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TWO-PHASE CRITICAL FLOW WITH APPLICATION TO LIQUID-METAL SYSTEMS (MERCURY, CESIUM, RUBIDIUM, POTASSIUM, SODIUM, AND LITHIUM)

by

Hans K. Fauske

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TWO-PHASE CRITICAL FLOW WITH APPLICATION TO LIQUID-METAL SYSTEMS
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Reactor Engineering Division, ANL
and
Associated Midwest Universities

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ABSTRACT

Existing data and models for critical two-phase flow of steam-water mixtures are examined. One model in particular shows considerable success in predicting the phenomena of critical flow. A Fortran program for an IBM-704 digital computer, for the application of this model to predict void fraction, slip ratio, and critical flow rates to the flashing flow for various liquid-vapor metal systems in pipes when the conditions are such that critical flow may be experienced, was developed. Calculations have been made for the following liquid-metal systems: mercury (temperature range, 450-1600°F), cesium (temperature range, 500-2300°F), rubidium (temperature range, 500-2300°F), potassium (temperature range, 900-2500°F), sodium (temperature range, 950-2500°F), and lithium (temperature range, 2000-3500°F). The vapor fraction or quality ranges from 0 to 100%.

It is shown that the critical flow rates for liquid-metal systems calculated from the best model describing steam-water data are considerably higher in the low-quality region than predicted from a so-called "homogeneous flow model." This is explained by the large slippage between the liquid and the vapor phases, because the ratio of the densities of the liquid state to the vapor state is usually large for metallic fluids.

I. INTRODUCTION

Although steam-water systems have been utilized for a long time as a coolant, the higher heat fluxes experienced in current reactors, missiles, rockets, and space applications require the use of coolants with more attractive thermodynamic properties than water. For this reason the problems of two-phase flow and of heat transfer to liquid metals have recently received a great deal of attention. Although considerable critical flow data are available for water, no data exist for liquid metals. Extrapolation of a correlation built up of experimental parameters based primarily on water is dangerous because the physical properties of liquid metals differ markedly from those of water. Particularly striking for a given temperature is the occurrence of extremely high liquid-to-gas density ratios for liquid metals. However, one would be on much safer ground to utilize a model or theory with no experimental constants that explain steam-water data in order to estimate critical flow rates for liquid-vapor metal systems.

In the present report the best available theory is utilized to calculate void fractions, slip ratios, and flow rates for liquid-vapor metal systems in pipes under critical flow conditions. It is postulated that the mechanism causing critical flow for a liquid-vapor metal system is the same as for a steam-water system. Therefore, the only apparent dissimilarity between the two systems is the respective physical properties.

In the two sections that follow, existing data and models for critical two-phase flow of steam water are summarized.

II. EXISTING DATA FOR STEAM-WATER CRITICAL FLOW IN PIPES

The primary purpose of this section is to summarize the present available data sources for one-component, two-phase critical flow of water in constant-area tubes. Only works which have specifically treated the phenomenon of critical flow will be mentioned.

Data of Isbin *et al.*

Isbin *et al.*[1] in 1957 reported on the results of one of the first non-classified studies undertaken explicitly to measure critical flows of steam-water mixtures over a wide range of qualities. Critical exit pressures from 4 to 43 psia were obtained, and the quality ranged from saturated vapor to 1 w/o vapor. Discharges were measured from $\frac{1}{4}$-, $\frac{1}{2}$-, $\frac{3}{4}$-, and 1-in. pipes and from annuli of intermediate cross-sectional areas. The experimental mass flow rates were found always to be greater than the values calculated on the basis of a homogeneous-flow model, discussed in the section that follows. Several empirical methods for correlating the data were determined, and comparisons were presented of the predictions of several semi-analytical flow models. All of these models showed substantial deviations from the measured flow rates at small qualities (less than 20%).

