. 7)
LDN	midmetal node of station IS + 2 (fig. 6)

LIN	wall-inner-surface node of station IS (fig. 6)
LJ	node at junction of wall cladding and metal of station IS (fig. 6)
LOUT	wall-outer-surface node of station IS (fig. 6)
LUP	midmetal node of station IS - 2 (fig. 6)
L, LDN	mean quantity between nodes L and LDN
L, LIN	mean quantity between nodes L and LIN
LJ, L	mean quantity between nodes LJ and L
LUP, L	mean quantity between nodes LUP and L
p	pin fins
R	mean quantity in spanwise or radial direction

Superscripts:

$(\bar{\ })$	time-averaged quantity, weighted by ϵ
j	time step number

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TABLE I. - INPUT DATA FOR SAMPLE STEADY-STATE PROBLEM

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       2.794,  4.318,  5.080,  5.588,  0.000,  0.102,  0.178,  0.203,  0.305,  0.508,
       0.762,  1.016,  1.270,  1.778,  2.794,  4.318,  5.080,  5.588,  0.000,  0.102,
       0.178,  0.203,  0.305,  0.508,  0.762,  1.016,  1.270,  1.778,  2.794,  4.318,
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       0.533,  0.711,  1.118,  1.727,  2.438,  3.124,  3.556,  3.835,  0.000,  0.102,
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&GEO ISTA=41,THK=.0003,.0381,.0914,TDLX=.24130,0.,0.,.24130,0.,TDHJ=.0000,TXN=.0889,TRR=23.50,IHCT=2,&END
&GEO ISTA= 2,THK=.0003,.1267,.0508,TDLX=.22860,0.,0.,.12950,0.,TDHJ=.0508,TXN=.1600,TRR=23.50,IHCT=1,&END
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&GEO ISTA= 6,THK=.0003,.1267,.0813,TDLX=.18800,0.,0.,.16760,0.,TDHJ=.0000,TXN=.1905,TRR=23.50,IHCT=1,&END
&GEO ISTA= 8,THK=.0003,.1267,.0940,TDLX=.22860,0.,0.,.20570,0.,TDHJ=.0508,TXN=.5080,TRR=23.50,IHCT=1,&END
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&GEO ISTA=26,THK=.0003,.1267,.2184,TDLX=.19560,0.,0.,.19300,0.,TDHJ=.0000,TXN=.2159,TRR=23.50,IHCT=3,
TDP=.051,TSP=.406, &END
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&GEO ISTA=36,THK=.0003,.0991,.0914,TDLX=.20320,0.,0.,.20070,0.,TDHJ=.0000,TXN=.2286,TRR=23.50,IHCT=2,&END
&GEO ISTA=38,THK=.0003,.0711,.0914,TDLX=.25400,0.,0.,.25400,0.,TDHJ=.0000,TXN=.0889,TRR=23.50,IHCT=2,&END
&GEO ISTA=40,THK=.0003,.0381,.0914,TDLX=.24890,0.,0.,.24640,0.,TDHJ=.0000,TXN=.2286,TRR=23.50,IHCT=2,&END
&CONTRL NFWD= 25, ICOR= 2, NGEO= 41, &END
&PROPS CD=0.80, SPAN= 1.27000, ADUMP= 0.00000, DHYD= 0.58400, APLEN= 0.73810, RI=24.1300, RO=25.4000, &END
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&GEO ISTA= 3,THK=.0003,.1267,.0508,TDLX=.22860,0.,0.,.12950,0.,TDHJ=.0508,TXN=.1600,TRR=24.77,IHCT=1,&END
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&GEO ISTA= 7,THK=.0003,.1267,.0762,TDLX=.18290,0.,0.,.18800,0.,TDHJ=.0000,TXN=.1956,TRR=24.77,IHCT=1,&END
&GEO ISTA= 9,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18800,0.,TDHJ=.0381,TXN=.3810,TRR=24.77,IHCT=1,&END
&GEO ISTA=11,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18290,0.,TDHJ=.0000,TXN=.2007,TRR=24.77,IHCT=1,&END
&GEO ISTA=13,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.19050,0.,TDHJ=.0381,TXN=.3810,TRR=24.77,IHCT=1,&END
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&GEO ISTA=17,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18800,0.,TDHJ=.0381,TXN=.4064,TRR=24.77,IHCT=1,&END
&GEO ISTA=19,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.19560,0.,TDHJ=.0000,TXN=.1956,TRR=24.77,IHCT=1,&END
&GEO ISTA=21,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18800,0.,TDHJ=.0381,TXN=.3937,TRR=24.77,IHCT=1,&END
&GEO ISTA=23,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18290,0.,TDHJ=.0000,TXN=.2032,TRR=24.77,IHCT=1,&END
&GEO ISTA=25,THK=.0003,.1267,.0762,TDLX=.18290,0.,0.,.19300,0.,TDHJ=.0000,TXN=.1778,TRR=24.77,IHCT=2,&END
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TDP=.051,TSP=.406, &END
&GEO ISTA=29,THK=.0003,.1267,.1778,TDLX=.16760,0.,0.,.17530,0.,TDHJ=.0000,TXN=.1905,TRR=24.77,IHCT=3,&END
&GEO ISTA=31,THK=.0003,.1267,.1422,TDLX=.17270,0.,0.,.18290,0.,TDHJ=.0000,TXN=.1905,TRR=24.77,IHCT=2,&END
&GEO ISTA=33,THK=.0003,.1267,.1118,TDLX=.18290,0.,0.,.18800,0.,TDHJ=.0000,TXN=.1905,TRR=24.77,IHCT=2,&END
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TABLE I. - Concluded.

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&GEO ISTA=37,THK=.0003,.0991,.0914,TDLX=.19810,0.,0.,.20320,0.,TDHJ=.0000,TXN=.1778,TRR=24.77,IHCT=2,&END
&GEO ISTA=39,THK=.0003,.0711,.0914,TDLX=.24890,0.,0.,.25400,0.,TDHJ=.0000,TXN=.1905,TRR=24.77,IHCT=2,&END
&GEO ISTA=41,THK=.0003,.0381,.0914,TDLX=.24130,0.,0.,.24130,0.,TDHJ=.0000,TXN=.0889,TRR=24.77,IHCT=2,&END
&GEO ISTA= 2,THK=.0003,.1267,.0508,TDLX=.22860,0.,0.,.12350,0.,TDHJ=.0508,TXN=.1600,TRR=24.77,IHCT=1,&END
&GEO ISTA= 4,THK=.0003,.1267,.0610,TDLX=.26160,0.,0.,.16800,0.,TDHJ=.0508,TXN=.3556,TRR=24.77,IHCT=1,&END
&GEO ISTA= 6,THK=.0003,.1267,.0813,TDLX=.18800,0.,0.,.16760,0.,TDHJ=.0000,TXN=.1905,TRR=24.77,IHCT=1,&END
&GEO ISTA= 8,THK=.0003,.1267,.0940,TDLX=.22860,0.,0.,.20570,0.,TDHJ=.0508,TXN=.5080,TRR=24.77,IHCT=1,&END
&GEO ISTA=10,THK=.0003,.1267,.1016,TDLX=.29460,0.,0.,.26920,0.,TDHJ=.0000,TXN=.2540,TRR=24.77,IHCT=1,&END
&GEO ISTA=12,THK=.0003,.1267,.1016,TDLX=.29970,0.,0.,.27430,0.,TDHJ=.0508,TXN=.5080,TRR=24.77,IHCT=1,&END
&GEO ISTA=14,THK=.0003,.1267,.1016,TDLX=.31240,0.,0.,.27940,0.,TDHJ=.0000,TXN=.2540,TRR=24.77,IHCT=1,&END
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&GEO ISTA=18,THK=.0003,.1267,.1016,TDLX=.28960,0.,0.,.27180,0.,TDHJ=.0000,TXN=.2540,TRR=24.77,IHCT=1,&END
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&GEO ISTA=22,THK=.0003,.1267,.1016,TDLX=.27430,0.,0.,.26420,0.,TDHJ=.0000,TXN=.2540,TRR=24.77,IHCT=1,&END
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&GEO ISTA=26,THK=.0003,.1267,.2134,TDLX=.19560,0.,0.,.19300,0.,TDHJ=.0000,TXN=.2159,TRR=24.77,IHCT=3,
TDP=.051,TSP=.406, &END
&GEO ISTA=28,THK=.0003,.1267,.1778,TDLX=.19050,0.,0.,.18800,0.,TDHJ=.0000,TXN=.2159,TRR=24.77,IHCT=3,&END
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&GEO ISTA=32,THK=.0003,.1267,.1118,TDLX=.19300,0.,0.,.19050,0.,TDHJ=.0000,TXN=.2159,TRR=24.77,IHCT=2,&END
&GEO ISTA=34,THK=.0003,.1267,.0914,TDLX=.19300,0.,0.,.19050,0.,TDHJ=.0000,TXN=.2159,TRR=24.77,IHCT=2,&END
&GEO ISTA=36,THK=.0003,.0991,.0914,TDLX=.20320,0.,0.,.20070,0.,TDHJ=.0000,TXN=.2286,TRR=24.77,IHCT=2,&END
&GEO ISTA=38,THK=.0003,.0711,.0914,TDLX=.25400,0.,0.,.25400,0.,TDHJ=.0000,TXN=.0889,TRR=24.77,IHCT=2,&END
&GEO ISTA=40,THK=.0003,.0381,.0914,TDLX=.24890,0.,0.,.24640,0.,TDHJ=.0000,TXN=.2286,TRR=24.77,IHCT=2,&END
```

TABLE II. - INPUT DATA FOR SAMPLE TRANSIENT PROBLEM

```
&TITL TITLE= 'TACT1 SAMPLE CASE, TRANSIENT ACCELERATION, 3 SLICE BLADE. ',&END
&CHANLS NSLICE= 3, NSTA=41, INEDIT= 1, IPLOT= 3, IWRITE= 0, IUNITS= 1, IFILM= 0, IADJIN= 0,&END
&BC NBCS= 14, NBCP= 14,
BCXS=  0.000,  0.102,  0.178,  0.203,  0.305,  0.508,  0.762,  1.016,  1.270,  1.778,
       2.794,  4.318,  5.080,  5.588,  0.000,  0.102,  0.178,  0.203,  0.305,  0.508,
       0.762,  1.016,  1.270,  1.778,  2.794,  4.318,  5.080,  5.588,  0.000,  0.102,
       0.178,  0.203,  0.305,  0.508,  0.762,  1.016,  1.270,  1.778,  2.794,  4.318,
       5.080,  5.588,  0.000,  0.000,  0.000,  0.000,  0.000,  0.000,  0.000,  0.000,
BCXP=  0.000,  0.102,  0.178,  0.279,  0.356,  0.432,  0.533,  0.711,  1.118,  1.727,
       2.438,  3.124,  3.556,  3.835,  0.000,  0.102,  0.178,  0.279,  0.356,  0.432,
       0.533,  0.711,  1.118,  1.727,  2.438,  3.124,  3.556,  3.835,  0.000,  0.102,
       0.178,  0.279,  0.356,  0.432,  0.533,  0.711,  1.118,  1.727,  2.438,  3.124,
       3.556,  3.835,  0.000,  0.000,  0.000,  0.000,  0.000,  0.000,  0.000,  0.000,
BCHGS=11973.0,11916.2,11348.8,10894.9, 7093.0,10440.9, 9249.3, 8625.1, 8738.6, 8681.8,
      7717.2, 7263.2, 6866.0, 6866.0,11973.0,11916.2,11348.8,10894.9, 7093.0,10440.9,
      9249.3, 8625.1, 8738.6, 8681.8, 7717.2, 7263.2, 6866.0, 6866.0,11973.0,11916.2,
     11348.8,10894.9, 7093.0,10440.9, 9249.3, 8625.1, 8738.6, 8681.8, 7717.2, 7263.2,
      6866.0, 6866.0,
      11973.0,11916.2,11348.8,10894.9, 7093.0,10440.9, 9249.3, 8625.1, 8738.6, 8681.8,
      7717.2, 7263.2, 6866.0, 6866.0,11973.0,11916.2,11348.8,10894.9, 7093.0,10440.9,
      9249.3, 8625.1, 8738.6, 8681.8, 7717.2, 7263.2, 6866.0, 6866.0,11973.0,11916.2,
     11348.8,10894.9, 7093.0,10440.9, 9249.3, 8625.1, 8738.6, 8681.8, 7717.2, 7263.2,
      6866.0, 6866.0,
BCHGP=11973.0,11916.2,11348.8, 9504.6, 9873.5, 9192.5, 8171.1, 7263.2, 6525.6, 6582.3,
      7093.0, 8284.6, 8653.5, 8454.9,11973.0,11916.2,11348.8, 9504.6, 9873.5, 9192.5,
      8171.1, 7263.2, 6525.6, 6582.3, 7093.0, 8284.6, 8653.5, 8454.9,11973.0,11916.2,
     11348.8, 9504.6, 9873.5, 9192.5, 8171.1, 7263.2, 6525.6, 6582.3, 7093.0, 8284.6,
      8653.5, 8454.9,
     11973.0,11916.2,11348.8, 9504.6, 9873.5, 9192.5, 8171.1, 7263.2, 6525.6, 6582.3,
      7093.0, 8284.6, 8653.5, 8454.9,11973.0,11916.2,11348.8, 9504.6, 9873.5, 9192.5,
      8171.1, 7263.2, 6525.6, 6582.3, 7093.0, 8284.6, 8653.5, 8454.9,11973.0,11916.2,
     11348.8, 9504.6, 9873.5, 9192.5, 8171.1, 7263.2, 6525.6, 6582.3, 7093.0, 8284.6,
      8653.5, 8454.9,
BCTGS=  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,
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       950.0,  950.0,  950.0,  950.0,  950.0,  950.0,  950.0,  950.0,  920.0,  920.0,
       920.0,  920.0,  920.0;  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,
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      1590.0, 1590.0, 1590.0, 1590.0, 1670.0, 1670.0, 1670.0, 1670.0, 1670.0, 1670.0,
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      1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0,
      1590.0, 1590.0,
BCTGP=  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,
       920.0,  920.0,  920.0,  920.0,  950.0,  950.0,  950.0,  950.0,  950.0,  950.0,
       950.0,  950.0,  950.0,  950.0,  950.0,  950.0,  950.0,  950.0,  920.0,  920.0,
       920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,  920.0,
       920.0,  920.0,
       1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0,
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      1670.0, 1670.0, 1670.0, 1670.0, 1670.0, 1670.0, 1670.0, 1670.0, 1590.0, 1590.0,
      1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0, 1590.0,
      1590.0, 1590.0,
QHUBIN=  82*-1324044.,
PEX=  3*370.,3*1800.0,
BCTIME=0.0, 2.5,
TTIO=  530., 0.0, 810.0, 2.5,
PTIO= 655., 0.0, 2680.0, 2.5,
WPLEN=   75.0, WSVST=  10000., 0.0, 15800.0, 2.5
AKWTBL=   811.0, 17.43,  911.0, 18.73,  972.0, 20.18, 1023.0, 21.62, 1073.0, 23.06,
         1124.0, 24.51, 1169.0, 25.94, 1216.0, 27.38, 1261.0, 28.83, 1367.0, 32.15,
AKCTBL=   811.0, 17.43,  911.0, 18.73,  972.0, 20.18, 1023.0, 21.62, 1073.0, 23.06,
         1124.0, 24.51, 1169.0, 25.94, 1216.0, 27.38, 1261.0, 28.83, 1367.0, 32.15,
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&END
&CONTRL NFWD= 25, ICOR= 2, NGEO= 41, &END
&PROPS CD=0.80, SPAN= 1.27000, ADUMP= 0.00000, DHYD= 0.58400, APLEN= 0.73810, RI=21.5900, RO=22.8600, &END
&GEO ISTA= 1,THK=.0003,.1267,.0508,TDLX=.00000,0.,0.,.00000,0.,TDHJ=.0508,TXN=.1016,TRR=22.23,IHCT=1,&END
&GEO ISTA= 3,THK=.0003,.1267,.0508,TDLX=.22860,0.,0.,.12950,0.,TDHJ=.0508,TXN=.1600,TRR=22.23,IHCT=1,&END
&GEO ISTA= 5,THK=.0003,.1267,.0762,TDLX=.24130,0.,0.,.18290,0.,TDHJ=.0381,TXN=.3810,TRR=22.23,IHCT=1,&END
&GEO ISTA= 7,THK=.0003,.1267,.0762,TDLX=.18290,0.,0.,.18800,0.,TDHJ=.0000,TXN=.1956,TRR=22.23,IHCT=1,&END
&GEO ISTA= 9,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18800,0.,TDHJ=.0381,TXN=.3810,TRR=22.23,IHCT=1,&END
&GEO ISTA=11,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18290,0.,TDHJ=.0000,TXN=.2007,TRR=22.23,IHCT=1,&END
&GEO ISTA=13,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.19050,0.,TDHJ=.0381,TXN=.3810,TRR=22.23,IHCT=1,&END
&GEO ISTA=15,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18800,0.,TDHJ=.0000,TXN=.1930,TRR=22.23,IHCT=1,&END
&GEO ISTA=17,THK=.0003,.1267,.0762,TDLX=.17780,0.,0.,.18800,0.,TDHJ=.0381,TXN=.4064,TRR=22.23,IHCT=1,&END
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TABLE II. - Continued.

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TABLE III. - PARTIAL OUTPUT FROM SAMPLE STEADY-STATE PROBLEM

PROPERTY TABLES

OUTER COATING EFFECTIVE THERMAL CONDUCTIVITY

T, (K)	811.0	911.0	972.0	1023.0	1073.0	1124.0	1169.0	1216.0	1261.0	1367.0
K, (W/M/K)	17.430	18.730	20.180	21.620	23.060	24.510	25.940	27.380	28.830	32.150

WALL METAL THERMAL CONDUCTIVITY

T, (K)	811.0	911.0	972.0	1023.0	1073.0	1124.0	1169.0	1216.0	1261.0	1367.0
K, (W/M/K)	17.430	18.730	20.180	21.620	23.060	24.510	25.940	27.380	28.830	32.150

TABLE OF GAS PROPERTIES

TEMPERATURE (K)	600.0	900.0	1200.0	1500.0	1800.0	2100.0
K, (W/M/K)	0.04435	0.06192	0.07866	0.09456	0.11130	0.12929
CP, (J/KG/K)	1050.63	1121.75	1177.41	1229.71	1284.52	1344.77
PRANDTL NUMBER	0.70600	0.70600	0.70500	0.70300	0.70200	0.69900
VIS. (N S/M**2)	0.00003	0.00004	0.00005	0.00005	0.00006	0.00007

HOT GAS BOUNDARY CONDITIONS

***************SUCTION SIDE*************** ***************PRESSURE SIDE***************

INITIAL STEADY STATE
SLICE NO. 1

X	HG	TG	QG	PG	X	HG	TG	QG	PG
0.00	11973.0	1590.0	0.0	0.0	0.00	11973.0	1590.0	0.0	0.0
0.10	11916.2	1590.0	0.0	0.0	0.10	11916.2	1590.0	0.0	0.0
0.18	11348.8	1590.0	0.0	0.0	0.18	11348.8	1590.0	0.0	0.0
0.20	10894.9	1590.0	0.0	0.0	0.28	9504.6	1590.0	0.0	0.0
0.30	7093.0	1590.0	0.0	0.0	0.36	9873.5	1590.0	0.0	0.0
0.51	10440.9	1590.0	0.0	0.0	0.43	9192.5	1590.0	0.0	0.0
0.76	9249.3	1590.0	0.0	0.0	0.53	8171.1	1590.0	0.0	0.0
1.02	8625.1	1590.0	0.0	0.0	0.71	7263.2	1590.0	0.0	0.0
1.27	8738.6	1590.0	0.0	0.0	1.12	6525.6	1590.0	0.0	0.0
1.78	8681.8	1590.0	0.0	0.0	1.73	6582.3	1590.0	0.0	0.0
2.79	7717.2	1590.0	0.0	0.0	2.44	7093.0	1590.0	0.0	0.0
4.32	7263.2	1590.0	0.0	0.0	3.12	8284.5	1590.0	0.0	0.0
5.08	6866.0	1590.0	0.0	0.0	3.56	8653.5	1590.0	0.0	0.0
5.59	6866.0	1590.0	0.0	0.0	3.83	8454.9	1590.0	0.0	0.0

INITIAL STEADY STATE
SLICE NO. 2

X	HG	TG	QG	PG	X	HG	TG	QG	PG
0.00	11973.0	1670.0	0.0	0.0	0.00	11973.0	1670.0	0.0	0.0
0.10	11916.2	1670.0	0.0	0.0	0.10	11916.2	1670.0	0.0	0.0
0.18	11348.8	1670.0	0.0	0.0	0.18	11348.8	1670.0	0.0	0.0
0.20	10894.9	1670.0	0.0	0.0	0.28	9504.6	1670.0	0.0	0.0
0.30	7093.0	1670.0	0.0	0.0	0.36	9873.5	1670.0	0.0	0.0
0.51	10440.9	1670.0	0.0	0.0	0.43	9192.5	1670.0	0.0	0.0
0.76	9249.3	1670.0	0.0	0.0	0.53	8171.1	1670.0	0.0	0.0
1.02	8625.1	1670.0	0.0	0.0	0.71	7263.2	1670.0	0.0	0.0
1.27	8738.6	1670.0	0.0	0.0	1.12	6525.6	1670.0	0.0	0.0
1.78	8681.8	1670.0	0.0	0.0	1.73	6582.3	1670.0	0.0	0.0
2.79	7717.2	1670.0	0.0	0.0	2.44	7093.0	1670.0	0.0	0.0
4.32	7263.2	1670.0	0.0	0.0	3.12	8284.6	1670.0	0.0	0.0
5.08	6866.0	1670.0	0.0	0.0	3.56	8653.5	1670.0	0.0	0.0
5.59	6866.0	1670.0	0.0	0.0	3.83	8454.9	1670.0	0.0	0.0

INITIAL STEADY STATE
SLICE NO. 3

X	HG	TG	QG	PG	X	HG	TG	QG	PG
0.00	11973.0	1590.0	0.0	0.0	0.00	11973.0	1590.0	0.0	0.0
0.10	11916.2	1590.0	0.0	0.0	0.10	11916.2	1590.0	0.0	0.0
0.18	11348.8	1590.0	0.0	0.0	0.18	11348.8	1590.0	0.0	0.0
0.20	10894.9	1590.0	0.0	0.0	0.28	9504.5	1590.0	0.0	0.0
0.30	7093.0	1590.0	0.0	0.0	0.36	9873.5	1590.0	0.0	0.0
0.51	10440.9	1590.0	0.0	0.0	0.43	9192.5	1590.0	0.0	0.0
0.76	9249.3	1590.0	0.0	0.0	0.53	8171.1	1590.0	0.0	0.0
1.02	8625.1	1590.0	0.0	0.0	0.71	7263.2	1590.0	0.0	0.0
1.27	8738.6	1590.0	0.0	0.0	1.12	6525.6	1590.0	0.0	0.0
1.78	8681.8	1590.0	0.0	0.0	1.73	6582.3	1590.0	0.0	0.0
2.79	7717.2	1590.0	0.0	0.0	2.44	7093.0	1590.0	0.0	0.0
4.32	7263.2	1590.0	0.0	0.0	3.12	8284.5	1590.0	0.0	0.0
5.08	6866.0	1590.0	0.0	0.0	3.56	8653.5	1590.0	0.0	0.0
5.59	6866.0	1590.0	0.0	0.0	3.83	8454.9	1590.0	0.0	0.0

TABLE III. - Continued.