Faletti's Data

In 1959, Faletti[2] presented one of the most extensive studies carried out on two-phase, one-component critical flow. The flow of steam-water mixtures was studied in concentric annuli having center rods of 0.187- and 0.375-in. OD. Critical throat pressures ranged from 26 to 106 psia, and qualities ranged from 0.1 to 97.5%. The data were correlated by plotting the ratio of the observed mass velocity to the theoretical mass velocity (homogeneous equilibrium theory) versus the quality. This is the same approach as was used by Isbin. Also, Faletti found his measured flow rates to be considerably higher than predicted from the homogeneous-flow theory. This work was recently and excellently summarized by Faletti and Moulton.[3]

Fauske's Data

In 1961, Fauske[4] presented critical-flow data at considerably higher pressures than previously reported. Critical two-phase, steam-water flows were measured over a range of quality from 0.01 to 1.0, total flows from 500 to 4200 lb/sec-ft^2, pressures from 40 to 360 psia, and with pipe diameters of 0.125-, 0.269-, and 0.5-in. ID. A theory was developed for the two-phase, critical-flow phenomenon, and extensive comparisons of predicted with experimental values showed substantial agreement. This theory will be derived in the section that follows. Details of this work are reported elsewhere.[5]

Zaloudek's Data

Also in 1961 Zaloudek[6] presented his data on two-phase critical flow in pipes. Experiments were limited to circular full-bore cross sections of 0.520- and 0.625-in. diameter, and lengths up to 4 ft. Test-section exit qualities from 0.4 to 99% and critical mass velocities between 10^2 and 10^3 lb/sec-ft^2 were investigated. Corresponding critical pressures ranged from 40 to 110 psia. The results obtained were correlated by employing the conventional technique of comparing results with theoretical predictions of the homogeneous-flow model. Also in this investigation the measured flow rates were considerably higher than predicted from the homogeneous-flow theory.

James' Data

In 1962, James[7] presented critical-flow data at considerably larger pipe sizes than previously reported. Steam and steam-water flashing flow were used to obtain critical discharge pressures for pipes over the stagnation enthalpy range from 230 to 1200 Btu/lb and for the critical pressure range from 14 to 64 psia. Pipes used were 3, 6, and 8 in. in diameter. A method similar to that of Isbin et al.[1] was used to correlate the data.

For experimental details and procedures of these works, the reader is referred to the respective reference. In the section that follows various flow models are derived and compared with the above-mentioned data.

The following major conclusions can be extracted from these works briefly summarized above:

1. Each set of experimental data seems to agree fairly well with the others. No irregularities appear, although experimental techniques are not always the same.

2. No geometry or upstream-mixing effects appear. Hence, for the geometries examined, the critical-flow phenomenon can be described by the local conditions at the exit of the test section only.

3. In all cases the measured critical-flow rates were higher than values calculated from the homogeneous-flow model, particularly in the low-quality region.

4. A theoretical model has been developed that satisfactorily describes the above-mentioned data (see next section).

III. MODELS OF CRITICAL TWO-PHASE FLOW

Before discussing individual flow models, the basic equations of change governing a two-phase flow system will be written:

$$\frac{\partial}{\partial t}\left(\sum_{i=1}^{2} \alpha_i \rho_i\right) + \frac{\partial}{\partial x}\left(\sum_{i=1}^{2} \alpha_i \rho_i \bar{u}_i\right) = 0 \quad ; \tag{1}$$

$$\frac{\partial}{\partial t}\left(\sum_{i=1}^{2} \alpha_i \rho_i \bar{u}_i\right) + \frac{\partial}{\partial x}\left(\sum_{i=1}^{2} \alpha_i \rho_i \bar{u}_i^2\right) + \frac{\partial p}{\partial x} + \frac{\partial \tau_2}{\partial x} + \sum_{i=1}^{2} \alpha_i \rho_i g = 0 \quad , \tag{2}$$

where $\bar{u}_i$ is the average velocity of the i^{th} phase in the x direction.

Equations (1) and (2) will now be utilized to derive various simplified models.

A. Homogeneous-flow Model

In this theory, the momentum and continuity equations are applied to a homogeneous mixture in which the average velocities of liquid and steam are equal. Furthermore, steady-state flow is assumed, and the critical-flow condition is defined under the restraints that the change in mass flow rate with respect to the pressure is zero at constant entropy. Under these conditions, Eqs. (1) and (2) reduce to the following equations which define the critical mass flow rate:

$$G^2 = -g_c \left(\frac{dp}{dv}\right)_s \quad ; \tag{3}$$

$$v = v_f + v_{fg}\chi \quad . \tag{4}$$

B. Annular-flow Model

An annular-flow pattern is assumed with an average liquid velocity in the annulus and an average steam velocity in the core, but different in magnitude. The process is considered isentropic with both phases in equilibrium. Under these conditions, Eqs. (1) and (2) reduce to the following equations, which define the critical mass flow rate:

$$G^2 = -g_c \left(\frac{dp}{dv}\right)_s \quad ; \tag{5}$$

$$v = \frac{\chi^2 v_g}{\alpha_g} + \frac{(1-\chi)^2 v_f}{1-\alpha_g} \quad . \tag{6}$$

The unknown quantity introduced here, the void fraction α, has indeed never been measured for steam-water systems under critical-flow conditions. It has, therefore, been the practice to utilize void-fraction correlations obtained under restricted flow conditions where normally the velocities are much smaller than pertaining to critical flow. Two of the most frequently used void-fraction correlations will be quoted here.

1. Modified Martinelli Data for Void Fraction

The Martinelli values of void fraction were modified and fitted to a curve at the Bettis Atomic Power Laboratory, Westinghouse Electric Corporation.[8]

2. Modified Armand Formula for Void Fraction

The Armand formula for void fraction, modified at the Hanford Atomic Products Operation, General Electric,[9] is as follows:

$$\alpha_g = \frac{(0.833 + 0.167\chi)\chi v_g}{(1-\chi)v_f + \chi v_g} \quad . \tag{7}$$

The incorporation of these two void-fraction correlations with Eqs. (5) and (6) renders two possible solutions for the critical-flow rate.

3. Fauske Model

The following assumptions are made in the development of the model (for a more detailed discussion, see Ref. 5):

a. An average velocity exists for each phase and is different in magnitude for each phase.

b. The vapor and liquid are in equilibrium throughout the flow path.

c. Critical flow is attained when the flow rate no longer increases with decreasing static pressure:

$$\frac{dG}{dp} = 0 \quad . \tag{8}$$

d. The pressure gradient attains a finite, maximum value for a given flow rate and quality:

$$\left|\frac{dp}{dx}\right|_{G,\chi} = \{Max\}_{Finite} \quad . \tag{9}$$

In a two-phase flow system, the pressure drop becomes a function of slip ratio besides the usual variables occurring in single-phase flow. From Eq. (9) it can be seen that all system variables are fixed except the void fraction α. The void fraction is, in other words, one extra degree of freedom in the two-phase system. If isentropic flow is assumed for these conditions, the maximization of the flow rate is achieved by varying the void fraction α:

$$\frac{\partial}{\partial \alpha_g}\left[\left\{\begin{matrix}\text{Rate of momentum}\\ \text{gain by convection}\end{matrix}\right\}\right] = 0 \quad . \tag{10}$$

Under these conditions Eqs. (1) and (2) reduce to the following equations defining the critical mass flow rate:

$$G^2 = -g_c \left(\frac{dp}{dv}\right)_s \quad ; \tag{11}$$

$$v = \frac{\chi^2 v_g}{\alpha_g} + \frac{(1-\chi)^2 v_f}{1-\alpha_g} \quad ; \tag{12}$$

$$\alpha_g = \left[\frac{1-\chi}{\chi}\left(\frac{v_f}{v_g}\right)^{1/2} + 1\right]^{-1} \quad . \tag{13}$$

IV. COMPARISON OF FLOW MODELS AND EXPERIMENTAL DATA FOR CRITICAL FLOW OF STEAM-WATER

Due to the extremely steep pressure gradients prevailing under critical-flow conditions, one would expect slip to occur between the liquid and vapor phases, even more so for liquid-metal than for steam-water systems. It is, therefore, to be expected that models including slip will yield results closer to the experimental findings than obtained from the homogeneous-flow model. Since void-fraction measurements have not been carried out for critical flow, various void-fraction correlations for restricted steam-water flow have been utilized. To extrapolate these to liquid-metal systems may be dangerous. A theoretical relationship for the void fraction under critical-flow conditions has been developed in the Fauske model. Because of its theoretical derivation, there appears to be no reason why this relationship should not hold for liquid-metal systems.