INPUT FOR SLICE NUMBER 1

HUB HEAT FLUX IS SPECIFIED

COOLANT PLENUM: RI= 21.590 CM   RO= 22.860 CM   DHYD= 0.5840 CM   APLEN= 0.7381 CM**2

NUMBER OF STATIONS IN IMPINGEMENT REGION IS 25, TOTAL NUMBER OF STATIONS IS 41, SPAN OF THIS SLICE IS 1.270 CM
IMPINGEMENT HOLE DISCHARGE COEF.= 0.800,   AREA OF DUMP TO TRAILING EDGE = 0.00000 CM**2
COOLANT INLET TEMP.= 810.0 K, COOLANT INLET PRESSURE = 2680.0 KPA, EXIT PRESSURE = 1800.0 KPA,
COOLANT FLOW = 320.0 KG/HR

PRESSURE SIDE, SLICE 1, TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	1	3	5	7	9	11	13	15	17	19
COOLANT NODE NUMBER	5	15	25	35	45	55	65	75	85	95
RADIAL LOCATION (CM)	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230
X, OUTSIDE SUR. (CM)	0.00000	0.22860	0.46990	0.65280	0.83060	1.00840	1.18620	1.36400	1.54180	1.71960
X, INTERFACE (CM)	0.00000	0.22837	0.46953	0.65244	0.83026	1.00807	1.18590	1.36373	1.54155	1.71939
X, MID-METAL (CM)	0.00000	0.17893	0.39096	0.57642	0.75933	0.93969	1.12385	1.30676	1.48958	1.67640
X, INSIDE SURF. (CM)	0.00000	0.12950	0.31240	0.50040	0.68840	0.87130	1.06180	1.24980	1.43780	1.63340
X, MID.COOL.CH. (CM)	0.00000	0.10968	0.27506	0.46459	0.65565	0.84003	1.03439	1.22545	1.41651	1.61745
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670
CHANNEL WIDTH (CM)	0.05080	0.05080	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620
CHANNEL AREA (CM**2)	0.06452	0.06452	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677
CHANNEL HYD.DIA (CM)	0.09769	0.09769	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377
IMP.JET HYD.DIA (CM)	0.05080	0.05080	0.03810	0.00000	0.03810	0.00000	0.03810	0.00000	0.03810	0.00000
NO. OF IMP. JETS	12.50	7.94	3.33	0.00	3.33	0.00	3.33	0.00	3.12	0.00
TOT.JET AREA (CM**2)	0.02534	0.01609	0.00380	0.00000	0.00380	0.00000	0.00380	0.00000	0.00356	0.00000
TYPE OF HC CALC.	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG
OUTSIDE BC: TG, (K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	11973.0	10424.9	8809.2	7560.1	7046.4	6724.2	6531.9	6548.5	6565.1	6581.6
QHUB (W/M**2)	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0

STATION NUMBER	21	23	25	27	29	31	33	35	37	39
COOLANT NODE NUMBER	105	115	125	135	145	155	165	175	185	195
RADIAL LOCATION (CM)	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230
X, OUTSIDE SUR. (CM)	1.89740	2.07519	2.25809	2.42319	2.59079	2.76349	2.94639	3.13439	3.33249	3.58139
X, INTERFACE (CM)	1.89721	2.07503	2.25795	2.42307	2.59068	2.76341	2.94632	3.13432	3.33243	3.58136
X, MID-METAL (CM)	1.85931	2.03966	2.22762	2.39653	2.56799	2.74580	2.93126	3.11926	3.31991	3.57137
X, INSIDE SURF. (CM)	1.82140	2.00430	2.19730	2.37000	2.54530	2.72820	2.91620	3.10420	3.30739	3.56139
X, MID.COOL.CH. (CM)	1.80851	1.99293	2.18896	2.36820	2.54889	2.73750	2.92774	3.11574	3.32129	3.57855
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.09910	0.07110
CHANNEL WIDTH (CM)	0.07620	0.07620	0.07620	0.21840	0.17780	0.14220	0.11180	0.09140	0.09140	0.09140
CHANNEL AREA (CM**2)	0.09677	0.09677	0.09677	0.27737	0.22581	0.18059	0.14199	0.11608	0.11608	0.11608
CHANNEL HYD.DIA (CM)	0.14377	0.14377	0.14377	0.37271	0.31193	0.25576	0.20551	0.17053	0.17053	0.17053
IMP.JET HYD.DIA (CM)	0.03810	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
NO. OF IMP. JETS	3.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOT.JET AREA (CM**2)	0.00368	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TYPE OF HC CALC.	IMPG	IMPG	CHAN	PINS	PINS	CHAN	CHAN	CHAN	CHAN	CHAN
OUTSIDE BC: TG, (K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	6704.7	6832.4	6963.8	7082.4	7358.4	7658.4	7976.1	8293.5	8462.6	8635.4
QHUB (W/M**2)	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0

STATION NUMBER	41
COOLANT NODE NUMBER	205
RADIAL LOCATION (CM)	22.230
X, OUTSIDE SUR. (CM)	3.82269
X, INTERFACE (CM)	3.82265
X, MID-METAL (CM)	3.81267
X, INSIDE SURF. (CM)	3.80269
X, MID.COOL.CH. (CM)	3.81985
COATING THKNSS (CM)	0.00030
WALL THICKNESS (CM)	0.03810
CHANNEL WIDTH (CM)	0.09140
CHANNEL AREA (CM**2)	0.11608
CHANNEL HYD.DIA (CM)	0.17053
IMP.JET HYD.DIA (CM)	0.00000
NO. OF IMP. JETS	0.00
TOT.JET AREA (CM**2)	0.00000
TYPE OF HC CALC.	CHAN
OUTSIDE BC: TG, (K)	1590.0
HG (W/M**2/K)	8463.7
QHUB (W/M**2)	-1324043.0

TABLE III. - Continued.

SUCTION SIDE, SLICE 1, TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	2	4	6	8	10	12	14	16	18	20
COOLANT NODE NUMBER	10	20	30	40	50	60	70	80	90	100
RADIAL LOCATION(CM)	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230
X, OUTSIDE SUR.(CM)	0.22860	0.49020	0.67820	0.90680	1.20140	1.50110	1.81350	2.12590	2.41550	2.70510
X, INTERFACE (CM)	0.22837	0.48979	0.67774	0.90629	1.20083	1.50047	1.81279	2.12511	2.41467	2.70422
X, MID-METAL (CM)	0.17893	0.40365	0.58142	0.79854	1.08041	1.36738	1.66324	1.95910	2.23978	2.51916
X, INSIDE SURF.(CM)	0.12950	0.31750	0.48510	0.69080	0.96000	1.23430	1.51370	1.79310	2.06490	2.33410
X, MID.COOL.CH.(CM)	0.10968	0.28300	0.44107	0.63830	0.89734	1.16148	1.42768	1.69388	1.95856	2.21960
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670
CHANNEL WIDTH (CM)	0.05080	0.06100	0.08130	0.09400	0.10160	0.10160	0.10160	0.10160	0.10160	0.10160
CHANNEL AREA(CM**2)	0.06452	0.07747	0.10325	0.11938	0.12903	0.12903	0.12903	0.12903	0.12903	0.12903
CHANNEL HYD.DIA(CM)	0.09769	0.11641	0.15282	0.17504	0.18815	0.18815	0.18815	0.18815	0.18815	0.18815
IMP.JET HYD.DIA(CM)	0.05080	0.05080	0.00000	0.05080	0.00000	0.05080	0.00000	0.05080	0.00000	0.05080
NO. OF IMP. JETS	7.94	3.57	0.00	2.50	0.00	2.50	0.00	2.50	0.00	2.50
TOT.JET AREA(CM**2)	0.01609	0.00724	0.00000	0.00507	0.00000	0.00507	0.00000	0.00507	0.00000	0.00507
TYPE OF HC CALC.	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG
OUTSIDE BC: TG,(K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	9940.7	10147.3	9642.4	8893.5	8707.9	8712.8	8648.1	8351.5	8076.5	7801.6
QHUB (W/M**2)	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0

STATION NUMBER	22	24	26	28	30	32	34	36	38	40
COOLANT NODE NUMBER	110	120	130	140	150	160	170	180	190	200
RADIAL LOCATION(CM)	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230	22.230
X, OUTSIDE SUR.(CM)	2.97939	3.24859	3.44419	3.63469	3.82769	4.02069	4.21369	4.41689	4.67089	4.91979
X, INTERFACE (CM)	2.97850	3.24768	3.44328	3.63377	3.82676	4.01976	4.21275	4.41594	4.65994	4.91882
X, MID-METAL (CM)	2.78839	3.05509	3.24938	3.43863	3.63038	3.82212	4.01387	4.21582	4.46982	4.71745
X, INSIDE SURF.(CM)	2.59830	2.86250	3.05550	3.24349	3.43399	3.62449	3.81499	4.01569	4.26969	4.51609
X, MID.COOL.CH.(CM)	2.47976	2.74196	2.93272	3.11897	3.30807	3.49747	3.68707	3.88662	4.14062	4.38404
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.09910	0.07110	0.03810
CHANNEL WIDTH (CM)	0.10160	0.10160	0.21840	0.17780	0.14220	0.11180	0.09140	0.09140	0.09140	0.09140
CHANNEL AREA(CM**2)	0.12903	0.12903	0.27737	0.22581	0.18059	0.14199	0.11608	0.11608	0.11608	0.11608
CHANNEL HYD.DIA(CM)	0.18815	0.18815	0.37271	0.31193	0.25576	0.20551	0.17053	0.17053	0.17053	0.17053
IMP.JET HYD.DIA(CM)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
NO. OF IMP. JETS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOT.JET AREA(CM**2)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TYPE OF HC CALC.	IMPG	CHAN	PINS	PINS	CHAN	CHAN	CHAN	CHAN	CHAN	CHAN
OUTSIDE BC: TG,(K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	7662.0	7581.8	7523.5	7466.8	7409.3	7351.8	7294.3	7211.6	7079.3	5949.5
QHUB (W/M**2)	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0	-1324043.0

WARNING, RATIO OF JET HOLE SPACING TO JET DIAMETER FOR JET 1 IS 2.0000 WHICH IS OUT OF THE RANGE OF VALIDITY OF THE

TABLE III. - Continued.

INPUT FOR SLICE NUMBER 2

COOLANT PLENUM: RI= 22.860 CM RO= 24.130 CM DHYD= 0.5840 CM APLEN= 0.7381 CM**2

NUMBER OF STATIONS IN IMPINGEMENT REGION IS 25, TOTAL NUMBER OF STATIONS IS 41, SPAN OF THIS SLICE IS 1.270 CM
IMPINGEMENT HOLE DISCHARGE COEF.= 0.800, AREA OF DUMP TO TRAILING EDGE = 0.00000 CM**2
COOLANT INLET TEMP.= 810.0 K, COOLANT INLET PRESSURE = 2680.0 KPA, EXIT PRESSURE = 1800.0 KPA,
COOLANT FLOW = 320.0 KG/HR

PRESSURE SIDE, SLICE 2, TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	1	3	5	7	9	11	13	15	17	19
COOLANT NODE NUMBER	5	15	25	35	45	55	65	75	85	95
RADIAL LOCATION(CM)	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500
X, OUTSIDE SUR.(CM)	0.00000	0.22860	0.46990	0.65280	0.83060	1.00840	1.18620	1.36400	1.54180	1.71960
X, INTERFACE (CM)	0.00000	0.22837	0.46953	0.65244	0.83026	1.00807	1.18590	1.36373	1.54155	1.71939
X, MID-METAL (CM)	0.00000	0.17893	0.39096	0.57642	0.75933	0.93969	1.12385	1.30676	1.48968	1.67640
X, INSIDE SURF.(CM)	0.00000	0.12950	0.31240	0.50040	0.68840	0.87130	1.06180	1.24980	1.43780	1.63340
X, MID.COOL.CH.(CM)	0.00000	0.10968	0.27506	0.46459	0.65565	0.84008	1.03439	1.22545	1.41651	1.61745
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12570	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670
CHANNEL WIDTH (CM)	0.05080	0.05080	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620
CHANNEL AREA(CM**2)	0.06452	0.06452	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677
CHANNEL HYD.DIA(CM)	0.09769	0.09769	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377
IMP.JET HYD.DIA(CM)	0.05080	0.05080	0.03810	0.00000	0.03810	0.00000	0.03810	0.00000	0.03810	0.00000
NO. OF IMP. JETS	12.50	7.94	3.33	0.00	3.33	0.00	3.33	0.00	3.12	0.00
TOT.JET AREA(CM**2)	0.02534	0.01509	0.00380	0.00000	0.00380	0.00000	0.00380	0.00000	0.00356	0.00000
TYPE OF HC CALC.	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG
OUTSIDE BC: TG,(K)	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0
HG (W/M**2/K)	11973.0	10424.9	8809.2	7560.1	7046.4	6724.2	6531.9	6548.5	5565.1	6581.6

STATION NUMBER	21	23	25	27	29	31	33	35	37	39
COOLANT NODE NUMBER	105	115	125	135	145	155	165	175	185	195
RADIAL LOCATION(CM)	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500
X, OUTSIDE SUR.(CM)	1.89740	2.07519	2.25809	2.42319	2.59079	2.76349	2.94639	3.13439	3.33249	3.58139
X, INTERFACE (CM)	1.89721	2.07503	2.25795	2.42307	2.59068	2.76341	2.94632	3.13432	3.33243	3.58136
X, MID-METAL (CM)	1.85931	2.03966	2.22762	2.39653	2.56799	2.74580	2.93126	3.11926	3.31991	3.57137
X, INSIDE SURF.(CM)	1.82140	2.00430	2.19730	2.37000	2.54530	2.72820	2.91620	3.10420	3.30739	3.56139
X, MID.COOL.CH.(CM)	1.80851	1.99293	2.18896	2.36820	2.54889	2.73750	2.92774	3.11574	3.32129	3.57855
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.09910	0.07110
CHANNEL WIDTH (CM)	0.07620	0.07520	0.07620	0.21840	0.17780	0.14220	0.11180	0.09140	0.09140	0.09140
CHANNEL AREA(CM**2)	0.09677	0.09677	0.09677	0.27737	0.22581	0.18059	0.14199	0.11608	0.11608	0.11608
CHANNEL HYD.DIA(CM)	0.14377	0.14377	0.14377	0.37271	0.31193	0.25576	0.20551	0.17053	0.17053	0.17053
IMP.JET HYD.DIA(CM)	0.03810	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
NO. OF IMP. JETS	3.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOT.JET AREA(CM**2)	0.00368	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TYPE OF HC CALC.	IMPG	IMPG	CHAN	PINS	PINS	CHAN	CHAN	CHAN	CHAN	CHAN
OUTSIDE BC: TG,(K)	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0
HG (W/M**2/K)	6704.7	6832.4	6963.8	7082.4	7358.4	7658.4	7976.1	8293.5	8462.6	8635.4

STATION NUMBER	41
COOLANT NODE NUMBER	205
RADIAL LOCATION(CM)	23.500
X, OUTSIDE SUR.(CM)	3.82269
X, INTERFACE (CM)	3.82265
X, MID-METAL (CM)	3.81267
X, INSIDE SURF.(CM)	3.80269
X, MID.COOL.CH.(CM)	3.81985
COATING THKNSS (CM)	0.00030
WALL THICKNESS (CM)	0.03810
CHANNEL WIDTH (CM)	0.09140
CHANNEL AREA(CM**2)	0.11608
CHANNEL HYD.DIA(CM)	0.17053
IMP.JET HYD.DIA(CM)	0.00000
NO. OF IMP. JETS	0.00
TOT.JET AREA(CM**2)	0.00000
TYPE OF HC CALC.	CHAN
OUTSIDE BC: TG,(K)	1670.0
HG (W/M**2/K)	8463.7

TABLE III. - Continued.

SUCTION SIDE, SLICE 2, TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	2	4	6	8	10	12	14	16	18	20
COOLANT NODE NUMBER	10	20	30	40	50	60	70	80	90	100
RADIAL LOCATION(CM)	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500
X, OUTSIDE SUR.(CM)	0.22860	0.49020	0.67820	0.90680	1.20140	1.50110	1.81350	2.12590	2.41550	2.70510
X, INTERFACE (CM)	0.22837	0.48979	0.67774	0.90629	1.20083	1.50047	1.81279	2.12511	2.41467	2.70422
X, MID-METAL (CM)	0.17893	0.40365	0.58142	0.79854	1.08041	1.36738	1.66324	1.95910	2.23978	2.51916
X, INSIDE SURF.(CM)	0.12950	0.31750	0.48510	0.69080	0.96000	1.23430	1.51370	1.79310	2.06490	2.33410
X, MID.COOL.CH.(CM)	0.10968	0.28300	0.44107	0.63830	0.89734	1.16148	1.42768	1.69388	1.95856	2.21960
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670
CHANNEL WIDTH (CM)	0.05080	0.06100	0.08130	0.09400	0.10160	0.10160	0.10160	0.10160	0.10160	0.10160
CHANNEL AREA(CM**2)	0.06452	0.07747	0.10325	0.11938	0.12903	0.12903	0.12903	0.12903	0.12903	0.12903
CHANNEL HYD.DIA(CM)	0.09769	0.11641	0.15282	0.17504	0.18815	0.18815	0.18815	0.18815	0.18815	0.18815
IMP.JET HYD.DIA(CM)	0.05080	0.05080	0.00000	0.05080	0.00000	0.05080	0.00000	0.05080	0.00000	0.05080
NO. OF IMP. JETS	7.94	3.57	0.00	2.50	0.00	2.50	0.00	2.50	0.00	2.50
TOT.JET AREA(CM**2)	0.01609	0.00724	0.00000	0.00507	0.00000	0.00507	0.00000	0.00507	0.00000	0.00507
TYPE OF HC CALC.	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG
OUTSIDE BC: TG,(K)	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0
HG (W/M**2/K)	9940.7	10147.3	9642.4	8893.5	8707.9	8712.9	8648.1	8351.5	8076.5	7801.6

STATION NUMBER	22	24	26	28	30	32	34	36	38	40
COOLANT NODE NUMBER	110	120	130	140	150	160	170	180	190	200
RADIAL LOCATION(CM)	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500	23.500
X, OUTSIDE SUR.(CM)	2.97939	3.24859	3.44419	3.63469	3.82769	4.02069	4.21369	4.41689	4.67089	4.91979
X, INTERFACE (CM)	2.97850	3.24768	3.44328	3.63377	3.82676	4.01976	4.21275	4.41594	4.65934	4.91882
X, MID-METAL (CM)	2.78839	3.05509	3.24938	3.43863	3.63038	3.82212	4.01387	4.21582	4.46452	4.71745
X, INSIDE SURF.(CM)	2.59830	2.86250	3.05550	3.24349	3.43399	3.62449	3.81499	4.01569	4.26969	4.51609
X, MID.COOL.CH.(CM)	2.47976	2.74196	2.93272	3.11897	3.30807	3.49747	3.68707	3.88662	4.14062	4.38404
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.09910	0.07110	0.03810
CHANNEL WIDTH (CM)	0.10160	0.10160	0.21840	0.17780	0.14220	0.11180	0.09140	0.09140	0.09140	0.09140
CHANNEL AREA(CM**2)	0.12903	0.12903	0.27737	0.22581	0.18059	0.14199	0.11608	0.11608	0.11608	0.11608
CHANNEL HYD.DIA(CM)	0.18815	0.18815	0.37271	0.31193	0.25576	0.20551	0.17053	0.17053	0.17053	0.17053
IMP.JET HYD.DIA(CM)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
NO. OF IMP. JETS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOT.JET AREA(CM**2)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TYPE OF HC CALC.	IMPG	CHAN	PINS	PINS	CHAN	CHAN	CHAN	CHAN	CHAN	CHAN
OUTSIDE BC: TG,(K)	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0	1670.0
HG (W/M**2/K)	7662.0	7581.8	7523.5	7466.8	7409.3	7351.8	7294.3	7211.6	7079.3	6949.5

WARNING, RATIO OF JET HOLE SPACING TO JET DIAMETER FOR JET 1 IS 2.0000 WHICH IS
OUT OF THE RANGE OF VALIDITY OF THE CORRELATION

INPUT FOR SLICE NUMBER 3
ADIABATIC TIP SPECIFIED

COOLANT PLENUM: RI= 24.130 CM RO= 25.400 CM DHYD= 0.5840 CM APLEN= 0.7381 CM**2

NUMBER OF STATIONS IN IMPINGEMENT REGION IS 25, TOTAL NUMBER OF STATIONS IS 41, SPAN OF THIS SLICE IS 1.270 CM
IMPINGEMENT HOLE DISCHARGE COEF.= 0.800, AREA OF DUMP TO TRAILING EDGE = 0.00000 CM**2
COOLANT INLET TEMP.= 810.0 K, COOLANT INLET PRESSURE = 2680.0 KPA, EXIT PRESSURE = 1800.0 KPA,
COOLANT FLOW = 320.0 KG/HR

PRESSURE SIDE, SLICE 3, TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	1	3	5	7	9	11	13	15	17	19
COOLANT NODE NUMBER	5	15	25	35	45	55	65	75	85	95
RADIAL LOCATION(CM)	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770
X, OUTSIDE SUR.(CM)	0.00000	0.22860	0.46990	0.65280	0.83060	1.00840	1.18620	1.36400	1.54180	1.71960
X, INTERFACE (CM)	0.00000	0.22837	0.46953	0.65244	0.83026	1.00807	1.18590	1.36373	1.54155	1.71939
X, MID-METAL (CM)	0.00000	0.17893	0.39096	0.57642	0.75933	0.93969	1.12385	1.30676	1.48968	1.67640
X, INSIDE SURF.(CM)	0.00000	0.12950	0.31240	0.50040	0.68840	0.87130	1.06180	1.24980	1.43780	1.63340
X, MID.COOL.CH.(CM)	0.00000	0.10968	0.27506	0.46459	0.65565	0.84008	1.03439	1.22545	1.41651	1.61745
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670
CHANNEL WIDTH (CM)	0.05080	0.05080	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620	0.07620
CHANNEL AREA(CM**2)	0.06452	0.06452	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677	0.09677
CHANNEL HYD.DIA(CM)	0.09769	0.09769	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377	0.14377
IMP.JET HYD.DIA(CM)	0.05080	0.05080	0.03810	0.00000	0.03810	0.00000	0.03810	0.00000	0.03810	0.00000
NO. OF IMP. JETS	12.50	7.94	3.33	0.00	3.33	0.00	3.33	0.00	3.12	0.00
TOT.JET AREA(CM**2)	0.02534	0.01609	0.00380	0.00000	0.00380	0.00000	0.00380	0.00000	0.00356	0.00000
TYPE OF HC CALC.	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG
OUTSIDE BC: TG,(K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	11973.0	10424.9	8809.2	7560.1	7046.4	6724.2	6531.9	6548.5	6565.1	6581.6

TABLE III. - Continued.

STATION NUMBER	21	23	25	27	29	31	33	35	37	39
COOLANT NODE NUMBER	105	115	125	135	145	155	165	175	185	195
RADIAL LOCATION (CM)	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770
X, OUTSIDE SUR. (CM)	1.89740	2.07519	2.25809	2.42319	2.59079	2.76349	2.94639	3.13439	3.33249	3.58139
X, INTERFACE (CM)	1.89721	2.07503	2.25795	2.42307	2.59068	2.76341	2.94632	3.13432	3.33243	3.58136
X, MID-METAL (CM)	1.85931	2.03966	2.22762	2.39653	2.56799	2.74580	2.93126	3.11926	3.31991	3.57137
X, INSIDE SURF. (CM)	1.82140	2.00430	2.19730	2.37000	2.54530	2.72820	2.91620	3.10420	3.30739	3.56139
X, MID.COOL.CH. (CM)	1.80851	1.99293	2.18896	2.36820	2.54889	2.73750	2.92774	3.11574	3.32129	3.57855
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.09910	0.07110
CHANNEL WIDTH (CM)	0.07620	0.07520	0.07620	0.21840	0.17780	0.14220	0.11180	0.09140	0.09140	0.09140
CHANNEL AREA(CM**2)	0.09677	0.09677	0.09677	0.27737	0.22581	0.18059	0.14199	0.11608	0.11608	0.11608
CHANNEL HYD.DIA (CM)	0.14377	0.14377	0.14377	0.37271	0.31193	0.25576	0.20551	0.17053	0.17053	0.17053
IMP.JET HYD.DIA (CM)	0.03810	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
NO. OF IMP. JETS	3.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOT.JET AREA (CM**2)	0.00368	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TYPE OF HC CALC.	IMPG	IMPG	CHAN	PINS	PINS	CHAN	CHAN	CHAN	CHAN	CHAN
OUTSIDE BC: TG, (K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	6704.7	6832.4	6963.8	7082.4	7358.4	7658.4	7976.1	8293.5	8462.6	8635.4

STATION NUMBER	41
COOLANT NODE NUMBER	205
RADIAL LOCATION (CM)	24.770
X, OUTSIDE SUR. (CM)	3.82269
X, INTERFACE (CM)	3.82265
X, MID-METAL (CM)	3.81267
X, INSIDE SURF. (CM)	3.80269
X, MID.COOL.CH. (CM)	3.81985
COATING THKNSS (CM)	0.00030
WALL THICKNESS (CM)	0.03810
CHANNEL WIDTH (CM)	0.09140
CHANNEL AREA(CM**2)	0.11608
CHANNEL HYD.DIA (CM)	0.17053
IMP.JET HYD.DIA (CM)	0.00000
NO. OF IMP. JETS	0.00
TOT.JET AREA (CM**2)	0.00000
TYPE OF HC CALC.	CHAN
OUTSIDE BC: TG, (K)	1590.0
HG (W/M**2/K)	8463.7

SUCTION SIDE, SLICE 3, TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	2	4	6	8	10	12	14	16	18	20
COOLANT NODE NUMBER	10	20	30	40	50	60	70	80	90	100
RADIAL LOCATION (CM)	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770
X, OUTSIDE SUR. (CM)	0.22860	0.49020	0.67820	0.90680	1.20140	1.50110	1.81350	2.12590	2.41550	2.70510
X, INTERFACE (CM)	0.22837	0.48979	0.67774	0.90629	1.20083	1.50047	1.81279	2.12511	2.41467	2.70422
X, MID-METAL (CM)	0.17893	0.40365	0.58142	0.79854	1.08041	1.36738	1.66324	1.95910	2.23978	2.51916
X, INSIDE SURF. (CM)	0.12950	0.31750	0.48510	0.69080	0.96000	1.23430	1.51370	1.79310	2.06490	2.33410
X, MID.COOL.CH. (CM)	0.10968	0.28300	0.44107	0.63830	0.89734	1.16148	1.42768	1.69388	1.95856	2.21960
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670
CHANNEL WIDTH (CM)	0.05080	0.06100	0.08130	0.09400	0.10160	0.10160	0.10160	0.10160	0.10160	0.10160
CHANNEL AREA(CM**2)	0.06452	0.07747	0.10325	0.11938	0.12903	0.12903	0.12903	0.12903	0.12903	0.12903
CHANNEL HYD.DIA (CM)	0.09769	0.11641	0.15282	0.17504	0.18815	0.18815	0.18815	0.18815	0.18815	0.18815
IMP.JET HYD.DIA (CM)	0.05080	0.05080	0.00000	0.05080	0.00000	0.05080	0.00000	0.05080	0.00000	0.05080
NO. OF IMP. JETS	7.94	3.57	0.00	2.50	0.00	2.50	0.00	2.50	0.00	2.50
TOT.JET AREA (CM**2)	0.01609	0.00724	0.00000	0.00507	0.00000	0.00507	0.00000	0.00507	0.00000	0.00507
TYPE OF HC CALC.	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG	IMPG
OUTSIDE BC: TG, (K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	9940.7	10147.3	9642.4	8893.5	8707.9	8712.8	8648.1	8351.5	8076.5	7801.6

TABLE III. - Continued.

STATION NUMBER	22	24	26	28	30	32	34	36	38	40
COOLANT NODE NUMBER	110	120	130	140	150	160	170	180	190	200
RADIAL LOCATION(CM)	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770	24.770
X, OUTSIDE SUR.(CM)	2.97939	3.24859	3.44419	3.63469	3.82769	4.02069	4.21369	4.41689	4.67089	4.91979
X, INTERFACE (CM)	2.97850	3.24768	3.44328	3.63377	3.82676	4.01976	4.21275	4.41594	4.65994	4.91882
X, MID-METAL (CM)	2.78839	3.05509	3.24938	3.43863	3.63038	3.82212	4.01387	4.21582	4.46932	4.71745
X, INSIDE SURF.(CM)	2.59830	2.86250	3.05550	3.24349	3.43399	3.62449	3.81499	4.01569	4.26969	4.51609
X, MID.COOL.CH.(CM)	2.47976	2.74196	2.93272	3.11897	3.30807	3.49747	3.68707	3.88662	4.14062	4.38404
COATING THKNSS (CM)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
WALL THICKNESS (CM)	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.12670	0.09910	0.07110	0.03810
CHANNEL WIDTH (CM)	0.10160	0.10160	0.21840	0.17780	0.14220	0.11180	0.09140	0.09140	0.09140	0.09140
CHANNEL AREA(CM**2)	0.12903	0.12903	0.27737	0.22581	0.18059	0.14199	0.11608	0.11608	0.11608	0.11608
CHANNEL HYD.DIA(CM)	0.18815	0.18315	0.37271	0.31193	0.25576	0.20551	0.17053	0.17053	0.17053	0.17053
IMP.JET HYD.DIA(CM)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
NO. OF IMP. JETS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOT.JET AREA(CM**2)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TYPE OF HC CALC.	IMPG	CHAN	PINS	PINS	CHAN	CHAN	CHAN	CHAN	CHAN	CHAN
OUTSIDE BC: TG,(K)	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
HG (W/M**2/K)	7662.0	7581.8	7523.5	7466.8	7409.3	7351.8	7294.3	7211.6	7079.3	6949.5

***** OUTPUT *****

TACT1 SAMPLE CASE,HOT STEADY STATE, 3 SLICE BLADE.,

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THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 1 ARE:

PIM = 2678.12 KPA,

TOG = 809.90 K

****

CENTRAL PLENUM FLOW IS 237.4 KG/HR

TIME = 0.00 SEC., STEP SIZE = 0.000 SEC., WHEEL SPEED = 16800.0 RPM

SLICE NO. 1, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 8 ITERATIONS

PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1285.1	1284.7	1196.9	1087.2	809.9	2239.4	2239.4	22015.6	11973.0	1590.0
3	15	1267.7	1267.3	1187.3	1082.5	815.8	2217.8	2228.6	19835.8	10424.9	1590.0
5	25	1270.4	1270.1	1206.8	1147.8	807.1	2174.1	2199.6	8316.4	8809.2	1590.0
7	35	1243.2	1242.9	1184.5	1125.2	811.9	2158.2	2191.7	8316.4	7560.1	1590.0
9	45	1229.1	1228.8	1171.4	1114.0	819.2	2157.6	2191.4	8198.2	7046.4	1590.0
11	55	1219.7	1219.4	1162.7	1106.0	820.6	2139.2	2182.4	8198.2	6724.2	1590.0
13	65	1214.7	1214.4	1158.3	1102.5	826.4	2138.6	2182.1	8101.0	6531.9	1590.0
15	75	1215.8	1215.6	1159.5	1103.7	826.1	2117.4	2171.7	8101.0	6548.5	1590.0
17	85	1220.7	1220.4	1165.6	1113.1	830.2	2116.8	2171.4	7386.1	6565.1	1590.0
19	95	1224.6	1224.3	1170.1	1117.1	829.2	2094.1	2160.3	7386.1	6581.6	1590.0
21	105	1231.5	1231.2	1177.0	1122.2	833.3	2093.5	2160.0	7643.2	6704.7	1590.0
23	115	1243.3	1243.1	1190.3	1134.2	831.0	2067.0	2147.1	7643.2	6832.4	1590.0
25	125	1271.1	1270.9	1223.1	1187.3	831.3	2066.9	2147.1	4664.0	6963.8	1590.0
BEGIN TRAILING EDGE REGION											
27	135	1261.7	1261.5	1210.9	1156.1	845.7	2085.8	2133.1	8050.8	7082.4	1590.0
29	145	1269.1	1268.9	1217.9	1160.5	847.6	2060.4	2133.1	8540.2	7358.4	1590.0
31	155	1301.4	1301.1	1255.0	1218.0	843.3	2017.2	2133.7	4771.2	7658.4	1590.0
33	165	1305.3	1305.1	1257.6	1212.6	839.1	1936.2	2134.4	6033.1	7976.1	1590.0
35	175	1300.7	1300.5	1250.0	1198.0	831.1	1814.4	2135.0	7331.7	8293.5	1590.0
37	185	1292.1	1291.9	1250.1	1208.1	834.5	1810.2	2133.2	7347.3	8462.6	1590.0
39	195	1290.2	1289.9	1259.0	1227.4	838.5	1804.6	2130.8	7373.9	8635.4	1590.0
41	205	1308.8	1308.6	1293.6	1274.9	840.8	1800.0	2128.9	7430.1	8463.7	1590.0

TABLE III. - Continued.

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.004799	25279.1	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003105	28574.1	0.002400	10932.9	0.085164	0.009034	0.000000	0.000000
5	25	0.000759	22175.6	0.005504	24158.5	0.132239	0.007957	0.000000	0.000000
7	35	0.000000	0.0	0.006263	27646.5	0.151991	0.007787	0.000000	0.000000
9	45	0.000768	22438.4	0.006263	27681.1	0.152706	0.007786	0.000000	0.000000
11	55	0.000000	0.0	0.007031	31140.4	0.173029	0.007641	0.000000	0.000000
13	65	0.000778	22730.5	0.007031	31117.5	0.173694	0.007642	0.000000	0.000000
15	75	0.000000	0.0	0.007809	34551.2	0.194799	0.007515	0.000000	0.000000
17	85	0.000739	23050.4	0.007809	34400.4	0.195377	0.007520	0.000000	0.000000
19	95	0.000000	0.0	0.008548	37621.8	0.216064	0.007413	0.000000	0.000000
21	105	0.000774	23378.0	0.008548	37512.4	0.216687	0.007416	0.000000	0.000000
23	115	0.000000	0.0	0.009323	40783.0	0.239026	0.007318	0.000000	0.000000
25	125	0.000000	0.0	0.009323	40099.8	0.239253	0.007338	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.020498	73237.1	0.183475	0.026270	0.000000	0.000000
29	145	0.000000	0.0	0.020498	82512.3	0.228379	0.025256	0.000000	0.000000
31	155	0.000000	0.0	0.020498	82937.0	0.291086	0.006534	0.000000	0.000000
33	165	0.000000	0.0	0.020498	85016.2	0.384523	0.006505	0.000000	0.000000
35	175	0.000000	0.0	0.020498	86899.8	0.498732	0.006480	0.000000	0.000000
37	185	0.000000	0.0	0.020498	86534.3	0.501113	0.006482	0.000000	0.000000
39	195	0.000000	0.0	0.020498	85910.9	0.504296	0.006487	0.000000	0.000000
41	205	0.000000	0.0	0.020498	84609.6	0.507127	0.006502	0.000000	0.000000

SLICE NO. 1 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1285.1	1284.7	1196.9	1087.2	809.9	2239.4	2239.4	22015.6	11973.0	1590.0
2	10	1263.2	1262.8	1184.7	1080.9	815.8	2217.8	2228.6	19835.8	9940.7	1590.0
4	20	1276.5	1276.2	1203.5	1126.5	808.8	2149.7	2190.2	12010.9	10147.3	1590.0
6	30	1268.3	1268.0	1198.4	1119.6	811.9	2134.6	2171.6	12010.9	9642.4	1590.0
8	40	1279.9	1279.6	1218.8	1157.5	818.8	2143.6	2171.3	8402.6	8893.5	1590.0
10	50	1281.8	1281.5	1222.5	1160.7	822.1	2131.3	2162.9	8402.6	8707.9	1590.0
12	60	1284.5	1284.2	1225.7	1164.2	830.5	2130.6	2162.6	8305.9	8712.8	1590.0
14	70	1284.4	1284.1	1225.7	1164.5	831.8	2112.2	2153.5	8305.9	8648.1	1590.0
16	80	1277.6	1277.3	1219.5	1159.1	839.8	2111.4	2153.1	8195.6	8351.5	1590.0
18	90	1269.8	1269.5	1212.1	1152.1	839.6	2089.9	2142.5	8195.6	8076.5	1590.0
20	100	1264.9	1264.6	1208.1	1148.8	846.1	2089.0	2142.1	8105.6	7801.6	1590.0
22	110	1268.3	1268.1	1213.8	1153.5	843.9	2064.4	2130.1	8105.6	7662.0	1590.0
24	120	1309.6	1309.4	1264.7	1232.2	843.3	2064.5	2130.1	4095.3	7581.8	1590.0
				BEGIN TRAILING EDGE REGION							
26	130	1281.6	1281.4	1231.3	1174.1	845.7	2085.8	2133.1	8050.8	7523.5	1590.0
28	140	1278.5	1278.3	1228.0	1169.5	847.6	2060.4	2133.1	8540.2	7466.8	1590.0
30	150	1304.1	1303.8	1259.1	1222.4	843.3	2017.2	2133.7	4774.4	7409.3	1590.0
32	160	1297.8	1297.6	1251.9	1207.5	839.1	1936.2	2134.4	6028.3	7351.8	1590.0
34	170	1284.8	1284.6	1236.6	1186.0	831.1	1814.4	2135.0	7317.9	7294.3	1590.0
36	180	1270.4	1270.2	1230.8	1190.4	834.5	1810.2	2133.2	7326.8	7211.6	1590.0
38	190	1260.7	1260.4	1231.5	1201.5	838.5	1804.6	2130.8	7344.3	7079.3	1590.0
40	200	1276.7	1276.5	1262.3	1244.5	840.8	1800.0	2128.9	7395.9	6949.5	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.004799	25279.1	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003105	28574.1	0.002400	10938.5	0.085164	0.009033	0.000000	0.000000
4	20	0.001471	30081.7	0.005504	24588.9	0.167187	0.007935	0.000000	0.000000
6	30	0.000000	0.0	0.006975	30726.2	0.160378	0.007657	0.000000	0.000000
8	40	0.001034	30205.4	0.006975	30005.6	0.138804	0.007686	0.000000	0.000000
10	50	0.000000	0.0	0.008008	34192.9	0.148608	0.007527	0.000000	0.000000
12	60	0.001043	30464.4	0.008008	34064.0	0.149434	0.007532	0.000000	0.000000
14	70	0.000000	0.0	0.009051	38480.1	0.170496	0.007386	0.000000	0.000000
16	80	0.001055	30837.2	0.009051	38448.4	0.171382	0.007387	0.000000	0.000000
18	90	0.000000	0.0	0.010106	43029.3	0.193285	0.007255	0.000000	0.000000
20	100	0.001069	31250.4	0.010106	42985.5	0.194118	0.007257	0.000000	0.000000
22	110	0.000000	0.0	0.011176	47496.1	0.216940	0.007142	0.000000	0.000000
24	120	0.000000	0.0	0.011176	46354.2	0.217084	0.007169	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
26	130	0.000000	0.0	0.020498	73237.1	0.183475	0.026270	0.000000	0.000000
28	140	0.000000	0.0	0.020498	82512.3	0.228379	0.025256	0.000000	0.000000
30	150	0.000000	0.0	0.020498	82826.1	0.291086	0.006534	0.000000	0.000000
32	160	0.000000	0.0	0.020498	85150.6	0.384523	0.006505	0.000000	0.000000
34	170	0.000000	0.0	0.020498	87226.3	0.498732	0.006480	0.000000	0.000000
36	180	0.000000	0.0	0.020498	87015.2	0.501113	0.006482	0.000000	0.000000
38	190	0.000000	0.0	0.020498	86604.4	0.504296	0.006487	0.000000	0.000000
40	200	0.000000	0.0	0.020498	85400.1	0.507127	0.006502	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1270.8 K, MID-WALL T = 1216.8 K, COOLANT H = 8208.2 WATTS/M**2/K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1308.8 AT STATION 41, 1214.7 AT STATION 13
SUCTION SIDE: 1309.6 AT STATION 24, 1260.7 AT STATION 38

TABLE III. - Continued.

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THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 2 ARE:

PIM = 2811.31 KPA,

TOG = 820.31 K

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TIME = 0.00 SEC., STEP SIZE = 0.000 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 2, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 8 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1326.3	1325.9	1231.2	1113.6	820.3	2312.7	2312.7	23318.9	11973.0	1670.0
3	15	1307.2	1306.9	1220.4	1108.1	826.3	2288.3	2300.5	21018.3	10424.9	1670.0
5	25	1308.5	1308.2	1239.3	1175.5	817.2	2238.5	2267.6	8927.1	8909.2	1670.0
7	35	1278.1	1277.8	1214.4	1150.2	822.3	2220.5	2258.6	8927.1	7560.1	1670.0
9	45	1262.7	1262.4	1200.0	1138.0	830.0	2219.7	2258.3	8796.2	7046.4	1670.0
11	55	1252.5	1252.3	1190.5	1129.5	831.4	2198.8	2248.0	8796.2	6724.2	1670.0
13	65	1246.8	1246.5	1185.7	1125.5	837.4	2198.0	2247.6	8686.9	6531.9	1670.0
15	75	1248.3	1248.0	1187.0	1126.9	837.0	2173.9	2235.7	8686.9	6548.5	1670.0
17	85	1253.4	1253.2	1193.6	1137.0	841.2	2173.2	2235.4	7919.9	6565.1	1670.0
19	95	1257.6	1257.3	1198.4	1141.2	840.1	2147.3	2222.8	7919.9	6581.6	1670.0
21	105	1265.0	1264.7	1205.8	1146.8	840.2	2146.5	2222.4	8187.3	6704.7	1670.0
23	115	1278.0	1277.8	1220.4	1159.9	841.7	2116.2	2207.7	9187.3	6932.4	1670.0
25	125	1308.6	1308.3	1256.3	1217.7	841.8	2116.2	2207.7	4969.0	6963.8	1670.0
					BEGIN TRAILING EDGE REGION						
27	135	1299.1	1298.8	1244.0	1185.2	857.2	2137.9	2191.8	8496.4	7082.4	1670.0
29	145	1307.0	1306.8	1251.5	1189.9	858.9	2108.7	2191.8	9014.6	7358.4	1670.0
31	155	1341.6	1341.3	1291.0	1251.1	854.0	2059.1	2192.5	5083.8	7658.4	1670.0
33	165	1346.1	1345.8	1293.9	1245.3	848.7	1964.8	2193.4	6427.3	7976.1	1670.0
35	175	1341.0	1340.8	1285.7	1229.6	938.5	1820.1	2194.5	7807.4	8293.5	1670.0
37	185	1331.8	1331.5	1286.0	1240.6	841.9	1814.5	2192.2	7824.7	8462.6	1670.0
39	195	1329.5	1329.2	1295.5	1261.4	845.9	1806.8	2189.1	7854.2	8635.4	1670.0
41	205	1350.2	1349.9	1333.6	1313.2	848.1	1800.0	2186.4	7917.4	8863.7	1670.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005160	26942.7	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003336	30312.8	0.002580	11618.1	0.089357	0.008946	0.000000	0.000000
5	25	0.000814	23497.3	0.005916	25655.8	0.138961	0.007881	0.000000	0.000000
7	35	0.000000	0.0	0.006731	29374.6	0.159831	0.007712	0.000000	0.000000
9	45	0.000824	23765.9	0.006731	29417.2	0.160611	0.007711	0.000000	0.000000
11	55	0.000000	0.0	0.007554	33093.2	0.182117	0.007557	0.000000	0.000000
13	65	0.000834	24063.5	0.007554	33071.0	0.182841	0.007567	0.000000	0.000000
15	75	0.000000	0.0	0.008388	36712.0	0.205227	0.007442	0.000000	0.000000
17	85	0.000793	24389.2	0.008388	36544.1	0.205855	0.007447	0.000000	0.000000
19	95	0.000000	0.0	0.009181	39956.8	0.227863	0.007342	0.000000	0.000000
21	105	0.000829	24719.6	0.009181	39834.5	0.228544	0.007345	0.000000	0.000000
23	115	0.000000	0.0	0.010010	43287.2	0.252386	0.007248	0.000000	0.000000
25	125	0.000000	0.0	0.010010	42510.3	0.252612	0.007269	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.022006	77593.1	0.193551	0.025774	0.000000	0.000000
29	145	0.000000	0.0	0.022006	87432.6	0.241245	0.024778	0.000000	0.000000
31	155	0.000000	0.0	0.022006	87845.6	0.308187	0.006474	0.000000	0.000000
33	165	0.000000	0.0	0.022006	90082.7	0.409200	0.006445	0.000000	0.000000
35	175	0.000000	0.0	0.022006	92163.4	0.535878	0.006419	0.000000	0.000000
37	185	0.000000	0.0	0.022006	91754.9	0.538896	0.006421	0.000000	0.000000
39	195	0.000000	0.0	0.022006	91062.4	0.543081	0.006426	0.000000	0.000000
41	205	0.000000	0.0	0.022006	89588.0	0.547086	0.006442	0.000000	0.000000

TABLE III. - Continued.