Nahavandi and Rashevsky,[10] in describing the loss-of-coolant accident in a nuclear reactor, compared the same flow models as described in this report. Figures 1, 2, and 3 are reproduced from their report and illustrate their conclusions as quoted below:

1. The Fauske theory yields consistent results over a wide range of pressures and steam qualities encountered in the two-phase steam-water region.

2. The annular-flow theory with modified Martinelli or Armand void fractions is in good agreement with the Fauske theory for steam qualities above 10%. At lower steam qualities, the calculated values of mass flow velocities by this theory become inconsistent and are not dependable. This discontinuity is caused by the inaccuracies of modified Martinelli and Armand void fractions at low steam qualities.

3. The homogeneous-model theory does not agree generally with the other theories except at very high steam qualities.

4. The Fauske theory appears to be the best choice for the prediction of critical flow discharge of steam-water mixtures. On the basis of this theory, a critical flow chart has been prepared.

In Fig. 4 the critical-flow solutions for the Fauske model are shown for a pressure range from 20 psia to the critical pressure, and for qualities from 0.01 to 1.0. In Fig. 5, 6, 7, 8, 9, and 10 comparisons between the Fauske model and the previously discussed data are shown. Particularly encouraging is the good agreement with the New Zealand data, which were obtained with the use of considerably larger pipe sizes than had been previously reported in the literature.

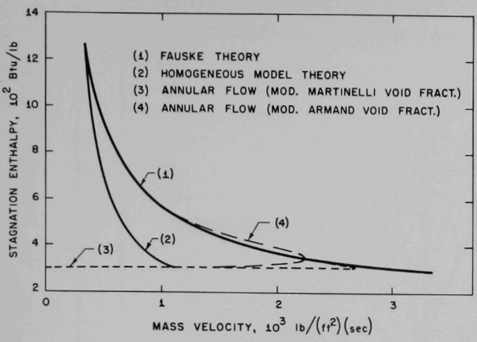


Fig. 1

Comparison between Various Two-phase Critical Flow Models at 100 psia (taken from Ref. 10)

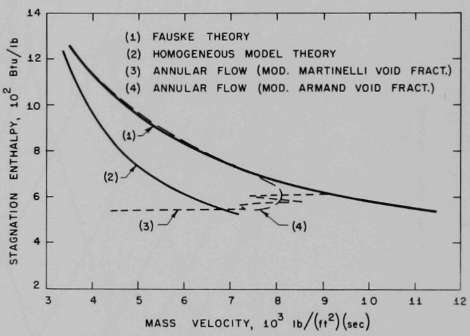


Fig. 2

Comparison between Various Two-phase Critical Flow Models at 1000 psia (taken from Ref. 10)