SLICE NO. 2 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1326.3	1325.9	1231.2	1113.6	820.3	2312.7	2312.7	23318.9	11973.0	1670.0
2	10	1302.5	1302.1	1217.7	1106.5	826.3	2288.3	2300.5	21018.4	9940.7	1670.0
4	20	1315.7	1315.4	1236.7	1153.6	818.8	2210.7	2256.8	12828.3	10147.3	1670.0
6	30	1306.4	1306.0	1230.6	1145.7	822.2	2193.6	2235.7	12828.3	9642.4	1670.0
8	40	1318.6	1318.3	1252.0	1185.7	829.4	2203.8	2235.4	9012.5	8893.5	1670.0
10	50	1320.0	1319.7	1255.4	1188.5	832.9	2189.8	2225.8	9012.5	8707.9	1670.0
12	60	1322.6	1322.3	1258.5	1192.2	841.6	2189.1	2225.4	8905.3	8712.8	1670.0
14	70	1322.7	1322.4	1258.8	1192.6	842.9	2168.0	2215.1	8905.3	8649.1	1670.0
16	80	1315.0	1314.7	1251.9	1186.7	851.3	2167.0	2214.6	8782.0	8351.5	1670.0
18	90	1306.6	1306.3	1243.8	1179.1	851.0	2142.5	2202.6	8782.0	8076.5	1670.0
20	100	1301.4	1301.1	1239.7	1175.7	857.8	2141.5	2202.1	8679.7	7801.6	1670.0
22	110	1305.4	1305.1	1246.0	1180.9	855.4	2113.4	2188.3	8679.7	7562.0	1670.0
24	120	1350.2	1350.0	1301.3	1266.1	854.5	2113.5	2188.4	4363.8	7581.8	1670.0
				BEGIN TRAILING EDGE REGION							
26	130	1320.8	1320.6	1266.1	1204.9	857.2	2137.9	2191.8	8496.4	7523.5	1670.0
28	140	1317.5	1317.3	1262.6	1199.9	858.9	2108.7	2191.8	9014.6	7466.8	1670.0
30	150	1344.5	1344.3	1295.5	1255.8	854.0	2059.1	2192.5	5087.4	7409.3	1670.0
32	160	1337.7	1337.4	1287.6	1239.6	848.7	1964.8	2193.4	6421.8	7351.8	1670.0
34	170	1323.6	1323.4	1271.1	1216.5	838.5	1820.1	2194.5	7791.7	7294.3	1670.0
36	180	1307.8	1307.5	1264.6	1221.0	841.9	1814.5	2192.2	7801.3	7211.5	1670.0
38	190	1297.0	1296.8	1265.3	1232.9	845.9	1806.8	2189.1	7820.3	7079.3	1670.0
40	200	1314.8	1314.5	1299.1	1279.7	848.1	1800.0	2186.4	7878.4	6949.5	1670.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005160	26942.7	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003336	30312.8	0.002580	11623.9	0.089357	0.008945	0.000000	0.000000
4	20	0.001577	31854.8	0.005916	26116.0	0.175889	0.007859	0.000000	0.000000
6	30	0.000000	0.0	0.007493	32628.3	0.168794	0.007584	0.000000	0.000000
8	40	0.001109	31980.3	0.007493	31845.4	0.146046	0.007613	0.000000	0.000000
10	50	0.000000	0.0	0.008602	36281.7	0.156432	0.007456	0.000000	0.000000
12	60	0.001118	32243.4	0.008602	36136.7	0.157333	0.007461	0.000000	0.000000
14	70	0.000000	0.0	0.009720	40814.5	0.179640	0.007317	0.000000	0.000000
16	80	0.001131	32621.4	0.009720	40784.3	0.180612	0.007318	0.000000	0.000000
18	90	0.000000	0.0	0.010850	45640.3	0.203872	0.007187	0.000000	0.000000
20	100	0.001145	33038.9	0.010850	45592.3	0.204784	0.007188	0.000000	0.000000
22	110	0.000000	0.0	0.011995	50359.8	0.229091	0.007075	0.000000	0.000000
24	120	0.000000	0.0	0.011995	49070.4	0.229220	0.007104	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
26	130	0.000000	0.0	0.022006	77593.1	0.193551	0.025774	0.000000	0.000000
28	140	0.000000	0.0	0.022006	87432.6	0.241245	0.024778	0.000000	0.000000
30	150	0.000000	0.0	0.022006	87719.4	0.308187	0.006474	0.000000	0.000000
32	160	0.000000	0.0	0.022006	90238.3	0.409200	0.006445	0.000000	0.000000
34	170	0.000000	0.0	0.022006	92536.3	0.535878	0.006419	0.000000	0.000000
36	180	0.000000	0.0	0.022006	92309.5	0.538896	0.006421	0.000000	0.000000
38	190	0.000000	0.0	0.022006	91858.4	0.543081	0.006426	0.000000	0.000000
40	200	0.000000	0.0	0.022006	90496.8	0.547086	0.006442	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1308.4 K, MID-WALL T = 1249.7 K, COOLANT H = 8758.6 WATTS/M**2/K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1350.2 AT STATION 41, 1246.8 AT STATION 13
SUCTION SIDE: 1350.2 AT STATION 24, 1297.0 AT STATION 38

TABLE III. - Continued.

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 3 ARE:

PIM = 2943.89 KPA,

TOG = 830.24 K

TIME = 0.00 SEC., STEP SIZE = 0.000 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 3, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 8 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1282.1	1281.7	1192.8	1081.4	830.2	2382.2	2382.2	24598.0	11973.0	1590.0
3	15	1264.8	1264.5	1183.3	1077.9	834.4	2354.8	2368.5	21888.6	10424.9	1590.0
5	25	1264.3	1264.0	1199.0	1137.5	826.1	2298.8	2331.4	9456.5	8809.2	1590.0
7	35	1236.0	1235.7	1175.6	1114.3	830.5	2278.5	2321.4	9456.5	7560.1	1590.0
9	45	1221.9	1221.6	1162.5	1103.5	837.0	2277.8	2321.1	9311.6	7046.4	1590.0
11	55	1212.7	1212.4	1154.1	1095.9	838.0	2254.3	2309.5	9311.6	6724.2	1590.0
13	65	1207.7	1207.5	1149.9	1092.7	843.1	2253.6	2309.1	9189.0	6531.9	1590.0
15	75	1208.8	1208.6	1151.0	1093.8	842.5	2226.4	2295.9	9189.0	6548.5	1590.0
17	85	1213.6	1213.3	1156.9	1102.9	846.1	2225.8	2295.6	8377.3	6565.1	1590.0
19	95	1217.0	1216.8	1161.0	1106.6	844.8	2196.7	2281.4	8377.3	6581.6	1590.0
21	105	1223.9	1223.6	1167.9	1111.5	848.3	2195.9	2281.0	8648.7	6704.7	1590.0
23	115	1235.6	1235.4	1181.1	1123.2	845.8	2161.8	2264.6	8648.7	6832.4	1590.0
25	125	1264.0	1263.8	1214.6	1177.3	845.6	2161.9	2264.6	5207.1	6963.8	1590.0
BEGIN TRAILING EDGE REGION											
27	135	1255.5	1255.3	1203.3	1147.5	859.7	2186.6	2246.9	8789.2	7082.4	1590.0
29	145	1262.4	1262.2	1209.8	1151.1	860.5	2154.0	2246.9	9326.9	7358.4	1590.0
31	155	1293.6	1293.3	1245.6	1207.0	854.9	2098.2	2247.8	5321.7	7658.4	1590.0
33	165	1297.2	1296.9	1247.6	1200.7	848.0	1991.3	2249.0	6725.5	7976.1	1590.0
35	175	1292.3	1292.0	1239.6	1185.6	834.9	1824.5	2251.3	8166.1	9293.5	1590.0
37	185	1283.0	1282.7	1239.2	1195.5	837.7	1818.3	2248.8	8182.4	9462.6	1590.0
39	195	1280.0	1279.7	1247.4	1214.4	840.9	1809.3	2245.3	8210.6	9635.4	1590.0
41	205	1297.5	1297.2	1281.4	1261.6	842.3	1800.0	2241.7	8272.0	9463.7	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005519	28577.3	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003565	32708.6	0.002759	12514.5	0.093283	0.008840	0.000000	0.000000
5	25	0.000869	25323.4	0.006325	27682.3	0.145385	0.007786	0.000000	0.000000
7	35	0.000000	0.0	0.007194	31678.4	0.167231	0.007620	0.000000	0.000000
9	45	0.000879	25598.2	0.007194	31722.4	0.167927	0.007618	0.000000	0.000000
11	55	0.000000	0.0	0.008073	35672.3	0.190495	0.007476	0.000000	0.000000
13	65	0.000889	25901.9	0.008073	35650.5	0.191140	0.007477	0.000000	0.000000
15	75	0.000000	0.0	0.008962	39572.1	0.214688	0.007353	0.000000	0.000000
17	85	0.000844	26232.2	0.008962	39409.8	0.215247	0.007358	0.000000	0.000000
19	95	0.000000	0.0	0.009807	43090.2	0.238456	0.007254	0.000000	0.000000
21	105	0.000883	26567.9	0.009807	42973.3	0.239067	0.007257	0.000000	0.000000
23	115	0.000000	0.0	0.010689	46705.2	0.264297	0.007161	0.000000	0.000000
25	125	0.000000	0.0	0.010689	45916.5	0.264462	0.007180	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
27	135	0.000000	0.0	0.023494	83814.7	0.202196	0.025126	0.000000	0.000000
29	145	0.000000	0.0	0.023494	94468.8	0.252205	0.024153	0.000000	0.000000
31	155	0.000000	0.0	0.023494	95042.2	0.322799	0.006393	0.000000	0.000000
33	165	0.000000	0.0	0.023494	97530.6	0.430434	0.006363	0.000000	0.000000
35	175	0.000000	0.0	0.023494	99864.5	0.568454	0.006337	0.000000	0.000000
37	185	0.000000	0.0	0.023494	99469.6	0.571715	0.006339	0.000000	0.000000
39	195	0.000000	0.0	0.023494	98789.5	0.576515	0.006344	0.000000	0.000000
41	205	0.000000	0.0	0.023494	97321.6	0.581678	0.006358	0.000000	0.000000

TABLE III. - Concluded.

SLICE NO. 3 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1282.1	1261.7	1192.8	1081.4	830.2	2382.2	2382.2	24598.0	11973.0	1590.0
2	10	1260.4	1260.1	1180.9	1076.5	834.4	2354.8	2368.5	21888.7	9940.7	1590.0
4	20	1271.5	1271.2	1196.9	1117.8	827.2	2267.4	2319.3	13502.0	10147.3	1590.0
6	30	1262.4	1262.1	1190.7	1110.1	830.3	2248.2	2295.6	13502.0	9642.4	1590.0
8	40	1272.4	1272.1	1209.3	1145.7	836.5	2259.8	2295.3	9537.4	8893.5	1590.0
10	50	1273.8	1273.5	1212.3	1148.1	839.4	2244.2	2284.6	9537.4	8707.9	1590.0
12	60	1276.3	1276.0	1215.3	1151.6	846.9	2243.4	2284.2	9418.8	8712.8	1590.0
14	70	1275.8	1275.5	1215.1	1151.6	847.8	2219.9	2272.6	9418.8	8648.1	1590.0
16	80	1269.0	1268.7	1209.0	1146.5	854.9	2218.9	2272.2	9280.9	8351.5	1590.0
18	90	1261.6	1261.4	1201.9	1139.9	854.5	2191.5	2258.7	9280.9	8076.5	1590.0
20	100	1256.8	1256.5	1198.2	1137.0	860.3	2190.5	2258.3	9164.2	7801.6	1590.0
22	110	1260.3	1260.1	1204.0	1141.6	857.9	2158.9	2242.9	9164.2	7662.0	1590.0
24	120	1301.9	1301.7	1255.5	1221.4	856.7	2159.2	2243.0	4568.0	7581.8	1590.0
				BEGIN TRAILING EDGE REGION							
26	130	1274.9	1274.7	1223.1	1164.8	859.7	2186.6	2246.9	8789.2	7523.5	1590.0
28	140	1271.7	1271.5	1219.7	1159.9	860.5	2154.0	2246.9	9326.9	7466.8	1590.0
30	150	1296.4	1296.2	1249.9	1211.3	854.9	2098.2	2247.8	5325.3	7409.3	1590.0
32	160	1289.5	1289.3	1241.9	1195.6	848.0	1991.2	2249.0	6720.2	7351.8	1590.0
34	170	1276.4	1276.2	1226.4	1174.0	834.9	1824.5	2251.3	8151.0	7294.3	1590.0
36	180	1261.3	1261.1	1220.1	1178.2	837.7	1818.3	2248.8	8160.1	7211.5	1590.0
38	190	1250.5	1250.3	1220.2	1188.9	840.9	1809.3	2245.3	8178.0	7079.3	1590.0
40	200	1265.6	1265.4	1250.5	1231.7	842.3	1800.0	2241.7	8234.5	6949.5	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005519	28577.3	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003565	32708.6	0.002759	12519.8	0.093282	0.008840	0.000000	0.000000
4	20	0.001683	34306.6	0.006325	28166.2	0.184179	0.007764	0.000000	0.000000
6	30	0.000000	0.0	0.008007	35175.6	0.176756	0.007493	0.000000	0.000000
8	40	0.001182	34432.3	0.008007	34386.0	0.152755	0.007520	0.000000	0.000000
10	50	0.000000	0.0	0.009190	39177.2	0.163612	0.007365	0.000000	0.000000
12	60	0.001191	34698.7	0.009190	39041.7	0.164418	0.007369	0.000000	0.000000
14	70	0.000000	0.0	0.010381	44090.0	0.187801	0.007227	0.000000	0.000000
16	80	0.001204	35080.8	0.010381	44061.3	0.188673	0.007228	0.000000	0.000000
18	90	0.000000	0.0	0.011585	49283.0	0.213110	0.007100	0.000000	0.000000
20	100	0.001219	35501.1	0.011585	49238.9	0.213933	0.007101	0.000000	0.000000
22	110	0.000000	0.0	0.012804	54379.6	0.239554	0.006989	0.000000	0.000000
24	120	0.000000	0.0	0.012804	53064.9	0.239622	0.007016	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
26	130	0.000000	0.0	0.023494	83814.7	0.202196	0.025126	0.000000	0.000000
28	140	0.000000	0.0	0.023494	94468.8	0.252205	0.024153	0.000000	0.000000
30	150	0.000000	0.0	0.023494	94913.2	0.322799	0.006393	0.000000	0.000000
32	160	0.000000	0.0	0.023494	97683.3	0.430434	0.006363	0.000000	0.000000
34	170	0.000000	0.0	0.023494	100229.0	0.568454	0.006337	0.000000	0.000000
36	180	0.000000	0.0	0.023494	100009.3	0.571715	0.006339	0.000000	0.000000
38	190	0.000000	0.0	0.023494	99575.1	0.576515	0.006344	0.000000	0.000000
40	200	0.000000	0.0	0.023494	98218.2	0.581678	0.006358	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1263.3 K, MID-WALL T = 1207.6 K, COOLANT H = 9199.7 WATTS/M**2/K

TIME = 0.000 SEC., OVERALL BULK METAL TEMPERATURE = 1224.6 K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1297.5 AT STATION 41, 1207.7 AT STATION 13
SUCTION SIDE: 1301.9 AT STATION 24, 1250.5 AT STATION 38

AMOUNT OF COOLANT ACTUALLY USED AT THIS TIME STEP IS 237.6 KG/HR

3 LOOP(S) ON INITIAL COOLANT FLOW WERE USED. FINAL VALUE IS 237.42 KG/HR
RESIDUAL COOLING AIR FLOW IS -0.1676 KG/HR

TABLE IV. - PARTIAL OUTPUT FROM TRANSIENT PROBLEM

***** OUTPUT *****

TACT1 SAMPLE CASE, TRANSIENT ACCELERATION, 3 SLICE BLADE.

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 1 ARE:

PIM = 648.00 KPA,

TOG = 528.51 K

CENTRAL PLENUM FLOW IS 73.6 KG/HR

TIME = 0.00 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 10000.0 RPM
SLICE NO. 1, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 8 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	832.6	832.4	790.3	735.9	528.5	519.8	519.8	8721.4	11973.0	920.0
3	15	827.1	826.9	788.9	737.3	550.7	513.3	516.6	7753.3	10424.9	920.0
5	25	837.6	837.5	810.7	787.3	542.5	500.1	507.8	2628.6	8809.2	920.0
7	35	830.0	829.9	805.7	781.6	545.2	495.3	505.4	2628.6	7560.1	920.0
9	45	825.8	825.7	801.9	778.4	551.0	495.0	505.3	2599.2	7045.4	920.0
11	55	822.4	822.3	798.9	775.6	551.7	489.4	502.6	2589.2	6724.2	920.0
13	65	820.7	820.6	797.5	774.4	556.7	489.2	502.4	2556.3	6531.9	920.0
15	75	821.5	821.4	798.3	775.3	556.2	482.6	499.3	2556.3	6548.5	920.0
17	85	823.9	823.8	801.5	780.2	560.0	482.4	499.1	2306.1	6565.1	920.0
19	95	825.4	825.3	803.3	781.9	559.0	475.3	495.7	2306.1	6581.6	920.0
21	105	827.6	827.5	805.5	783.4	562.6	475.1	495.6	2394.4	6704.7	920.0
23	115	831.5	831.4	809.9	787.5	560.6	466.8	491.6	2394.4	6832.4	920.0
25	125	839.7	839.6	819.9	805.7	562.5	466.6	491.5	1673.6	6963.9	920.0
					BEGIN TRAILING EDGE REGION						
27	135	831.8	831.7	809.5	784.2	574.3	472.2	486.9	3362.5	7082.4	920.0
29	145	834.2	834.0	811.7	785.3	575.6	464.1	486.8	3554.0	7358.4	920.0
31	155	850.3	850.2	831.5	817.2	572.3	450.2	487.0	1708.0	7659.4	920.0
33	165	853.1	853.0	834.2	816.5	565.9	423.4	487.3	2159.7	7976.1	920.0
35	175	851.8	851.7	831.8	811.0	553.7	380.6	488.2	2623.9	8293.5	920.0
37	185	849.7	849.6	833.2	816.7	556.0	378.3	487.3	2628.4	8462.6	920.0
39	195	850.5	850.4	838.4	826.3	558.6	374.7	486.0	2635.3	8635.4	920.0
41	205	858.3	858.2	852.7	845.8	560.2	370.0	484.3	2647.1	8463.7	920.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.001546	9894.2	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.000999	11998.2	0.000773	4551.6	0.096244	0.010393	0.000000	0.000000
5	25	0.000244	9294.8	0.001772	10032.9	0.150006	0.009159	0.000000	0.000000
7	35	0.000000	0.0	0.002016	11429.6	0.172710	0.008970	0.000000	0.000000
9	45	0.000247	9398.6	0.002016	11415.1	0.173709	0.008971	0.000000	0.000000
11	55	0.000000	0.0	0.002262	12824.2	0.197300	0.008806	0.000000	0.000000
13	65	0.000250	9513.8	0.002262	12800.9	0.198295	0.008808	0.000000	0.000000
15	75	0.000000	0.0	0.002512	14210.1	0.223040	0.008663	0.000000	0.000000
17	85	0.000237	9639.2	0.002512	14150.4	0.223959	0.008668	0.000000	0.000000
19	95	0.000000	0.0	0.002749	15480.6	0.248469	0.008545	0.000000	0.000000
21	105	0.000248	9766.4	0.002749	15441.8	0.249443	0.008548	0.000000	0.000000
23	115	0.000000	0.0	0.002997	16818.4	0.276262	0.008432	0.000000	0.000000
25	125	0.000000	0.0	0.002997	16659.4	0.276961	0.008445	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.006587	30480.9	0.212078	0.035086	0.000000	0.000000
29	145	0.000000	0.0	0.006587	34319.8	0.265294	0.033738	0.000000	0.000000
31	155	0.000000	0.0	0.006587	34561.2	0.341052	0.007515	0.000000	0.000000
33	165	0.000000	0.0	0.006587	35437.9	0.458052	0.007483	0.000000	0.000000
35	175	0.000000	0.0	0.006587	36267.8	0.613919	0.007454	0.000000	0.000000
37	185	0.000000	0.0	0.006587	36132.3	0.619429	0.007458	0.000000	0.000000
39	195	0.000000	0.0	0.006587	35926.3	0.628104	0.007463	0.000000	0.000000
41	205	0.000000	0.0	0.006587	35576.4	0.639693	0.007474	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 1 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	832.6	832.4	790.3	735.9	528.5	519.8	519.8	8721.4	11973.0	920.0
2	10	824.5	824.3	786.8	735.8	550.6	513.3	516.6	7753.3	9940.7	920.0
4	20	836.4	836.3	804.3	771.4	543.9	492.6	504.9	4055.9	10147.3	920.0
6	30	835.3	835.2	805.2	771.1	545.8	488.0	499.3	4055.9	9642.4	920.0
8	40	843.7	843.6	818.8	794.4	552.4	490.7	499.1	2652.7	8893.5	920.0
10	50	845.3	845.2	821.6	797.0	554.5	486.9	496.6	2652.7	8707.9	920.0
12	60	846.7	846.6	823.3	798.8	561.2	486.7	496.5	2620.6	8712.8	920.0
14	70	846.6	846.5	823.4	799.0	561.7	481.0	493.7	2620.6	8648.1	920.0
16	80	844.4	844.3	821.3	797.2	567.9	480.7	493.5	2583.3	8351.5	920.0
18	90	841.5	841.4	818.4	794.5	567.2	474.0	490.3	2583.3	8076.5	920.0
20	100	839.8	839.7	817.1	793.4	572.3	473.7	490.1	2551.7	7301.5	920.0
22	110	840.7	840.6	818.8	794.8	570.3	466.0	486.4	2551.7	7662.0	920.0
24	120	853.4	853.3	835.4	822.8	572.1	465.9	486.3	1464.2	7581.8	920.0
BEGIN TRAILING EDGE REGION											
26	130	838.5	838.4	816.4	790.3	574.3	472.2	486.9	3362.5	7523.5	920.0
28	140	837.4	837.3	815.1	788.5	575.6	464.1	486.8	3554.0	7466.8	920.0
30	150	851.3	851.2	833.1	819.0	572.3	450.2	487.0	1708.6	7409.3	920.0
32	160	850.7	850.6	832.4	815.0	565.9	423.4	487.3	2159.0	7351.8	920.0
34	170	846.6	846.5	827.4	807.1	553.7	380.6	488.2	2621.6	7294.3	920.0
36	180	842.4	842.3	826.7	810.7	556.0	378.3	487.3	2625.0	7211.6	920.0
38	190	840.3	840.2	828.9	817.3	558.6	374.7	486.0	2630.2	7079.3	920.0
40	200	848.1	848.0	842.7	836.0	560.2	370.0	484.3	2641.6	6949.5	920.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.001546	9894.2	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.000999	11998.2	0.000773	4554.8	0.096240	0.010392	0.000000	0.000000
4	20	0.000472	12596.4	0.001772	10219.2	0.190389	0.009132	0.000000	0.000000
6	30	0.000000	0.0	0.002244	12736.0	0.182920	0.008816	0.000000	0.000000
8	40	0.000332	12645.8	0.002244	12437.8	0.158390	0.008849	0.000000	0.000000
10	50	0.000000	0.0	0.002576	14165.8	0.169825	0.008667	0.000000	0.000000
12	60	0.000334	12747.4	0.002576	14107.7	0.170976	0.008673	0.000000	0.000000
14	70	0.000000	0.0	0.002910	15934.1	0.195527	0.008505	0.000000	0.000000
16	80	0.000338	12892.3	0.002910	15900.9	0.196743	0.008508	0.000000	0.000000
18	90	0.000000	0.0	0.003248	17778.1	0.222490	0.008358	0.000000	0.000000
20	100	0.000342	13051.0	0.003248	17744.0	0.223669	0.008360	0.000000	0.000000
22	110	0.000000	0.0	0.003591	19619.6	0.250838	0.008227	0.000000	0.000000
24	120	0.000000	0.0	0.003591	19346.8	0.251468	0.008245	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
26	130	0.000000	0.0	0.006587	30480.9	0.212078	0.035086	0.000000	0.000000
28	140	0.000000	0.0	0.006587	34319.8	0.265294	0.033738	0.000000	0.000000
30	150	0.000000	0.0	0.006587	34532.6	0.341052	0.007515	0.000000	0.000000
32	160	0.000000	0.0	0.006587	35463.6	0.458052	0.007483	0.000000	0.000000
34	170	0.000000	0.0	0.006587	36336.1	0.613919	0.007454	0.000000	0.000000
36	180	0.000000	0.0	0.006587	36235.2	0.619429	0.007458	0.000000	0.000000
38	190	0.000000	0.0	0.006587	36079.0	0.628104	0.007463	0.000000	0.000000
40	200	0.000000	0.0	0.006587	35738.2	0.639693	0.007474	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 839.4 K, MID-WALL T = 817.2/K, COOLANT H = 2837.3 WATTS/M**2 K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 858.3 AT STATION 41, 820.7 AT STATION 13
SUCTION SIDE: 853.4 AT STATION 24, 824.5 AT STATION 2

TABLE IV. - Continued.