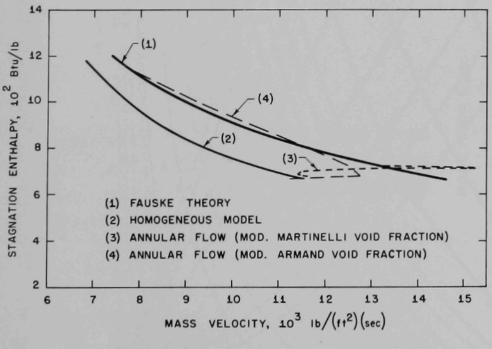
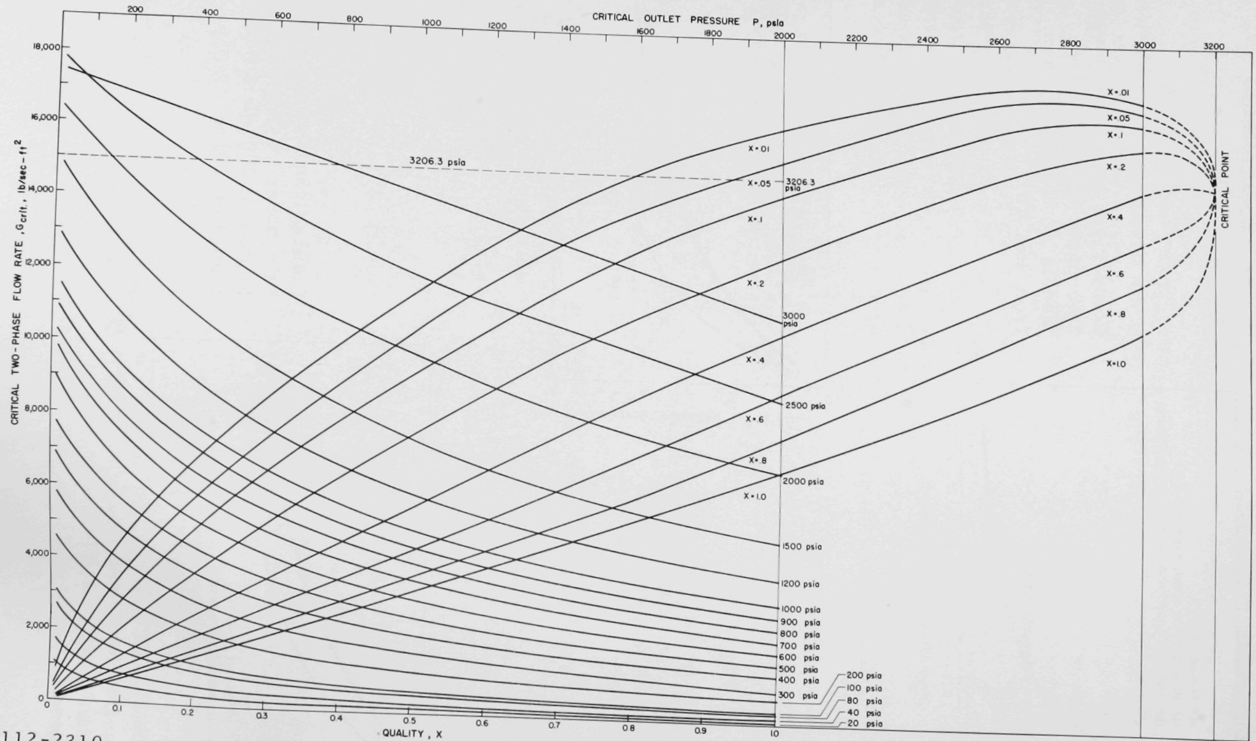


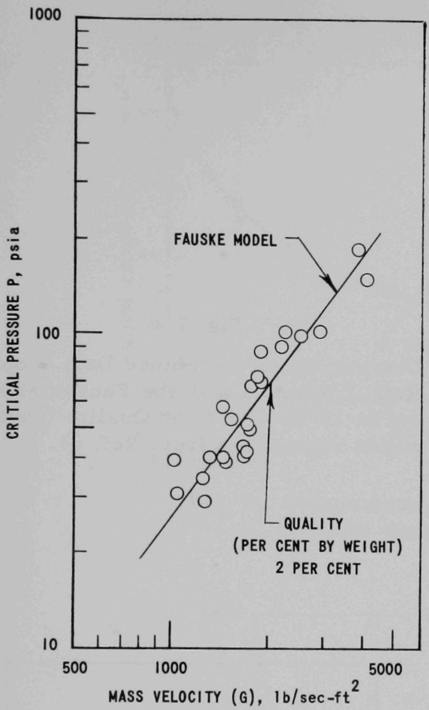
Fig. 3

Comparison between Various Two-phase Critical Flow Models at 2000 psia (taken from Ref. 10)



112-2310

Fig. 4. Theoretical Predictions of Critical-flow Rates for Steam-Water from the Fauske Theory