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                 THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 2 ARE:

                                        PIM =  668.86 KPA,

                                        TOG =  533.19 K

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     TIME =    0.00 SEC.,  STEP SIZE =  0.250 SEC.,  WHEEL SPEED = 10000.0 RPM
SLICE NO. 2, FLOW SPLIT NO.  1, SPLIT AT STATION  1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000     9 ITERATIONS
                   PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27
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STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	854.7	854.5	809.3	751.5	533.2	532.9	532.9	8961.3	11973.0	950.0
3	15	848.6	848.4	807.5	752.4	555.2	526.0	529.4	9005.5	10424.9	950.0
5	25	859.3	859.2	830.2	805.0	546.8	511.9	520.1	2729.4	8809.2	950.0
7	35	851.0	850.9	824.6	798.8	549.7	506.8	517.6	2729.4	7560.1	950.0
9	45	846.2	846.0	820.4	795.2	555.7	506.6	517.5	2698.0	7046.4	950.0
11	55	842.7	842.6	817.1	792.1	556.5	500.6	514.6	2688.0	6724.2	950.0
13	65	840.7	840.6	815.5	790.9	561.6	500.3	514.4	2653.1	6531.3	950.0
15	75	841.5	841.4	816.4	791.7	561.2	493.4	511.0	2653.1	6548.5	950.0
17	85	844.2	844.0	819.8	797.0	565.2	493.1	510.9	2393.4	6565.1	950.0
19	95	845.9	845.8	821.9	798.9	564.1	485.6	507.3	2393.4	6591.6	950.0
21	105	848.3	848.2	824.3	800.6	567.8	485.3	507.1	2483.9	6704.7	950.0
23	115	852.3	852.2	828.9	804.8	565.8	476.5	502.9	2483.9	5832.4	950.0
25	125	861.2	861.1	839.6	824.3	567.7	476.3	502.8	1732.1	6263.8	950.0
BEGIN TRAILING EDGE REGION											
27	135	852.8	852.7	828.6	801.5	580.1	482.2	497.8	3463.7	7082.4	950.0
29	145	855.4	855.2	831.0	802.8	581.5	473.6	497.8	3661.1	7358.4	950.0
31	155	872.6	872.5	852.0	836.6	577.9	458.7	498.0	1767.9	7659.4	950.0
33	165	875.6	875.5	854.9	835.9	571.1	429.9	498.4	2235.3	7976.1	950.0
35	175	874.3	874.2	852.4	830.1	557.7	383.2	499.5	2715.1	8293.5	950.0
37	185	872.2	872.1	854.2	836.4	560.0	380.5	498.5	2720.0	8462.6	950.0
39	195	873.0	872.9	859.9	846.8	562.5	376.1	496.9	2727.4	8535.4	950.0
41	205	881.9	881.8	875.7	868.2	563.8	370.0	494.8	2740.3	8463.7	950.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.001604	10268.9	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.001037	12311.7	0.000802	4678.7	0.097926	0.010348	0.000000	0.000000
5	25	0.000253	9532.4	0.001839	10302.2	0.152711	0.009120	0.000000	0.000000
7	35	0.000000	0.0	0.002092	11737.6	0.175895	0.008932	0.000000	0.000000
9	45	0.000256	9637.1	0.002092	11723.9	0.176956	0.008933	0.000000	0.000000
11	55	0.000000	0.0	0.002347	13170.7	0.201066	0.008768	0.000000	0.000000
13	65	0.000259	9753.2	0.002347	13146.4	0.202121	0.008771	0.000000	0.000000
15	75	0.000000	0.0	0.002606	14592.2	0.227441	0.008626	0.000000	0.000000
17	85	0.000246	9879.3	0.002606	14528.1	0.228415	0.008632	0.000000	0.000000
19	95	0.000000	0.0	0.002852	15891.3	0.253532	0.008509	0.000000	0.000000
21	105	0.000257	10006.8	0.002852	15850.7	0.254569	0.008512	0.000000	0.000000
23	115	0.000000	0.0	0.003108	17260.3	0.282101	0.008397	0.000000	0.000000
25	125	0.000000	0.0	0.003108	17088.0	0.282841	0.008411	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
27	135	0.000000	0.0	0.006832	31262.6	0.216541	0.034794	0.000000	0.000000
29	145	0.000000	0.0	0.006832	35203.5	0.271096	0.033456	0.000000	0.000000
31	155	0.000000	0.0	0.006832	35430.8	0.348966	0.007486	0.000000	0.000000
33	165	0.000000	0.0	0.006832	36336.8	0.470134	0.007453	0.000000	0.000000
35	175	0.000000	0.0	0.006832	37209.8	0.634317	0.007424	0.000000	0.000000
37	185	0.000000	0.0	0.006832	37061.3	0.640739	0.007427	0.000000	0.000000
39	195	0.000000	0.0	0.006832	36839.9	0.651156	0.007433	0.000000	0.000000
41	205	0.000000	0.0	0.006832	36457.6	0.665921	0.007444	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 2 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	854.7	854.5	809.3	751.5	533.2	532.9	532.9	8961.3	11973.0	950.0
2	10	845.9	845.7	805.4	751.0	555.2	526.0	529.4	8005.5	9940.7	950.0
4	20	858.5	858.3	823.8	788.5	548.2	504.0	517.1	4202.1	10147.3	950.0
6	30	857.1	857.0	824.6	788.0	550.3	499.1	511.1	4202.1	9642.4	950.0
8	40	865.7	865.6	838.7	812.5	557.1	501.9	510.9	2753.5	8893.5	950.0
10	50	867.7	867.6	841.9	815.4	559.3	497.9	508.2	2753.5	8707.9	950.0
12	60	868.9	868.8	843.5	817.3	566.4	497.7	508.1	2719.7	8712.8	950.0
14	70	868.9	868.8	843.6	817.4	566.9	491.6	505.1	2719.7	8648.1	950.0
16	80	866.4	866.3	841.3	815.5	573.4	491.3	504.9	2680.3	8351.5	950.0
18	90	863.5	863.4	838.5	812.7	572.6	484.2	501.5	2680.3	8076.5	950.0
20	100	861.7	861.6	837.0	811.5	578.0	483.9	501.3	2646.8	7901.6	950.0
22	110	862.5	862.4	838.6	812.9	575.9	475.7	497.4	2646.8	7662.0	950.0
24	120	876.2	876.1	856.5	843.0	577.8	475.5	497.3	1515.7	7581.8	950.0
BEGIN TRAILING EDGE REGION											
26	130	860.2	860.1	836.2	808.2	580.1	482.2	497.8	3463.7	7523.5	950.0
28	140	858.8	858.7	834.7	806.1	581.5	473.6	497.8	3661.1	7466.8	950.0
30	150	873.7	873.6	853.9	838.6	577.9	458.7	498.0	1768.6	7409.3	950.0
32	160	872.9	872.8	852.9	834.2	571.1	429.9	498.4	2234.5	7351.8	950.0
34	170	868.5	868.4	847.6	825.7	557.7	383.2	499.5	2712.6	7294.3	950.0
36	180	864.2	864.1	847.0	829.8	560.0	380.5	498.5	2716.2	7211.5	950.0
38	190	862.2	862.1	849.8	837.2	562.5	376.1	496.9	2721.9	7079.3	950.0
40	200	870.7	870.6	864.8	857.6	563.8	370.0	494.8	2734.3	6949.5	950.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.001604	10268.9	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.001037	12311.7	0.000802	4682.0	0.097923	0.010346	0.000000	0.000000
4	20	0.000489	12914.7	0.001839	10495.8	0.193940	0.009093	0.000000	0.000000
6	30	0.000000	0.0	0.002328	13078.8	0.186377	0.008778	0.000000	0.000000
8	40	0.000344	12964.4	0.002328	12765.2	0.161390	0.008812	0.000000	0.000000
10	50	0.000000	0.0	0.002672	14534.5	0.173090	0.008631	0.000000	0.000000
12	60	0.000347	13066.8	0.002672	14473.4	0.174314	0.008637	0.000000	0.000000
14	70	0.000000	0.0	0.003019	16345.3	0.199422	0.008471	0.000000	0.000000
16	80	0.000350	13212.3	0.003019	16310.3	0.200716	0.008474	0.000000	0.000000
18	90	0.000000	0.0	0.003369	18234.3	0.227083	0.008324	0.000000	0.000000
20	100	0.000355	13371.5	0.003369	18198.5	0.228339	0.008326	0.000000	0.000000
22	110	0.000000	0.0	0.003724	20121.0	0.256211	0.008194	0.000000	0.000000
24	120	0.000000	0.0	0.003724	19825.4	0.256873	0.008213	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
26	130	0.000000	0.0	0.006832	31262.6	0.216541	0.034794	0.000000	0.000000
28	140	0.000000	0.0	0.006832	35203.5	0.271096	0.033456	0.000000	0.000000
30	150	0.000000	0.0	0.006832	35398.3	0.348966	0.007486	0.000000	0.000000
32	160	0.000000	0.0	0.006832	36365.6	0.470134	0.007453	0.000000	0.000000
34	170	0.000000	0.0	0.006832	37285.6	0.634317	0.007424	0.000000	0.000000
36	180	0.000000	0.0	0.006832	37175.3	0.640739	0.007427	0.000000	0.000000
38	190	0.000000	0.0	0.006832	37004.9	0.651156	0.007433	0.000000	0.000000
40	200	0.000000	0.0	0.006832	36636.4	0.665921	0.007444	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 861.2/K, MID-WALL T = 837.0 K, COOLANT H = 2937.6 WATTS/M**2 K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 881.9 AT STATION 41, 840.7 AT STATION 13
SUCTION SIDE: 876.2 AT STATION 24, 845.9 AT STATION 2

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 3 ARE:

PIM = 688.05 KPA,

TOG = 537.37 K

TIME = 0.00 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 10000.0 RPM
SLICE NO. 3, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 8 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	832.1	831.9	789.5	734.9	537.4	543.5	543.5	9199.8	11973.0	920.0
3	15	826.6	826.4	788.1	736.2	557.1	536.2	539.9	8170.0	10424.9	920.0
5	25	836.3	836.1	808.9	784.9	549.3	521.3	530.0	2812.6	8809.2	920.0
7	35	828.5	828.3	803.6	779.0	551.8	515.9	527.3	2812.6	7560.1	920.0
9	45	824.0	823.9	799.7	775.7	557.3	515.7	527.2	2768.9	7046.4	920.0
11	55	820.8	820.7	796.7	772.9	557.9	509.3	524.1	2768.9	6724.2	920.0
13	65	819.0	818.9	795.3	771.8	562.6	509.1	524.0	2731.7	6531.9	920.0
15	75	819.6	819.5	796.1	772.5	562.0	501.7	520.4	2731.7	6548.5	920.0
17	85	822.3	822.2	799.4	777.6	565.6	501.5	520.3	2464.1	6565.1	920.0
19	95	823.8	823.7	801.2	779.4	564.5	493.6	516.5	2464.1	6581.6	920.0
21	105	826.1	826.0	803.6	781.0	567.9	493.3	516.3	2555.2	6704.7	920.0
23	115	830.0	829.9	807.9	785.0	565.8	483.9	511.8	2555.2	6832.4	920.0
25	125	838.4	838.3	818.2	803.6	567.5	483.7	511.7	1773.4	6963.8	920.0
BEGIN TRAILING EDGE REGION											
27	135	830.5	830.4	807.8	782.2	579.2	490.1	506.6	3517.2	7082.4	920.0
29	145	832.8	832.7	810.0	783.2	580.1	481.1	506.5	3718.0	7358.4	920.0
31	155	848.7	848.6	829.5	814.8	576.2	465.3	506.7	1809.0	7658.4	920.0
33	165	851.4	851.3	832.0	813.9	568.7	434.8	507.2	2286.8	7976.1	920.0
35	175	850.1	850.0	829.5	808.3	554.0	384.9	508.6	2776.7	8293.5	920.0
37	185	847.9	847.8	830.9	814.0	555.9	382.0	507.6	2781.3	8462.6	920.0
39	195	848.4	848.3	836.0	823.5	558.0	377.2	505.9	2788.3	8635.4	920.0
41	205	856.4	856.3	850.6	843.4	558.7	370.0	503.5	2800.4	8463.7	920.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.001663	10645.1	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.001074	12858.8	0.000832	4884.0	0.099707	0.010277	0.000000	0.000000
5	25	0.000262	9948.9	0.001906	10767.7	0.155702	0.009056	0.000000	0.000000
7	35	0.000000	0.0	0.002168	12266.7	0.179335	0.008869	0.000000	0.000000
9	45	0.000265	10054.6	0.002168	12253.6	0.180315	0.008870	0.000000	0.000000
11	55	0.000000	0.0	0.002432	13763.7	0.204918	0.008707	0.000000	0.000000
13	65	0.000268	10171.6	0.002432	13740.2	0.205893	0.008709	0.000000	0.000000
15	75	0.000000	0.0	0.002700	15250.7	0.231760	0.008565	0.000000	0.000000
17	85	0.000254	10298.4	0.002700	15187.5	0.232660	0.008571	0.000000	0.000000
19	95	0.000000	0.0	0.002954	16612.0	0.258349	0.008449	0.000000	0.000000
21	105	0.000266	10426.3	0.002954	16572.4	0.259312	0.008452	0.000000	0.000000
23	115	0.000000	0.0	0.003219	18044.5	0.287519	0.008338	0.000000	0.000000
25	125	0.000000	0.0	0.003219	17872.5	0.288198	0.008350	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
27	135	0.000000	0.0	0.007075	32691.1	0.220340	0.034284	0.000000	0.000000
29	145	0.000000	0.0	0.007075	36818.0	0.275906	0.032965	0.000000	0.000000
31	155	0.000000	0.0	0.007075	37093.2	0.355470	0.007431	0.000000	0.000000
33	165	0.000000	0.0	0.007075	38058.1	0.479961	0.007398	0.000000	0.000000
35	175	0.000000	0.0	0.007075	38996.9	0.650750	0.007368	0.000000	0.000000
37	185	0.000000	0.0	0.007075	38856.4	0.657471	0.007371	0.000000	0.000000
39	195	0.000000	0.0	0.007075	38646.4	0.668804	0.007376	0.000000	0.000000
41	205	0.000000	0.0	0.007075	38278.9	0.686025	0.007387	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 3 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	832.1	831.9	789.5	734.9	537.4	543.5	543.5	9199.8	11973.0	920.0
2	10	824.0	823.9	786.1	734.9	557.1	536.2	539.9	8170.0	9940.7	920.0
4	20	835.5	835.3	802.9	769.4	550.3	512.9	526.7	4314.3	10147.3	920.0
6	30	834.2	834.0	803.6	768.9	552.3	507.7	520.4	4314.3	9642.4	920.0
8	40	842.1	842.0	816.7	791.7	558.6	510.8	520.3	2835.7	8893.5	920.0
10	50	843.7	843.6	819.4	794.2	560.5	506.6	517.4	2835.7	8707.9	920.0
12	60	845.0	844.9	821.1	796.0	567.0	506.3	517.3	2800.0	8712.8	920.0
14	70	844.9	844.8	821.2	796.2	567.4	499.9	514.1	2800.0	8648.1	920.0
16	80	842.7	842.6	819.1	794.5	573.3	499.6	514.0	2758.0	8351.5	920.0
18	90	840.0	839.9	816.5	791.9	572.4	492.1	510.4	2758.0	8076.5	920.0
20	100	838.3	838.2	815.1	790.9	577.3	491.8	510.2	2722.0	7801.6	920.0
22	110	839.0	838.9	816.6	792.1	575.2	483.2	506.0	2722.0	7662.0	920.0
24	120	852.1	852.1	833.7	820.8	576.8	483.0	505.9	1551.0	7581.8	920.0
					BEGIN TRAILING EDGE REGION						
26	130	837.3	837.2	814.8	788.4	579.2	490.1	506.6	3517.2	7523.5	920.0
28	140	836.1	836.0	813.5	786.4	580.1	481.1	506.5	3718.0	7466.8	920.0
30	150	849.9	849.8	831.4	816.8	576.2	465.3	506.7	1809.7	7409.3	920.0
32	160	849.0	848.9	830.3	812.4	568.7	434.8	507.2	2286.0	7351.8	920.0
34	170	845.0	844.9	825.2	804.4	554.0	384.9	508.6	2774.4	7294.3	920.0
36	180	840.5	840.4	824.4	807.9	555.9	382.0	507.6	2777.7	7211.6	920.0
38	190	838.3	838.2	826.5	814.6	558.0	377.2	505.9	2782.9	7079.3	920.0
40	200	846.0	845.9	840.4	833.5	558.7	370.0	503.5	2794.6	6949.5	920.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	PE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.001663	10645.1	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.001074	12858.8	0.000832	4867.2	0.099704	0.010276	0.000000	0.000000
4	20	0.000506	13473.2	0.001906	10966.7	0.197808	0.009029	0.000000	0.000000
6	30	0.000000	0.0	0.002412	13662.9	0.190088	0.008717	0.000000	0.000000
8	40	0.000356	13522.7	0.002412	13348.0	0.164460	0.008750	0.000000	0.000000
10	50	0.000000	0.0	0.002768	15200.2	0.176370	0.008570	0.000000	0.000000
12	60	0.000359	13625.3	0.002768	15140.4	0.177500	0.008575	0.000000	0.000000
14	70	0.000000	0.0	0.003127	17097.0	0.203101	0.008410	0.000000	0.000000
16	80	0.000362	13771.2	0.003127	17063.3	0.204299	0.008413	0.000000	0.000000
18	90	0.000000	0.0	0.003489	19071.7	0.231213	0.008264	0.000000	0.000000
20	100	0.000367	13930.3	0.003489	19037.1	0.232378	0.008267	0.000000	0.000000
22	110	0.000000	0.0	0.003856	21045.2	0.260870	0.008135	0.000000	0.000000
24	120	0.000000	0.0	0.003856	20748.9	0.261473	0.008153	0.000000	0.000000
					BEGIN TRAILING EDGE REGION				
26	130	0.000000	0.0	0.007075	32691.1	0.220340	0.034284	0.000000	0.000000
28	140	0.000000	0.0	0.007075	36818.0	0.275906	0.032965	0.000000	0.000000
30	150	0.000000	0.0	0.007075	37059.7	0.355470	0.007431	0.000000	0.000000
32	160	0.000000	0.0	0.007075	38084.8	0.479961	0.007398	0.000000	0.000000
34	170	0.000000	0.0	0.007075	39068.2	0.650750	0.007368	0.000000	0.000000
36	180	0.000000	0.0	0.007075	38967.6	0.657471	0.007371	0.000000	0.000000
38	190	0.000000	0.0	0.007075	38809.7	0.668804	0.007376	0.000000	0.000000
40	200	0.000000	0.0	0.007075	38456.0	0.686025	0.007387	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 837.9 K, MID-WALL T = 815.2/K, COOLANT H = 3010.6 WATTS/M**2 K

TIME = 0.000 SEC., OVERALL BULK METAL TEMPERATURE = 823.2 K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 856.4 AT STATION 41, 819.0 AT STATION 13
SUCTION SIDE: 852.1 AT STATION 24, 824.0 AT STATION 2

AMOUNT OF COOLANT ACTUALLY USED AT THIS TIME STEP IS 73.8 KG/HR

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(THE PROGRAM CONTINUES TO CALCULATE AT .25 SECOND STEPS.
THE OUTPUT FOR THE NEXT 9 STEPS IS SKIPPED)
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TABLE IV. - Continued.

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 1 ARE:

PIM = 2676.96 KPA,

TOG = 809.81 K

CENTRAL PLENUM FLOW IS 240.0 KG/HR

TIME = 2.50 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 1, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 5 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1223.8	1223.3	1110.2	1021.1	809.8	2247.9	2247.9	21893.8	11973.0	1590.0
3	15	1200.1	1199.6	1094.6	1013.1	813.2	2226.5	2237.1	19163.3	10424.9	1590.0
5	25	1179.3	1178.9	1088.7	1044.3	807.0	2182.7	2207.8	8115.3	8809.2	1590.0
7	35	1142.2	1141.8	1057.1	1014.7	810.8	2166.4	2199.2	8115.3	7560.1	1590.0
9	45	1125.0	1124.6	1040.8	1000.9	815.8	2165.1	2198.2	8008.8	7046.4	1590.0
11	55	1114.0	1113.6	1030.7	992.1	816.3	2146.2	2198.4	8008.8	6724.2	1590.0
13	65	1107.4	1107.0	1025.2	987.5	820.0	2144.9	2187.2	7922.2	6531.9	1590.0
15	75	1107.9	1107.5	1025.3	987.7	819.1	2123.1	2176.0	7922.2	6548.5	1590.0
17	85	1110.2	1109.8	1028.4	993.0	821.6	2121.7	2174.8	7234.2	6565.1	1590.0
19	95	1112.4	1112.0	1031.1	995.3	820.4	2098.4	2162.7	7234.2	6581.6	1590.0
21	105	1118.5	1118.1	1036.7	999.3	822.7	2096.8	2161.3	7492.4	6704.7	1590.0
23	115	1126.5	1126.2	1045.3	1006.9	820.6	2069.8	2147.6	7492.4	6832.4	1590.0
25	125	1144.0	1143.6	1066.2	1041.5	820.7	2068.4	2146.2	4520.5	6963.8	1590.0
					BEGIN TRAILING EDGE REGION						
27	135	1139.6	1139.2	1059.3	1021.9	832.0	2084.5	2130.4	7760.4	7082.4	1590.0
29	145	1147.0	1146.6	1065.7	1026.2	832.3	2058.9	2129.4	8232.0	7358.4	1590.0
31	155	1171.2	1170.8	1093.4	1067.3	828.1	2015.8	2128.6	4620.3	7658.4	1590.0
33	165	1179.9	1179.5	1100.9	1068.6	822.7	1936.3	2127.8	5847.1	7976.1	1590.0
35	175	1185.6	1185.2	1105.0	1066.7	813.3	1818.4	2126.6	7117.2	8293.5	1590.0
37	185	1193.1	1192.7	1130.5	1096.7	814.3	1812.7	2122.8	7154.8	8462.6	1590.0
39	195	1214.5	1214.1	1171.9	1143.8	815.6	1805.5	2118.0	7212.6	8635.4	1590.0
41	205	1260.4	1260.2	1241.6	1223.4	815.4	1800.0	2114.0	7304.9	8463.7	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.004763	25090.8	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003081	29730.2	0.002382	11111.4	0.084022	0.009010	0.000000	0.000000
5	25	0.000753	23061.0	0.005463	24798.7	0.130566	0.007924	0.000000	0.000000
7	35	0.000000	0.0	0.006216	28463.6	0.149963	0.007751	0.000000	0.000000
9	45	0.000763	23376.6	0.006216	28547.3	0.150498	0.007748	0.000000	0.000000
11	55	0.000000	0.0	0.006980	32140.6	0.170457	0.007602	0.000000	0.000000
13	65	0.000774	23702.3	0.006980	32150.6	0.170946	0.007602	0.000000	0.000000
15	75	0.000000	0.0	0.007753	35722.6	0.191693	0.007475	0.000000	0.000000
17	85	0.000736	24057.8	0.007753	35629.3	0.192138	0.007478	0.000000	0.000000
19	95	0.000000	0.0	0.008490	38998.8	0.212505	0.007370	0.000000	0.000000
21	105	0.000772	24421.7	0.008490	38915.1	0.212992	0.007373	0.000000	0.000000
23	115	0.000000	0.0	0.009261	42374.3	0.235022	0.007273	0.000000	0.000000
25	125	0.000000	0.0	0.009261	41890.7	0.235291	0.007287	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.020366	76340.4	0.180504	0.025912	0.000000	0.000000
29	145	0.000000	0.0	0.020366	86032.8	0.224539	0.024910	0.000000	0.000000
31	155	0.000000	0.0	0.020366	86864.0	0.286149	0.006485	0.000000	0.000000
33	165	0.000000	0.0	0.020366	88894.4	0.377396	0.006457	0.000000	0.000000
35	175	0.000000	0.0	0.020366	90557.6	0.488053	0.006436	0.000000	0.000000
37	185	0.000000	0.0	0.020366	89647.9	0.490327	0.006444	0.000000	0.000000
39	195	0.000000	0.0	0.020366	88261.5	0.493289	0.006457	0.000000	0.000000
41	205	0.000000	0.0	0.020366	86080.6	0.495640	0.006482	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 1 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1223.8	1223.3	1110.2	1021.1	809.8	2247.9	2247.9	21893.8	11973.0	1590.0
2	10	1196.3	1195.9	1094.1	1012.9	813.2	2226.5	2237.1	19163.3	9940.7	1590.0
4	20	1199.7	1199.3	1100.4	1040.7	807.4	2158.8	2198.5	11682.2	10147.3	1590.0
6	30	1185.3	1184.9	1088.9	1029.2	810.0	2143.3	2179.5	11682.2	9642.4	1590.0
8	40	1184.6	1184.2	1095.6	1049.6	815.3	2151.3	2178.4	8207.3	9893.5	1590.0
10	50	1182.4	1182.0	1094.6	1048.6	817.5	2138.2	2169.0	8207.3	8707.9	1590.0
12	60	1183.8	1183.4	1096.3	1050.6	823.1	2136.6	2167.7	8124.2	8712.8	1590.0
14	70	1183.1	1182.7	1095.8	1050.2	823.6	2117.3	2157.5	8124.2	8648.1	1590.0
16	80	1174.6	1174.2	1088.1	1043.6	829.2	2115.4	2155.9	8027.2	8351.5	1590.0
18	90	1165.6	1165.2	1079.6	1035.9	828.7	2093.1	2144.2	8027.2	8076.5	1590.0
20	100	1158.2	1157.8	1073.2	1030.4	833.1	2091.0	2142.5	7949.7	7801.6	1590.0
22	110	1156.1	1155.7	1072.6	1029.6	831.3	2065.5	2129.2	7949.7	7662.0	1590.0
24	120	1177.8	1177.4	1101.5	1078.4	830.9	2063.8	2127.6	3967.0	7581.8	1590.0
				BEGIN TRAILING EDGE REGION							
26	130	1159.2	1158.9	1078.3	1038.5	832.0	2084.5	2130.4	7760.4	7523.5	1590.0
28	140	1156.5	1156.1	1075.4	1034.6	832.3	2058.9	2129.4	8232.0	7466.8	1590.0
30	150	1171.3	1170.9	1095.0	1069.1	828.1	2015.7	2128.6	4621.8	7409.3	1590.0
32	160	1168.1	1167.7	1091.5	1060.2	822.7	1936.3	2127.8	5838.7	7351.8	1590.0
34	170	1164.1	1163.7	1087.1	1050.9	813.3	1818.4	2126.6	7097.7	7294.3	1590.0
36	180	1165.2	1164.8	1105.8	1074.3	814.3	1812.7	2122.8	7127.7	7211.6	1590.0
38	190	1178.6	1178.2	1138.7	1112.7	815.6	1805.5	2118.0	7175.6	7079.3	1590.0
40	200	1224.0	1223.7	1206.0	1188.9	815.4	1800.0	2114.0	7265.1	6949.5	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.004763	25090.8	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003081	29730.3	0.002382	11112.0	0.084022	0.009010	0.000000	0.000000
4	20	0.001460	31304.4	0.005463	25109.1	0.164895	0.007908	0.000000	0.000000
6	30	0.000000	0.0	0.006923	31434.3	0.158128	0.007629	0.000000	0.000000
8	40	0.001027	31465.5	0.006923	30877.0	0.136767	0.007651	0.000000	0.000000
10	50	0.000000	0.0	0.007950	35248.8	0.146374	0.007491	0.000000	0.000000
12	60	0.001037	31774.0	0.007950	35159.7	0.147007	0.007494	0.000000	0.000000
14	70	0.000000	0.0	0.008987	39745.9	0.167712	0.007348	0.000000	0.000000
16	80	0.001051	32200.5	0.008987	39760.5	0.168419	0.007348	0.000000	0.000000
18	90	0.000000	0.0	0.010038	44529.6	0.190002	0.007216	0.000000	0.000000
20	100	0.001066	32669.2	0.010038	44545.5	0.190691	0.007215	0.000000	0.000000
22	110	0.000000	0.0	0.011105	49321.9	0.213251	0.007099	0.000000	0.000000
24	120	0.000000	0.0	0.011105	48544.8	0.213518	0.007117	0.000000	0.000000
			BEGIN TRAILING EDGE REGION						
26	130	0.000000	0.0	0.020366	76340.4	0.180504	0.025912	0.000000	0.000000
28	140	0.000000	0.0	0.020366	86032.8	0.224539	0.024910	0.000000	0.000000
30	150	0.000000	0.0	0.020366	86812.8	0.286149	0.006485	0.000000	0.000000
32	160	0.000000	0.0	0.020366	89139.0	0.377396	0.006457	0.000000	0.000000
34	170	0.000000	0.0	0.020366	91031.1	0.488053	0.006436	0.000000	0.000000
36	180	0.000000	0.0	0.020366	90301.7	0.490327	0.006444	0.000000	0.000000
38	190	0.000000	0.0	0.020366	89148.0	0.493289	0.006457	0.000000	0.000000
40	200	0.000000	0.0	0.020366	87015.1	0.495640	0.006482	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1168.3 K, MID-WALL T = 1087.5 K, COOLANT H = 7933.7 WATTS/M**2/K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1260.4 AT STATION 41, 1107.8 AT STATION 13
SUCTION SIDE: 1224.0 AT STATION 40, 1156.1 AT STATION 22

TABLE IV. - Continued.

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THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 2 ARE:

PIM = 2810.36 KPA,

TOG = 820.24 K

****

TIME = 2.50 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 2, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 5 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1268.7	1268.2	1150.4	1052.0	820.2	2322.0	2322.0	23198.8	11973.0	1670.0
3	15	1243.7	1243.2	1134.2	1043.7	824.1	2297.7	2309.7	20366.5	10424.9	1670.0
5	25	1223.8	1223.4	1130.1	1079.9	817.3	2248.0	2276.5	8728.8	8809.2	1670.0
7	35	1184.6	1184.2	1097.1	1048.7	821.4	2229.4	2266.9	8728.8	7560.1	1670.0
9	45	1166.5	1166.1	1080.0	1034.4	826.9	2228.0	2265.7	8609.0	7046.4	1670.0
11	55	1155.1	1154.7	1069.5	1025.2	827.5	2206.6	2254.6	8609.0	6724.2	1670.0
13	65	1148.4	1148.0	1063.8	1020.5	831.6	2205.0	2253.3	8510.0	6531.9	1670.0
15	75	1148.8	1148.4	1064.0	1020.7	830.7	2180.3	2240.6	8510.0	6548.5	1670.0
17	85	1151.6	1151.2	1067.7	1026.9	833.5	2178.7	2239.2	7769.2	6565.1	1670.0
19	95	1154.0	1153.6	1070.6	1029.4	832.1	2152.1	2225.6	7769.2	6581.6	1670.0
21	105	1160.6	1160.2	1076.7	1033.8	834.8	2150.3	2224.0	8037.3	6704.7	1670.0
23	115	1169.4	1169.0	1086.3	1042.2	832.5	2119.5	2208.4	8037.3	6832.4	1670.0
25	125	1189.4	1189.0	1110.1	1081.9	832.4	2118.0	2207.0	4829.5	6963.9	1670.0
					BEGIN TRAILING EDGE REGION						
27	135	1184.3	1183.9	1102.2	1059.9	844.8	2136.7	2189.1	8215.3	7082.4	1670.0
29	145	1192.4	1192.0	1109.1	1064.3	845.1	2107.3	2188.0	8715.9	7358.4	1670.0
31	155	1218.8	1218.5	1139.4	1109.7	840.3	2057.6	2187.2	4936.4	7658.4	1670.0
33	165	1227.7	1227.3	1146.8	1110.2	834.0	1965.0	2186.4	6245.3	7976.1	1670.0
35	175	1232.7	1232.3	1150.0	1106.7	822.6	1824.5	2185.4	7597.9	8293.5	1670.0
37	185	1238.6	1238.3	1174.1	1136.4	823.8	1817.0	2180.3	7636.7	8462.6	1670.0
39	195	1258.8	1258.4	1214.4	1183.6	825.2	1807.4	2175.0	7697.0	8635.4	1670.0
41	205	1304.6	1304.3	1284.7	1264.8	825.1	1800.0	2170.2	7794.9	8463.7	1670.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005124	26755.4	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003313	31431.6	0.002562	11789.8	0.088197	0.008925	0.000000	0.000000
5	25	0.000609	24369.9	0.005875	26268.6	0.137224	0.007851	0.000000	0.000000
7	35	0.000000	0.0	0.006683	30152.3	0.157721	0.007680	0.000000	0.000000
9	45	0.000819	24668.8	0.006683	30239.9	0.158335	0.007677	0.000000	0.000000
11	55	0.000000	0.0	0.007502	34041.3	0.179458	0.007532	0.000000	0.000000
13	65	0.000830	24997.5	0.007502	34048.1	0.180024	0.007532	0.000000	0.000000
15	75	0.000000	0.0	0.008332	37822.0	0.202026	0.007407	0.000000	0.000000
17	85	0.000789	25354.9	0.008332	37710.1	0.202541	0.007410	0.000000	0.000000
19	95	0.000000	0.0	0.009121	41265.0	0.224197	0.007304	0.000000	0.000000
21	105	0.000826	25719.5	0.009121	41168.9	0.224763	0.007307	0.000000	0.000000
23	115	0.000000	0.0	0.009947	44808.4	0.248253	0.007208	0.000000	0.000000
25	125	0.000000	0.0	0.009947	44233.1	0.248557	0.007223	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.021870	80598.5	0.190607	0.025452	0.000000	0.000000
29	145	0.000000	0.0	0.021870	90847.3	0.237473	0.024466	0.000000	0.000000
31	155	0.000000	0.0	0.021870	91646.4	0.303365	0.006429	0.000000	0.000000
33	165	0.000000	0.0	0.021870	93837.6	0.402166	0.006402	0.000000	0.000000
35	175	0.000000	0.0	0.021870	95697.5	0.525157	0.006379	0.000000	0.000000
37	185	0.000000	0.0	0.021870	94755.6	0.528309	0.006387	0.000000	0.000000
39	195	0.000000	0.0	0.021870	93306.1	0.532433	0.006400	0.000000	0.000000
41	205	0.000000	0.0	0.021870	90983.8	0.535744	0.006424	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 2 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1268.7	1268.2	1150.4	1052.0	820.2	2322.0	2322.0	23198.8	11973.0	1670.0
2	10	1239.7	1239.2	1133.5	1043.4	824.1	2297.7	2309.7	20366.5	9940.7	1670.0
4	20	1244.1	1243.7	1141.2	1074.4	817.7	2220.8	2265.9	12505.3	10147.3	1670.0
6	30	1229.5	1229.1	1129.4	1062.4	820.5	2203.2	2244.4	12505.3	9642.4	1670.0
8	40	1229.9	1229.5	1137.9	1085.9	826.4	2212.3	2243.1	8819.6	8893.5	1670.0
10	50	1227.6	1227.2	1137.1	1085.0	828.7	2197.4	2232.6	9819.6	8707.9	1670.0
12	60	1229.5	1229.0	1139.1	1087.3	835.0	2195.6	2231.1	8725.7	8712.8	1670.0
14	70	1228.6	1228.2	1138.5	1086.9	835.6	2173.8	2219.6	8725.7	8648.1	1670.0
16	80	1219.7	1219.3	1130.5	1080.1	841.6	2171.6	2217.8	8615.1	8351.5	1670.0
18	90	1210.2	1209.8	1121.6	1072.0	841.1	2146.2	2204.6	8615.1	8076.5	1670.0
20	100	1202.6	1202.1	1115.0	1066.4	846.0	2143.9	2202.7	8524.7	7801.6	1670.0
22	110	1200.9	1200.5	1115.0	1066.0	844.0	2114.8	2187.6	8524.7	7662.0	1670.0
24	120	1226.4	1226.0	1148.5	1122.2	843.4	2113.1	2185.9	4238.6	7581.8	1670.0
					BEGIN TRAILING EDGE REGION						
26	130	1205.5	1205.1	1122.7	1077.6	844.8	2136.7	2189.1	8215.3	7523.5	1670.0
28	140	1202.3	1202.0	1119.3	1073.2	845.1	2107.3	2188.0	8715.9	7466.8	1670.0
30	150	1219.3	1218.9	1141.4	1111.9	840.3	2057.6	2187.2	4938.1	7409.3	1670.0
32	160	1215.4	1215.0	1137.1	1101.5	834.0	1965.0	2186.4	6236.3	7351.8	1670.0
34	170	1210.3	1209.9	1131.3	1090.2	822.6	1824.5	2185.4	7576.9	7294.3	1670.0
36	180	1209.6	1209.2	1148.3	1113.0	823.8	1817.0	2180.9	7607.3	7211.6	1670.0
38	190	1221.1	1220.8	1179.5	1150.8	825.2	1807.4	2175.0	7656.5	7079.3	1670.0
40	200	1265.7	1265.4	1246.8	1228.1	825.1	1800.0	2170.2	7750.8	6949.5	1670.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005124	26755.4	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003313	31431.7	0.002562	11790.3	0.088198	0.008925	0.000000	0.000000
4	20	0.001566	33031.0	0.005875	26612.6	0.173498	0.007835	0.000000	0.000000
6	30	0.000000	0.0	0.007441	33301.7	0.166437	0.007559	0.000000	0.000000
8	40	0.001102	33192.2	0.007441	32677.9	0.143939	0.007582	0.000000	0.000000
10	50	0.000000	0.0	0.008543	37290.9	0.154121	0.007423	0.000000	0.000000
12	60	0.001112	33501.9	0.008543	37186.8	0.154845	0.007427	0.000000	0.000000
14	70	0.000000	0.0	0.009655	42025.8	0.176774	0.007283	0.000000	0.000000
16	80	0.001126	33929.8	0.009655	42036.3	0.177584	0.007282	0.000000	0.000000
18	90	0.000000	0.0	0.010781	47071.2	0.200497	0.007152	0.000000	0.000000
20	100	0.001142	34398.4	0.010781	47081.1	0.201288	0.007152	0.000000	0.000000
22	110	0.000000	0.0	0.011923	52108.7	0.225301	0.007036	0.000000	0.000000
24	120	0.000000	0.0	0.011923	51183.6	0.225586	0.007057	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
26	130	0.000000	0.0	0.021870	80598.5	0.190607	0.025452	0.000000	0.000000
28	140	0.000000	0.0	0.021870	90847.3	0.237473	0.024466	0.000000	0.000000
30	150	0.000000	0.0	0.021870	91582.4	0.303365	0.006429	0.000000	0.000000
32	160	0.000000	0.0	0.021870	94101.1	0.402166	0.006402	0.000000	0.000000
34	170	0.000000	0.0	0.021870	96209.9	0.525157	0.006379	0.000000	0.000000
36	180	0.000000	0.0	0.021870	95469.3	0.528309	0.006387	0.000000	0.000000
38	190	0.000000	0.0	0.021870	94278.1	0.532433	0.006400	0.000000	0.000000
40	200	0.000000	0.0	0.021870	92025.0	0.535744	0.006424	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1212.9 K, MID-WALL T = 1129.7 K, COOLANT H = 8548.5 WATTS/M**2/K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1304.6 AT STATION 41, 1148.4 AT STATION 13
SUCTION SIDE: 1268.7 AT STATION 1, 1200.9 AT STATION 22

TABLE IV. - Continued.

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 3 ARE:

PIM = 2943.29 KPA,

TOG = 830.21 K

TIME = 2.50 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 3, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 5 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1227.7	1227.3	1115.9	1024.6	830.2	2392.5	2392.5	24478.3	11973.0	1590.0
3	15	1204.6	1204.2	1101.1	1018.0	832.5	2365.3	2378.8	21241.4	10424.9	1590.0
5	25	1184.2	1183.8	1095.1	1048.3	826.5	2309.3	2341.4	9254.9	8809.2	1590.0
7	35	1147.9	1147.5	1064.5	1020.0	829.8	2288.6	2330.7	9254.9	7560.1	1590.0
9	45	1131.5	1131.1	1049.1	1007.3	834.5	2287.1	2329.4	9121.1	7046.4	1590.0
11	55	1120.9	1120.5	1039.6	999.1	834.7	2263.1	2317.1	9121.1	6724.2	1590.0
13	65	1114.8	1114.4	1034.5	995.1	838.0	2261.5	2315.7	9008.5	6531.9	1590.0
15	75	1115.2	1114.8	1034.6	995.3	837.0	2233.8	2301.5	9008.5	6548.5	1590.0
17	85	1117.5	1117.1	1037.8	1000.6	839.2	2232.1	2300.1	8222.9	6565.1	1590.0
19	95	1119.7	1119.3	1040.4	1002.9	837.7	2202.4	2284.9	8222.9	6581.6	1590.0
21	105	1125.9	1125.5	1045.9	1006.8	839.9	2200.5	2283.3	8494.7	6704.7	1590.0
23	115	1133.7	1133.3	1054.5	1014.2	837.5	2166.0	2265.8	8494.7	6832.4	1590.0
25	125	1151.5	1151.2	1075.9	1049.8	837.3	2164.4	2264.3	5067.4	6963.9	1590.0
					BEGIN TRAILING EDGE REGION						
27	135	1147.3	1146.9	1069.0	1030.2	848.7	2185.8	2244.5	8513.8	7082.4	1590.0
29	145	1154.1	1153.7	1075.0	1033.8	848.2	2152.9	2243.4	9034.6	7358.4	1590.0
31	155	1177.9	1177.6	1102.1	1074.4	842.7	2096.9	2242.5	5174.2	7658.4	1590.0
33	165	1186.0	1185.7	1108.7	1074.6	834.8	1991.7	2242.0	6544.0	7976.1	1590.0
35	175	1191.0	1190.6	1111.7	1071.4	820.7	1829.3	2241.7	7957.6	8293.5	1590.0
37	185	1196.2	1195.9	1134.3	1098.8	821.4	1820.5	2236.5	7995.5	8462.6	1590.0
39	195	1214.1	1213.7	1171.4	1141.9	822.2	1809.1	2229.9	8053.8	8635.4	1590.0
41	205	1255.6	1255.3	1236.4	1217.1	821.6	1800.0	2224.4	8150.4	8463.7	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005482	28388.5	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003542	33850.2	0.002741	12685.6	0.092087	0.008821	0.000000	0.000000
5	25	0.000864	26210.8	0.006283	28300.2	0.143557	0.007758	0.000000	0.000000
7	35	0.000000	0.0	0.007146	32457.0	0.165011	0.007590	0.000000	0.000000
9	45	0.000874	26515.0	0.007146	32544.0	0.165558	0.007587	0.000000	0.000000
11	55	0.000000	0.0	0.008020	36619.4	0.187717	0.007445	0.000000	0.000000
13	65	0.000885	26848.7	0.008020	36628.6	0.188222	0.007445	0.000000	0.000000
15	75	0.000000	0.0	0.008905	40680.8	0.211356	0.007321	0.000000	0.000000
17	85	0.000841	27210.4	0.008905	40577.8	0.211819	0.007324	0.000000	0.000000
19	95	0.000000	0.0	0.009746	44397.3	0.234639	0.007219	0.000000	0.000000
21	105	0.000879	27577.7	0.009746	44307.4	0.235154	0.007221	0.000000	0.000000
23	115	0.000000	0.0	0.010625	48226.2	0.259978	0.007124	0.000000	0.000000
25	125	0.000000	0.0	0.010625	47669.3	0.260251	0.007137	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.023354	86848.8	0.199240	0.024832	0.000000	0.000000
29	145	0.000000	0.0	0.023354	97911.6	0.248461	0.023869	0.000000	0.000000
31	155	0.000000	0.0	0.023354	98908.7	0.318059	0.006351	0.000000	0.000000
33	165	0.000000	0.0	0.023354	101336.4	0.423482	0.006324	0.000000	0.000000
35	175	0.000000	0.0	0.023354	103432.0	0.557864	0.006301	0.000000	0.000000
37	185	0.000000	0.0	0.023354	102493.7	0.561609	0.006308	0.000000	0.000000
39	195	0.000000	0.0	0.023354	101059.0	0.566502	0.006319	0.000000	0.000000
41	205	0.000000	0.0	0.023354	98711.5	0.570546	0.006342	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 3 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1227.7	1227.3	1115.9	1024.6	830.2	2392.5	2392.5	24478.3	11973.0	1590.0
2	10	1201.1	1200.7	1100.5	1017.9	832.6	2365.3	2378.8	21241.4	9940.7	1590.0
4	20	1203.8	1203.4	1106.1	1044.0	826.4	2278.7	2329.5	13176.2	10147.3	1590.0
6	30	1189.8	1189.3	1094.7	1032.9	828.9	2259.0	2305.3	13176.2	9642.4	1590.0
8	40	1189.1	1188.7	1101.5	1053.1	834.0	2269.4	2304.1	9340.9	8893.5	1590.0
10	50	1186.8	1186.4	1100.5	1052.0	835.9	2252.8	2292.3	9340.9	8707.9	1590.0
12	60	1188.3	1187.9	1102.2	1054.1	841.1	2251.0	2290.7	9235.3	8712.8	1590.0
14	70	1187.6	1187.2	1101.7	1053.8	841.3	2226.6	2278.0	9235.3	8648.1	1590.0
16	80	1179.6	1179.2	1094.6	1047.8	846.3	2224.4	2276.1	9109.9	8351.5	1590.0
18	90	1170.9	1170.5	1086.5	1040.6	845.6	2196.0	2261.4	9109.9	8076.5	1590.0
20	100	1163.9	1163.5	1080.6	1035.7	849.7	2193.6	2259.4	9004.8	7801.6	1590.0
22	110	1162.1	1161.7	1080.3	1035.2	847.6	2161.1	2242.6	9004.8	7662.0	1590.0
24	120	1185.0	1184.6	1110.6	1086.0	846.9	2159.3	2240.8	4442.3	7581.8	1590.0
BEGIN TRAILING EDGE REGION											
26	130	1166.3	1165.9	1087.4	1046.0	848.7	2185.8	2244.5	8513.8	7523.5	1590.0
28	140	1163.3	1162.9	1084.2	1041.8	848.2	2152.9	2243.4	9034.6	7466.8	1590.0
30	150	1178.4	1178.0	1103.9	1076.4	842.7	2096.9	2242.5	5175.9	7409.3	1590.0
32	160	1174.7	1174.3	1099.9	1066.8	834.8	1991.7	2242.0	6535.5	7351.8	1590.0
34	170	1170.1	1169.7	1094.6	1056.6	820.7	1829.3	2241.7	7937.4	7294.3	1590.0
36	180	1169.1	1168.8	1110.7	1077.7	821.4	1820.5	2236.5	7967.1	7211.5	1590.0
38	190	1179.3	1179.0	1139.5	1112.4	822.2	1809.1	2229.9	8014.6	7079.3	1590.0
40	200	1220.1	1219.8	1201.9	1183.8	821.6	1800.0	2224.4	8107.8	6949.5	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005482	28388.5	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003542	33850.3	0.002741	12685.7	0.092089	0.008821	0.000000	0.000000
4	20	0.001671	35501.1	0.006283	28664.7	0.181651	0.007743	0.000000	0.000000
6	30	0.000000	0.0	0.007954	35846.2	0.174256	0.007470	0.000000	0.000000
8	40	0.001175	35661.6	0.007954	35219.2	0.150550	0.007492	0.000000	0.000000
10	50	0.000000	0.0	0.009129	40187.6	0.161194	0.007335	0.000000	0.000000
12	60	0.001185	35973.1	0.009129	40091.6	0.161841	0.007338	0.000000	0.000000
14	70	0.000000	0.0	0.010315	45299.3	0.184823	0.007196	0.000000	0.000000
16	80	0.001200	36403.3	0.010315	45312.8	0.185554	0.007196	0.000000	0.000000
18	90	0.000000	0.0	0.011514	50713.6	0.209614	0.007067	0.000000	0.000000
20	100	0.001215	36872.5	0.011514	50727.7	0.210337	0.007067	0.000000	0.000000
22	110	0.000000	0.0	0.012729	56128.8	0.235621	0.006953	0.000000	0.000000
24	120	0.000000	0.0	0.012729	55223.5	0.235880	0.006971	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
26	130	0.000000	0.0	0.023354	86848.8	0.199240	0.024832	0.000000	0.000000
28	140	0.000000	0.0	0.023354	97911.6	0.248461	0.023869	0.000000	0.000000
30	150	0.000000	0.0	0.023354	98843.7	0.318059	0.006351	0.000000	0.000000
32	160	0.000000	0.0	0.023354	101592.8	0.423482	0.006324	0.000000	0.000000
34	170	0.000000	0.0	0.023354	103935.5	0.557864	0.006301	0.000000	0.000000
36	180	0.000000	0.0	0.023354	103198.1	0.561609	0.006308	0.000000	0.000000
38	190	0.000000	0.0	0.023354	102020.1	0.566502	0.006319	0.000000	0.000000
40	200	0.000000	0.0	0.023354	99742.3	0.570546	0.006342	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1173.5 K, MID-WALL T = 1094.2 K, COOLANT H = 8988.5 WATTS/M**2/K

TIME = 2.500 SEC., OVERALL BULK METAL TEMPERATURE = 1103.8 K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1255.6 AT STATION 41, 1114.8 AT STATION 13
SUCTION SIDE: 1227.7 AT STATION 1, 1162.1 AT STATION 22

AMOUNT OF COOLANT ACTUALLY USED AT THIS TIME STEP IS 236.1 KG/HR

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(THE PROGRAM CONTINUES TO CALCULATE AT .25 SECOND STEPS.
THE OUTPUT FOR THE NEXT 9 STEPS IS SKIPPED)

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TABLE IV. - Continued.