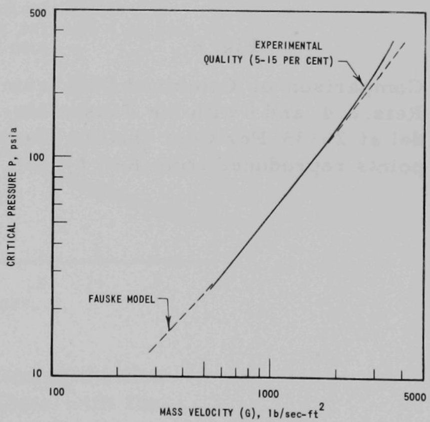
112-2168

Fig. 5

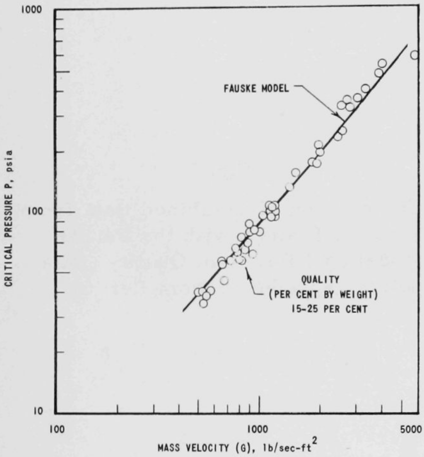
Comparison of Combined Data from Refs. 2, 4, and 6 with the Fauske Model at 2 Per Cent Quality (Data points reproduced from Ref. 6)

Fig. 6

Comparison of Combined Data from Refs. 2, 4, and 6 with the Fauske Model at 5-15 Per Cent Quality (Reproduced from Ref. 6)



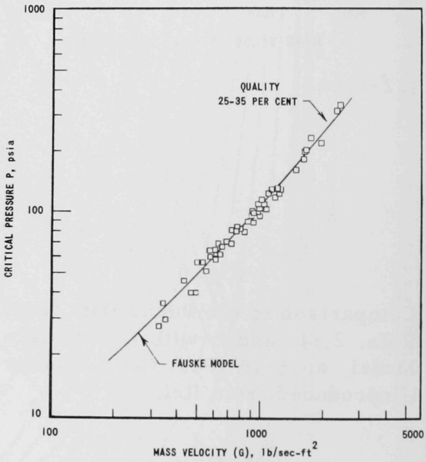
112-2169



112-2163

Fig. 7

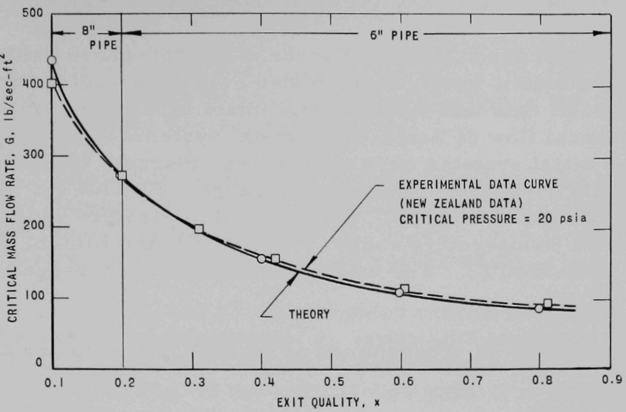
Comparison of Combined Data from Refs. 2, 4, and 6 with the Fauske Model at 15-25 Per Cent Quality (Data points reproduced from Ref. 6)



112-2166

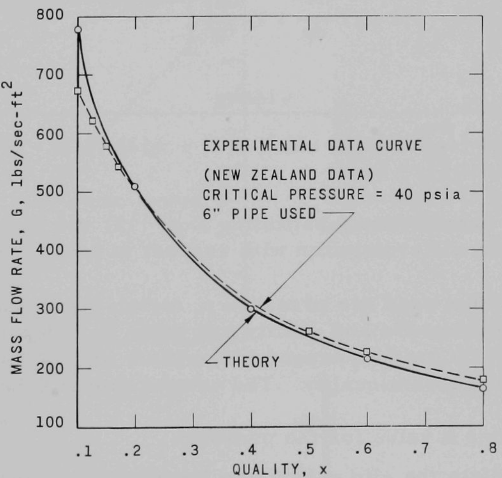
Fig. 8

Comparison of Combined Data from Refs. 2, 4, and 6 with the Fauske Model at 25-35 Per Cent Quality (Data points reproduced from Ref. 6)