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 1 ARE:

PIM = 2679.22 KPA,

TOG = 809.99 K

CENTRAL PLENUM FLOW IS 235.0 KG/HR

TIME = 5.00 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 1, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 4 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1285.1	1284.8	1196.9	1088.1	810.0	2257.1	2257.1	21782.4	11973.0	1590.0
3	15	1267.5	1267.1	1186.7	1083.0	816.0	2236.0	2246.4	19602.3	10424.9	1590.0
5	25	1268.3	1268.0	1203.8	1145.8	807.5	2193.0	2217.7	8208.6	8809.2	1590.0
7	35	1239.3	1239.0	1179.6	1121.4	812.4	2176.9	2209.2	8208.6	7560.1	1590.0
9	45	1224.0	1223.7	1165.0	1108.9	819.7	2175.4	2208.1	8106.1	7046.4	1590.0
11	55	1213.9	1213.6	1155.3	1100.1	821.1	2156.6	2198.3	8106.1	6724.2	1590.0
13	65	1208.0	1207.7	1150.0	1095.7	826.8	2155.0	2197.1	8024.6	6531.9	1590.0
15	75	1208.7	1208.5	1150.7	1096.3	826.5	2133.4	2185.9	8024.6	6548.5	1590.0
17	85	1213.1	1212.8	1156.1	1105.0	830.6	2131.7	2184.5	7330.2	6565.1	1590.0
19	95	1216.4	1216.2	1160.0	1108.4	829.6	2108.4	2172.5	7330.2	6581.6	1590.0
21	105	1222.9	1222.6	1166.4	1113.0	833.5	2106.5	2171.0	7600.8	6704.7	1590.0
23	115	1234.3	1234.0	1179.2	1124.5	831.2	2079.5	2157.2	7600.8	6832.4	1590.0
25	125	1261.4	1261.2	1211.3	1176.6	831.5	2078.0	2155.8	4610.0	6963.8	1590.0
BEGIN TRAILING EDGE REGION											
27	135	1253.0	1252.7	1200.0	1146.8	845.8	2094.1	2140.0	7974.3	7082.4	1590.0
29	145	1260.3	1260.1	1207.1	1151.3	847.6	2068.2	2138.9	8458.6	7358.4	1590.0
31	155	1292.1	1291.9	1243.6	1207.8	843.5	2024.9	2138.1	4717.8	7658.4	1590.0
33	165	1297.3	1297.1	1247.7	1203.8	839.4	1944.1	2137.0	5967.0	7976.1	1590.0
35	175	1294.6	1294.4	1242.4	1191.5	831.4	1822.2	2134.6	7254.0	8293.5	1590.0
37	185	1288.8	1288.6	1246.1	1204.7	834.5	1815.3	2130.4	7272.6	8462.6	1590.0
39	195	1289.4	1289.1	1258.0	1226.8	838.3	1806.8	2125.0	7301.9	8635.4	1590.0
41	205	1309.3	1309.0	1294.1	1275.4	840.5	1800.0	2120.5	7358.7	8463.7	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.004730	24909.7	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003061	28269.0	0.002365	10771.3	0.083271	0.009055	0.000000	0.000000
5	25	0.000749	21965.6	0.005426	23826.8	0.129286	0.007975	0.000000	0.000000
7	35	0.000000	0.0	0.006175	27286.6	0.148643	0.007804	0.000000	0.000000
9	45	0.000759	22259.4	0.006175	27333.1	0.149397	0.007802	0.000000	0.000000
11	55	0.000000	0.0	0.006934	30766.6	0.169350	0.007655	0.000000	0.000000
13	65	0.000770	22584.7	0.006934	30753.4	0.170070	0.007656	0.000000	0.000000
15	75	0.000000	0.0	0.007704	34166.2	0.190842	0.007528	0.000000	0.000000
17	85	0.000733	22940.1	0.007704	34026.3	0.191496	0.007533	0.000000	0.000000
19	95	0.000000	0.0	0.008438	37236.0	0.211926	0.007425	0.000000	0.000000
21	105	0.000769	23305.4	0.008438	37134.2	0.212645	0.007428	0.000000	0.000000
23	115	0.000000	0.0	0.009207	40400.0	0.234759	0.007329	0.000000	0.000000
25	125	0.000000	0.0	0.009207	39734.6	0.235126	0.007348	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
27	135	0.000000	0.0	0.020251	72555.5	0.180594	0.026351	0.000000	0.000000
29	145	0.000000	0.0	0.020251	81745.5	0.224836	0.025334	0.000000	0.000000
31	155	0.000000	0.0	0.020251	82193.3	0.286637	0.006543	0.000000	0.000000
33	165	0.000000	0.0	0.020251	84213.1	0.378697	0.006514	0.000000	0.000000
35	175	0.000000	0.0	0.020251	86017.2	0.491695	0.006490	0.000000	0.000000
37	185	0.000000	0.0	0.020251	85581.6	0.494523	0.006493	0.000000	0.000000
39	195	0.000000	0.0	0.020251	84897.9	0.498083	0.006499	0.000000	0.000000
41	205	0.000000	0.0	0.020251	83582.0	0.500939	0.006514	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 1 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1285.1	1284.8	1196.9	1088.1	810.0	2257.1	2257.1	21782.4	11973.0	1590.0
2	10	1263.5	1263.2	1184.8	1081.9	816.1	2236.0	2246.4	19602.3	9940.7	1590.0
4	20	1275.9	1275.6	1202.6	1126.4	809.1	2169.4	2208.4	11867.9	10147.3	1590.0
6	30	1267.0	1266.6	1196.6	1118.8	812.3	2154.0	2189.7	11867.9	9642.4	1590.0
8	40	1277.6	1277.3	1215.6	1155.2	819.3	2161.7	2188.5	8309.4	8993.5	1590.0
10	50	1278.3	1278.0	1217.9	1157.1	822.5	2148.7	2179.2	8309.4	8707.9	1590.0
12	60	1280.5	1280.2	1220.4	1160.1	830.9	2146.9	2177.8	8230.3	8712.8	1590.0
14	70	1279.9	1279.6	1220.0	1159.8	832.2	2127.6	2167.6	8230.3	9648.1	1590.0
16	80	1272.6	1272.3	1213.1	1153.8	840.1	2125.5	2165.9	8138.5	8351.5	1590.0
18	90	1264.1	1263.9	1205.0	1146.1	840.0	2103.1	2154.2	8138.5	8076.5	1590.0
20	100	1258.6	1258.3	1200.2	1142.0	846.4	2100.8	2152.3	8067.3	7801.6	1590.0
22	110	1260.8	1260.6	1204.5	1145.4	844.3	2075.1	2138.9	8067.3	7662.0	1590.0
24	120	1300.1	1299.9	1253.1	1221.5	843.7	2073.5	2137.4	4050.3	7581.8	1590.0
					BEGIN TRAILING EDGE REGION						
26	130	1273.2	1273.0	1220.7	1165.1	845.8	2094.1	2140.0	7974.3	7523.5	1590.0
28	140	1270.1	1269.9	1217.4	1160.6	847.6	2068.2	2138.9	8458.6	7466.8	1590.0
30	150	1294.4	1294.1	1247.3	1211.6	843.5	2024.9	2138.1	4720.6	7409.3	1590.0
32	160	1288.7	1288.5	1240.8	1197.7	839.4	1944.1	2137.0	5961.3	7351.8	1590.0
34	170	1277.6	1277.4	1227.8	1178.4	831.4	1822.2	2134.6	7238.9	7294.3	1590.0
36	180	1266.0	1265.8	1225.5	1185.8	834.5	1815.3	2130.4	7251.0	7211.6	1590.0
38	190	1259.5	1259.2	1230.1	1200.4	838.3	1806.8	2125.0	7271.9	7079.3	1590.0
40	200	1277.4	1277.2	1262.9	1245.2	840.5	1800.0	2120.5	7325.1	6949.5	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.004730	24909.7	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003061	28269.0	0.002365	10775.0	0.083271	0.009055	0.000000	0.000000
4	20	0.001452	29808.3	0.005426	24236.4	0.163391	0.007953	0.000000	0.000000
6	30	0.000000	0.0	0.006878	30305.2	0.156820	0.007674	0.000000	0.000000
8	40	0.001022	29971.9	0.006878	29609.4	0.135801	0.007702	0.000000	0.000000
10	50	0.000000	0.0	0.007900	33765.4	0.145496	0.007542	0.000000	0.000000
12	60	0.001033	30281.8	0.007900	33644.8	0.146378	0.007547	0.000000	0.000000
14	70	0.000000	0.0	0.008933	38030.1	0.167144	0.007400	0.000000	0.000000
16	80	0.001047	30709.9	0.008933	38007.3	0.168110	0.007401	0.000000	0.000000
18	90	0.000000	0.0	0.009981	42569.0	0.189783	0.007268	0.000000	0.000000
20	100	0.001063	31181.3	0.009981	42537.6	0.190724	0.007269	0.000000	0.000000
22	110	0.000000	0.0	0.011044	47050.6	0.213397	0.007152	0.000000	0.000000
24	120	0.000000	0.0	0.011044	45953.3	0.213708	0.007179	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
26	130	0.000000	0.0	0.020251	72555.5	0.180594	0.026351	0.000000	0.000000
28	140	0.000000	0.0	0.020251	81745.5	0.224836	0.025334	0.000000	0.000000
30	150	0.000000	0.0	0.020251	82095.9	0.286637	0.006543	0.000000	0.000000
32	160	0.000000	0.0	0.020251	84374.9	0.378697	0.006514	0.000000	0.000000
34	170	0.000000	0.0	0.020251	86371.3	0.491695	0.006490	0.000000	0.000000
36	180	0.000000	0.0	0.020251	86088.0	0.494523	0.006493	0.000000	0.000000
38	190	0.000000	0.0	0.020251	85596.4	0.498083	0.006499	0.000000	0.000000
40	200	0.000000	0.0	0.020251	84358.9	0.500939	0.006514	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1265.6 K, MID-WALL T = 1210.2 K, COOLANT H = 8127.6 WATTS/M**2/K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1309.3 AT STATION 41, 1208.0 AT STATION 13
SUCTION SIDE: 1300.1 AT STATION 24, 1258.6 AT STATION 20

TABLE IV. - Continued.

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 2 ARE:

PIM = 2811.90 KPA,

TOG = 820.35 K

TIME = 5.00 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 2, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 4 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1326.4	1326.0	1231.2	1114.5	820.3	2331.5	2331.5	23086.2	11973.0	1670.0
3	15	1306.8	1306.4	1219.8	1108.5	826.5	2307.6	2319.4	20790.7	10424.9	1670.0
5	25	1306.7	1306.4	1236.9	1174.0	817.5	2258.7	2286.7	8820.6	8809.2	1670.0
7	35	1275.0	1274.7	1210.5	1147.4	822.7	2240.3	2277.1	8820.6	7560.1	1670.0
9	45	1258.8	1258.5	1194.9	1134.1	830.3	2238.6	2275.9	8705.5	7046.4	1670.0
11	55	1247.8	1247.5	1184.5	1124.7	831.8	2217.3	2264.8	8705.5	6724.2	1670.0
13	65	1241.6	1241.3	1179.0	1120.1	837.8	2215.5	2263.4	8612.2	6531.9	1670.0
15	75	1242.4	1242.1	1179.7	1120.9	837.3	2190.8	2250.7	8612.2	6548.5	1670.0
17	85	1247.1	1246.8	1185.6	1130.2	841.6	2189.0	2249.3	7865.7	6565.1	1670.0
19	95	1250.7	1250.4	1189.9	1134.0	840.4	2162.4	2235.6	7865.7	6581.6	1670.0
21	105	1257.8	1257.5	1197.0	1139.1	844.5	2160.3	2233.9	8146.7	6704.7	1670.0
23	115	1270.4	1270.2	1211.0	1151.7	842.0	2129.3	2218.2	8146.7	6832.4	1670.0
25	125	1300.4	1300.1	1246.2	1208.6	842.1	2127.8	2216.8	4916.2	6963.8	1670.0
					BEGIN TRAILING EDGE REGION						
27	135	1291.4	1291.2	1234.5	1177.3	857.3	2146.4	2199.0	8422.2	7082.4	1670.0
29	145	1299.6	1299.3	1242.3	1182.2	859.0	2116.8	2197.8	8935.5	7358.4	1670.0
31	155	1333.7	1333.5	1281.3	1242.4	854.3	2066.9	2197.0	5031.4	7658.4	1670.0
33	165	1339.0	1338.8	1285.3	1237.8	849.1	1972.7	2195.7	6362.4	7976.1	1670.0
35	175	1335.7	1335.4	1279.1	1224.1	839.0	1826.7	2193.2	7730.9	9293.5	1670.0
37	185	1328.9	1328.6	1282.5	1237.7	842.1	1818.4	2188.3	7750.9	8462.6	1670.0
39	195	1329.2	1328.9	1295.1	1261.2	845.9	1808.0	2182.2	7783.1	8635.4	1670.0
41	205	1350.7	1350.5	1334.2	1313.9	848.0	1800.0	2177.1	7846.9	8463.7	1670.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005090	26573.8	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003292	30000.2	0.002545	11456.8	0.087432	0.008966	0.000000	0.000000
5	25	0.000805	23283.4	0.005837	25322.3	0.135950	0.007898	0.000000	0.000000
7	35	0.000000	0.0	0.006642	29009.3	0.156417	0.007728	0.000000	0.000000
9	45	0.000815	23582.9	0.006642	29062.1	0.157242	0.007726	0.000000	0.000000
11	55	0.000000	0.0	0.007457	32711.9	0.178374	0.007581	0.000000	0.000000
13	65	0.000827	23913.6	0.007457	32697.3	0.179162	0.007581	0.000000	0.000000
15	75	0.000000	0.0	0.008283	36317.8	0.201213	0.007455	0.000000	0.000000
17	85	0.000787	24273.7	0.008283	36160.5	0.201929	0.007460	0.000000	0.000000
19	95	0.000000	0.0	0.009070	39561.2	0.223682	0.007354	0.000000	0.000000
21	105	0.000824	24642.4	0.009070	39445.7	0.224473	0.007357	0.000000	0.000000
23	115	0.000000	0.0	0.009894	42893.3	0.248095	0.007259	0.000000	0.000000
25	125	0.000000	0.0	0.009894	42134.1	0.248478	0.007280	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.021758	76900.9	0.190698	0.025850	0.000000	0.000000
29	145	0.000000	0.0	0.021758	86652.2	0.237739	0.024851	0.000000	0.000000
31	155	0.000000	0.0	0.021758	87082.6	0.303800	0.006483	0.000000	0.000000
33	165	0.000000	0.0	0.021758	89263.9	0.403526	0.006454	0.000000	0.000000
35	175	0.000000	0.0	0.021758	91270.6	0.529641	0.006428	0.000000	0.000000
37	185	0.000000	0.0	0.021758	90799.2	0.533114	0.006432	0.000000	0.000000
39	195	0.000000	0.0	0.021758	90043.4	0.537486	0.006438	0.000000	0.000000
41	205	0.000000	0.0	0.021758	88560.1	0.540921	0.006454	0.000000	0.000000

TABLE IV. - Continued.

SLICE NO. 2 SUCTION SIDE, TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1326.4	1326.0	1231.2	1114.5	820.3	2331.5	2331.5	23086.2	11973.0	1670.0
2	10	1302.6	1302.3	1217.8	1107.4	826.6	2307.6	2319.4	20790.7	9940.7	1670.0
4	20	1315.5	1315.1	1236.1	1153.9	819.2	2231.7	2276.2	12688.7	10147.3	1670.0
6	30	1305.5	1305.1	1229.2	1145.3	822.6	2214.2	2254.8	12688.7	9642.4	1670.0
8	40	1316.5	1316.2	1249.2	1183.8	829.8	2223.1	2253.6	8921.1	8893.5	1670.0
10	50	1317.4	1317.1	1251.9	1186.0	833.3	2208.2	2243.1	8921.1	8707.9	1670.0
12	60	1319.6	1319.3	1254.5	1189.1	842.0	2206.2	2241.5	8831.4	8712.8	1670.0
14	70	1319.0	1318.7	1254.2	1188.9	843.3	2184.3	2230.0	8831.4	8648.1	1670.0
16	80	1311.3	1311.0	1246.8	1182.6	851.6	2181.9	2228.1	8726.6	8351.5	1670.0
18	90	1302.2	1301.9	1238.1	1174.4	851.4	2156.4	2214.8	8726.6	8076.5	1670.0
20	100	1296.1	1295.8	1233.0	1170.0	858.2	2153.8	2212.7	8642.9	7801.5	1670.0
22	110	1298.9	1298.6	1238.0	1174.0	855.8	2124.5	2197.6	8642.9	7662.0	1670.0
24	120	1342.2	1341.9	1291.4	1257.1	855.0	2122.8	2195.9	4319.8	7581.8	1670.0
BEGIN TRAILING EDGE REGION											
26	130	1313.4	1313.2	1257.0	1197.2	857.3	2146.4	2199.0	8422.2	7523.5	1670.0
28	140	1310.1	1309.8	1253.4	1192.2	859.0	2116.8	2197.8	8935.5	7466.8	1670.0
30	150	1336.1	1335.9	1285.2	1246.5	854.3	2066.9	2197.0	5034.6	7409.3	1670.0
32	160	1329.5	1329.3	1277.8	1231.0	849.1	1972.7	2195.7	6355.8	7351.8	1670.0
34	170	1317.4	1317.1	1263.4	1210.0	839.0	1826.7	2193.2	7714.0	7294.3	1670.0
36	180	1304.1	1303.8	1260.2	1217.2	842.1	1818.4	2188.3	7726.5	7211.6	1670.0
38	190	1296.1	1295.9	1264.3	1232.1	845.9	1808.0	2182.2	7748.7	7079.3	1670.0
40	200	1315.6	1315.3	1299.8	1280.6	848.0	1800.0	2177.1	7808.3	6949.5	1670.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005090	26573.8	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003292	30000.2	0.002545	11460.8	0.087432	0.008966	0.000000	0.000000
4	20	0.001559	31577.8	0.005837	25762.1	0.172009	0.007876	0.000000	0.000000
6	30	0.000000	0.0	0.007396	32205.6	0.165161	0.007600	0.000000	0.000000
8	40	0.001097	31742.3	0.007396	31447.6	0.142990	0.007629	0.000000	0.000000
10	50	0.000000	0.0	0.008493	35849.2	0.153268	0.007470	0.000000	0.000000
12	60	0.001108	32055.5	0.008493	35716.2	0.154234	0.007475	0.000000	0.000000
14	70	0.000000	0.0	0.009601	40360.9	0.176243	0.007330	0.000000	0.000000
16	80	0.001123	32487.9	0.009601	40336.6	0.177306	0.007331	0.000000	0.000000
18	90	0.000000	0.0	0.010724	45172.8	0.200339	0.007199	0.000000	0.000000
20	100	0.001139	32962.4	0.010724	45139.5	0.201377	0.007200	0.000000	0.000000
22	110	0.000000	0.0	0.011864	49908.7	0.225546	0.007085	0.000000	0.000000
24	120	0.000000	0.0	0.011864	48657.5	0.225861	0.007114	0.000000	0.000000
BEGIN TRAILING EDGE REGION									
26	130	0.000000	0.0	0.021758	76900.9	0.190698	0.025850	0.000000	0.000000
28	140	0.000000	0.0	0.021758	86652.2	0.237739	0.024851	0.000000	0.000000
30	150	0.000000	0.0	0.021758	86972.6	0.303800	0.006483	0.000000	0.000000
32	160	0.000000	0.0	0.021758	89448.7	0.403526	0.006454	0.000000	0.000000
34	170	0.000000	0.0	0.021758	91670.4	0.529641	0.006428	0.000000	0.000000
36	180	0.000000	0.0	0.021758	91374.4	0.533114	0.006432	0.000000	0.000000
38	190	0.000000	0.0	0.021758	90849.3	0.537486	0.006438	0.000000	0.000000
40	200	0.000000	0.0	0.021758	89454.8	0.540921	0.006454	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1304.2 K, MID-WALL T = 1244.2 K, COOLANT H = 8679.8 WATTS/M**2/K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1350.7 AT STATION 41, 1241.6 AT STATION 13
SUCTION SIDE: 1342.2 AT STATION 24, 1296.1 AT STATION 20

TABLE IV. - Continued.

THE IMPINGEMENT PLENUM CONDITIONS FOR SLICE NO. 3 ARE:

PIM = 2944.04 KPA,

TOG = 830.25 K

TIME = 5.00 SEC., STEP SIZE = 0.250 SEC., WHEEL SPEED = 16800.0 RPM
SLICE NO. 3, FLOW SPLIT NO. 1, SPLIT AT STATION 1; FRACTION SPLIT TO SUCTION SIDE IS 0.5000 4 ITERATIONS
PRESSURE SIDE , TRAILING EDGE REGION BEGINS AT STATION- 27

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1282.2	1281.8	1192.8	1082.2	830.2	2402.1	2402.1	24369.5	11973.0	1590.0
3	15	1264.4	1264.1	1182.7	1078.2	834.5	2375.3	2388.6	21669.3	10424.9	1590.0
5	25	1262.6	1262.3	1196.7	1136.1	826.4	2320.2	2351.8	9353.0	9909.2	1590.0
7	35	1233.2	1232.9	1172.0	1111.7	830.8	2299.5	2341.1	9353.0	7560.1	1590.0
9	45	1218.3	1218.0	1157.9	1099.9	837.3	2297.8	2339.7	9224.0	7046.4	1590.0
11	55	1208.3	1208.1	1148.6	1091.7	838.4	2273.9	2327.4	9224.0	6724.2	1590.0
13	65	1202.9	1202.6	1143.8	1087.8	843.5	2272.1	2325.9	9117.3	6531.9	1590.0
15	75	1203.7	1203.5	1144.5	1088.5	842.8	2244.4	2311.8	9117.3	6549.5	1590.0
17	85	1207.8	1207.5	1149.8	1097.0	846.4	2242.5	2310.2	8325.7	6565.1	1590.0
19	95	1211.1	1210.8	1153.6	1100.3	845.1	2212.6	2294.9	8325.7	6581.6	1590.0
21	105	1217.8	1217.5	1160.1	1104.9	848.6	2210.4	2293.2	8610.7	6704.7	1590.0
23	115	1228.9	1228.6	1172.7	1116.0	846.0	2175.6	2275.6	8610.7	6832.4	1590.0
25	125	1256.6	1256.4	1205.4	1169.1	845.8	2174.0	2274.1	5156.0	6963.8	1590.0
				BEGIN TRAILING EDGE REGION							
27	135	1248.5	1248.3	1194.6	1140.2	859.9	2195.5	2254.4	8718.3	7082.4	1590.0
29	145	1255.6	1255.3	1201.2	1144.0	860.6	2162.4	2253.2	9251.3	7358.4	1590.0
31	155	1286.4	1286.1	1236.6	1198.9	855.1	2106.1	2252.4	5271.1	7658.4	1590.0
33	165	1290.8	1290.5	1239.7	1193.8	848.4	1999.0	2251.2	6662.9	7976.1	1590.0
35	175	1287.7	1287.4	1233.7	1180.7	835.2	1828.8	2248.9	8092.2	8293.5	1590.0
37	185	1280.6	1280.3	1236.2	1193.0	837.8	1819.9	2243.7	8111.2	8462.6	1590.0
39	195	1279.6	1279.3	1246.8	1214.1	840.8	1808.7	2237.2	8141.9	8635.4	1590.0
41	205	1298.3	1298.0	1282.2	1262.5	842.4	1800.0	2231.9	9204.5	8463.7	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005449	28214.0	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
3	15	0.003522	32395.1	0.002724	12353.5	0.091341	0.008859	0.000000	0.000000
5	25	0.000860	25111.4	0.006246	27349.1	0.142340	0.007801	0.000000	0.000000
7	35	0.000000	0.0	0.007106	31314.4	0.163781	0.007634	0.000000	0.000000
9	45	0.000870	25417.7	0.007106	31367.4	0.164532	0.007632	0.000000	0.000000
11	55	0.000000	0.0	0.007977	35290.9	0.186725	0.007489	0.000000	0.000000
13	65	0.000882	25754.9	0.007977	35276.9	0.187445	0.007490	0.000000	0.000000
15	75	0.000000	0.0	0.008859	39176.4	0.210660	0.007365	0.000000	0.000000
17	85	0.000839	26121.4	0.008859	39025.1	0.211321	0.007370	0.000000	0.000000
19	95	0.000000	0.0	0.009697	42691.3	0.234281	0.007265	0.000000	0.000000
21	105	0.000878	26494.6	0.009697	42580.7	0.235018	0.007268	0.000000	0.000000
23	115	0.000000	0.0	0.010575	46308.9	0.260043	0.007171	0.000000	0.000000
25	125	0.000000	0.0	0.010575	45540.0	0.260386	0.007190	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
27	135	0.000000	0.0	0.023250	83124.6	0.199413	0.025194	0.000000	0.000000
29	145	0.000000	0.0	0.023250	93691.0	0.248800	0.024219	0.000000	0.000000
31	155	0.000000	0.0	0.023250	94281.5	0.318570	0.006401	0.000000	0.000000
33	165	0.000000	0.0	0.023250	96712.3	0.425091	0.006372	0.000000	0.000000
35	175	0.000000	0.0	0.023250	98971.3	0.563677	0.006346	0.000000	0.000000
37	185	0.000000	0.0	0.023250	98512.8	0.567365	0.006349	0.000000	0.000000
39	195	0.000000	0.0	0.023250	97775.3	0.572029	0.006354	0.000000	0.000000
41	205	0.000000	0.0	0.023250	96282.2	0.575671	0.006369	0.000000	0.000000

TABLE IV. - Concluded.

SLICE NO. 3 SUCTION SIDE , TRAILING EDGE REGION BEGINS AT STATION- 26

STATION NUMBER	COOLANT NODE NO	OUTSIDE T (K)	INTERFACE T (K)	MID-WALL T (K)	INSIDE T (K)	COOLANT T (K)	STATIC P (KPA)	TOTAL P (KPA)	HC W/M**2/K	HG W/M**2/K	TG (K)
1	5	1282.2	1281.8	1192.8	1082.2	830.2	2402.1	2402.1	24369.5	11973.0	1590.0
2	10	1260.6	1260.2	1181.0	1077.3	834.6	2375.3	2388.6	21669.3	9940.7	1590.0
4	20	1271.3	1270.9	1196.4	1118.0	827.5	2289.7	2339.9	13368.1	10147.3	1590.0
6	30	1261.5	1261.2	1189.5	1109.7	830.6	2270.1	2315.9	13368.1	9642.4	1590.0
8	40	1270.6	1270.3	1206.8	1144.0	836.8	2280.3	2314.6	9449.4	9893.5	1590.0
10	50	1271.1	1270.8	1208.8	1145.5	839.9	2263.7	2302.9	9449.4	9707.9	1590.0
12	60	1273.4	1273.1	1211.4	1148.6	847.2	2261.6	2301.2	9348.0	9712.8	1590.0
14	70	1272.8	1272.5	1211.0	1148.4	848.1	2237.1	2288.4	9348.0	9649.1	1590.0
16	80	1265.6	1265.3	1204.5	1142.8	855.3	2234.7	2286.4	9228.3	9351.5	1590.0
18	90	1257.6	1257.4	1196.8	1135.7	854.8	2206.1	2271.6	9228.3	9076.5	1590.0
20	100	1252.2	1251.9	1192.2	1132.0	860.6	2203.5	2269.5	9129.8	7901.6	1590.0
22	110	1254.5	1254.2	1196.7	1135.4	858.3	2170.6	2252.6	9129.8	7662.0	1590.0
24	120	1294.6	1294.3	1246.4	1213.1	857.1	2168.9	2250.8	4525.5	7591.9	1590.0
					BEGIN TRAILING EDGE REGION						
26	130	1268.3	1268.0	1214.8	1157.8	859.9	2195.5	2254.4	8718.3	7523.5	1590.0
28	140	1265.0	1264.8	1211.2	1152.9	860.6	2162.4	2253.2	9251.3	7466.9	1590.0
30	150	1288.6	1288.3	1240.3	1202.8	855.1	2105.1	2252.4	5274.2	7409.3	1590.0
32	160	1282.4	1282.1	1233.1	1188.0	848.4	1999.0	2251.2	6656.8	7351.9	1590.0
34	170	1270.7	1270.5	1219.4	1168.1	835.2	1828.8	2248.9	8075.9	7294.3	1590.0
36	180	1258.0	1257.7	1216.1	1174.8	837.8	1819.9	2243.7	8087.8	7211.6	1590.0
38	190	1249.7	1249.4	1219.1	1188.2	840.8	1808.7	2237.2	8108.9	7079.3	1590.0
40	200	1266.1	1265.8	1250.9	1232.3	842.4	1800.0	2231.9	8166.8	6349.5	1590.0

STATION NUMBER	COOLANT NODE NO	IMP. FLOW (KG/SEC)	RE-NO. JET	CROSSFLOW (KG/SEC)	RE-NO. CROSSFLOW	MACH NO., CROSSFLOW	FRICTION FACTOR	FILM FLOW (KG/SEC)	EFFECTIVENESS
1	5	0.005449	28214.0	0.000000	0.0	0.000000	0.000000	0.000000	0.000000
2	10	0.003522	32395.1	0.002724	12356.7	0.091343	0.008858	0.000000	0.000000
4	20	0.001665	34034.1	0.006246	27812.8	0.180249	0.007780	0.000000	0.000000
6	30	0.000000	0.0	0.007911	34754.8	0.173082	0.007508	0.000000	0.000000
8	40	0.001171	34198.9	0.007911	33988.0	0.149675	0.007534	0.000000	0.000000
10	50	0.000000	0.0	0.009082	38747.9	0.160430	0.007378	0.000000	0.000000
12	60	0.001182	34515.3	0.009082	38619.8	0.161310	0.007382	0.000000	0.000000
14	70	0.000000	0.0	0.010264	43635.4	0.184403	0.007239	0.000000	0.000000
16	80	0.001197	34952.0	0.010264	43613.7	0.185380	0.007240	0.000000	0.000000
18	90	0.000000	0.0	0.011461	48816.0	0.209602	0.007110	0.000000	0.000000
20	100	0.001213	35429.3	0.011461	48784.6	0.210566	0.007111	0.000000	0.000000
22	110	0.000000	0.0	0.012675	53929.3	0.236067	0.006998	0.000000	0.000000
24	120	0.000000	0.0	0.012675	52654.9	0.236340	0.007025	0.000000	0.000000
				BEGIN TRAILING EDGE REGION					
26	130	0.000000	0.0	0.023250	83124.6	0.199413	0.025194	0.000000	0.000000
28	140	0.000000	0.0	0.023250	93691.0	0.248800	0.024219	0.000000	0.000000
30	150	0.000000	0.0	0.023250	94169.9	0.318570	0.006401	0.000000	0.000000
32	160	0.000000	0.0	0.023250	96888.1	0.425091	0.006372	0.000000	0.000000
34	170	0.000000	0.0	0.023250	99365.6	0.563677	0.006346	0.000000	0.000000
36	180	0.000000	0.0	0.023250	99077.3	0.567365	0.006349	0.000000	0.000000
38	190	0.000000	0.0	0.023250	98568.3	0.572029	0.006354	0.000000	0.000000
40	200	0.000000	0.0	0.023250	97178.7	0.575671	0.006369	0.000000	0.000000

OVERALL AREA WEIGHTED AVERAGES--OUTSIDE T = 1259.5 K, MID-WALL T = 1202.6 K, COOLANT H = 9123.9 WATTS/M**2/K

TIME = 5.000 SEC., OVERALL BULK METAL TEMPERATURE = 1219.0 K

EXTREMES OF OUTER SURFACE TEMPERATURES (K)
PRESSURE SIDE: 1298.3 AT STATION 41, 1202.9 AT STATION 13
SUCTION SIDE: 1294.6 AT STATION 24, 1249.7 AT STATION 38

AMOUNT OF COOLANT ACTUALLY USED AT THIS TIME STEP IS 234.9 KG/HR

---

3 LOOP(S) ON INITIAL COOLANT FLOW WERE USED. FINAL VALUE IS 234.97 KG/HR
RESIDUAL COOLING AIR FLOW IS 0.0385 KG/HR

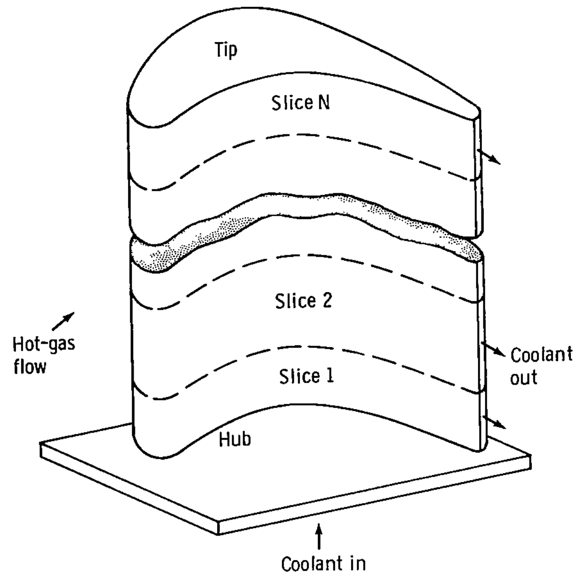

Figure 1. - Overall division of blade into slices.

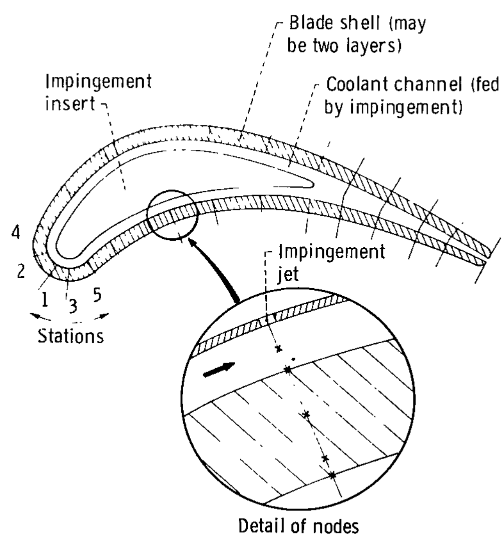

Figure 2. - Blade geometric model.

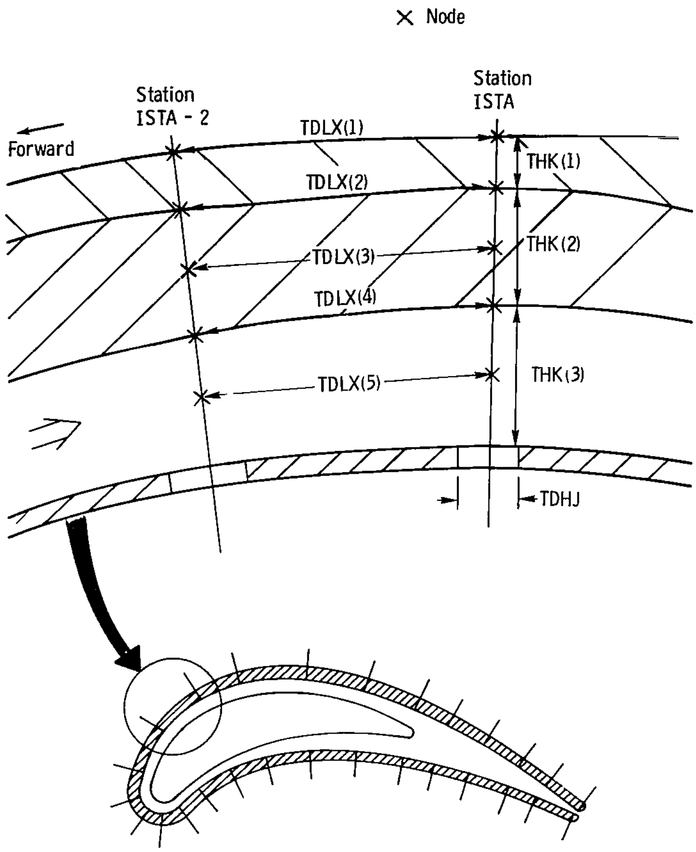

Figure 3. - Schematic geometric input variables. (SPAN and TXN are perpendicular to this plane.)

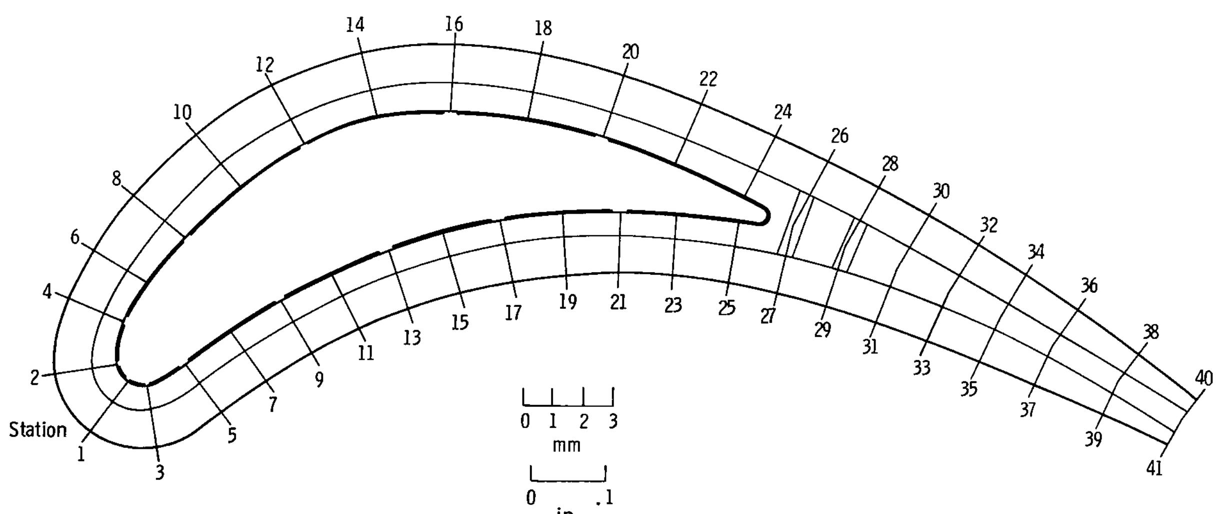

Figure 4. - Cross section of sample problem blade.

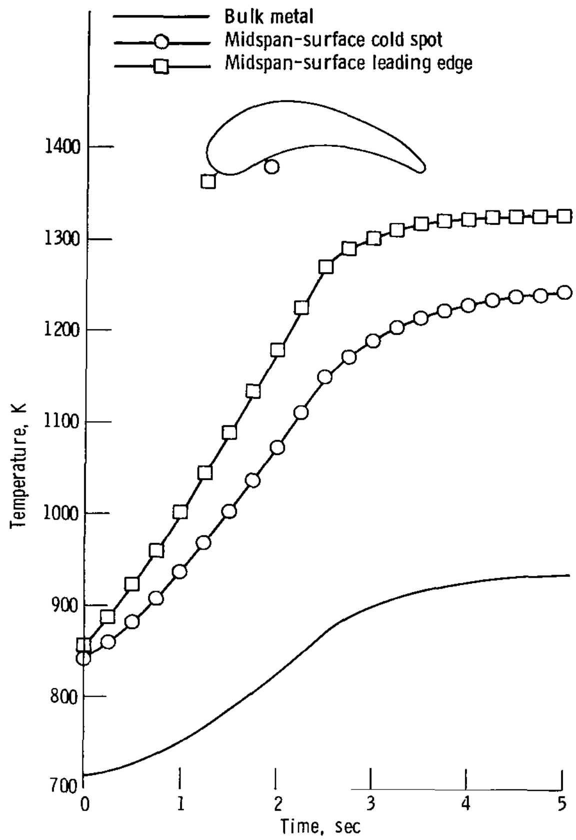

Figure 5. - Temperature histories for transient sample problem.

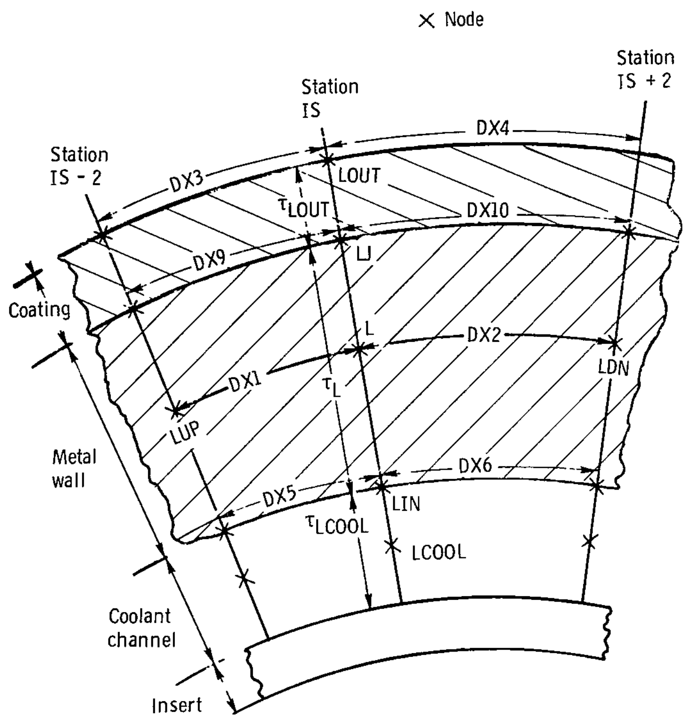

Figure 6. - Layout and nomenclature of nodal system, where S_i is the spanwise dimension, normal to the paper.

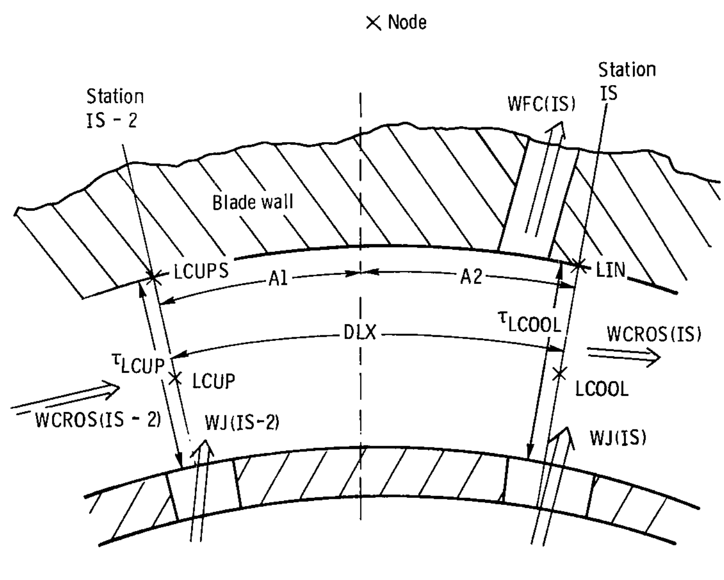

Figure 7. - Coolant-channel control volume and nomenclature.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TP-1271		
4. Title and Subtitle TACT1, A COMPUTER PROGRAM FOR THE TRANSIENT THERMAL ANALYSIS OF A COOLED TURBINE BLADE OR VANE EQUIPPED WITH A COOLANT INSERT I - USERS MANUAL		5. Report Date August 1978
		6. Performing Organization Code
7. Author(s) Raymond E. Gaugler		8. Performing Organization Report No. E-9554
		10. Work Unit No. 505-04
9. Performing Organization Name and Address National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio 44135		11. Contract or Grant No.
		13. Type of Report and Period Covered Technical Paper
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

A computer program to calculate transient and steady-state temperatures, pressures, and coolant flows in a cooled, axial-flow turbine blade or vane with an impingement insert is described. Coolant-side heat-transfer coefficients are calculated internally in the program, with the user specifying either impingement or convection heat transfer at each internal flow station. Spent impingement air flows in a chordwise direction and is discharged through the trailing edge and through film-cooling holes. The ability of the program to handle film cooling is limited by the internal flow model. Sample problems, with tables of input and output, are included in the report. Input to the program includes a description of the blade geometry, coolant-supply conditions, outside thermal boundary conditions, and wheel speed. The blade wall can have two layers of different materials, such as a ceramic thermal-barrier coating over a metallic substrate. Program output includes the temperature at each node, the coolant pressures and flow rates, and the inside heat-transfer coefficients.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Heat transfer; Turbine cooling; Computer program; Impingement cooling	Unclassified - unlimited STAR Category 34

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	76	A05

* For sale by the National Technical Information Service, Springfield, Virginia 22161

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