112-2173

Fig. 9. Comparison of the New Zealand Data with the Fauske Model at 20 psia



112-2164

Fig. 10. Comparison of the New Zealand Data with the Fauske Model at 40 psia

V. APPLICATION TO LIQUID-METAL SYSTEMS

Theoretical predictions by Fauske of the two-phase critical-flow phenomenon for steam-water, have yielded such encouraging agreement with experimental data that it seems legitimate to make a similar application to the critical flow of liquid-vapor metal systems in pipes. The following liquid-metal systems were considered: mercury (temperature range, 450-1600°F), cesium (temperature range, 500-2300°F), rubidium (temperature range, 500-2300°F), potassium (temperature range, 900-2500°F), sodium (temperature range, 950-2500°F), and lithium (temperature range, 2000-3500°F). The vapor fraction or quality ranged from 0 to 100%.

The equations as programmed on an IBM 704 computer are as follows:

$$k = (v_g/v_f)^{1/2} \quad ; \tag{14}$$

$$\alpha_g = \frac{1}{1 + k^{-1}[(1/\chi) - 1]} \quad ; \tag{15}$$

$$\frac{d\chi}{dp} = -\frac{1}{s_g - s_f}\left[(1-\chi)\frac{ds_f}{dp} + \chi\frac{ds_g}{dp}\right] \quad ; \tag{16}$$

$$G = \left\{\frac{-144kg}{[(1-\chi+k\chi)\chi]\frac{dv_g}{dp} + [v_g(1+2k\chi-2\chi) + v_f(2k\chi-2k-2k^2\chi+k^2)]\frac{d\chi}{dp}}\right\}^{1/2} . \tag{17}$$

Equation (17) is obtained by substituting Eqs. (12) and (13) into Eq. (11) and performing the differentiation with respect to pressure.

The variables used are pressure p, metal-vapor quality χ, and mass flow rate G. The pressure and quality are taken as independent variables. The mass velocity is used as dependent variable and is calculated in terms of the pressure and steam quality. The computational scheme is as follows:

1. Assume a value for the pressure.
2. Calculate the slip ratio from Eq. (14).
3. Assume a value for the quality.
4. Calculate void fraction from Eq. (15).
5. Calculate $d\chi/dp$ from Eq. (16).
6. Calculate the mass flow rate from Eq. (17).
7. Maintaining the pressure constant, assume a new value for the steam quality, and repeat steps 4 to 7 until all the values of quality array are used.

8. Assume a new value for the pressure and repeat steps 2 to 8 until all the values of pressure array are used.

Input data beside p and χ are v_g, v_f, s_g, s_f, dv_g/dp, ds_f/dp, and ds_g/dp. The physical and thermodynamic properties of the various liquid metals are taken from Weatherford et al.(11)

The Fortran source program listing and the output print-outs are presented in Appendices A and B. The output print-outs consist of the input data and the calculated values for $d\chi/dp$, slip ratio k, void fraction α_g, and critical flow rate G for the various liquid metals.

In Figs. 11, 12, and 13 the computed results are shown for rubidium. Figure 11 shows how void fraction α_g varies with quality χ, the pressure p being taken as a parameter. Figure 12 presents the slip ratio k as a function of pressure. In Fig. 13 the critical-flow rate G is plotted versus the quality, with pressure as parameter. The range of quality is from 1 to 100% and that of pressure from 1 to 300 psia. These graphs indicate the various trends of the computed results and are similar for each liquid-metal system. The computed results in tabulated form may be found in Appendix B.

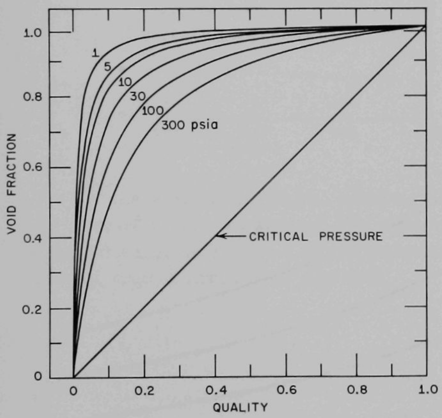


Fig. 11

Theoretical Prediction of Void Fraction for Rubidium under Critical-flow Conditions

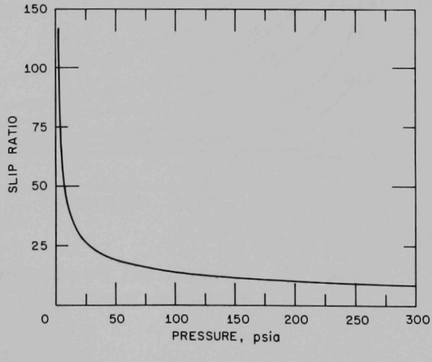
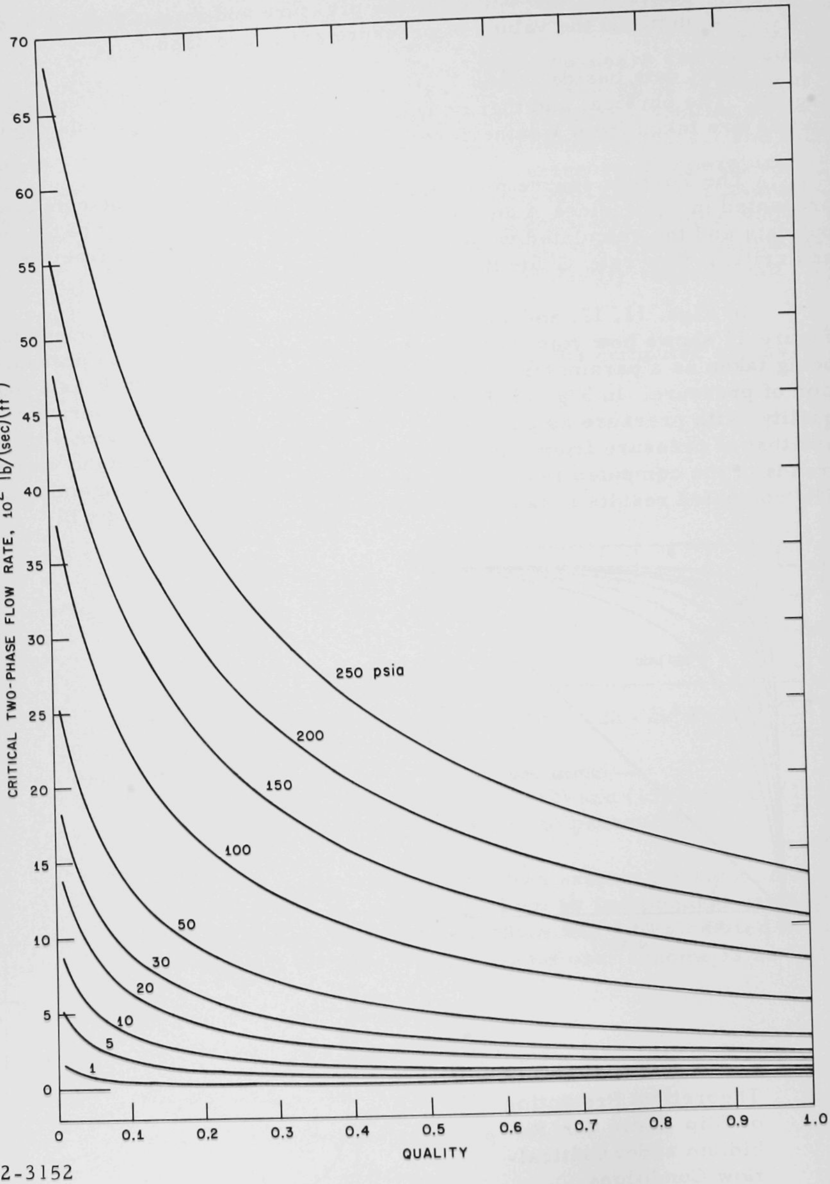


Fig. 12

Theoretical Prediction of Slip Ratio for Rubidium under Critical-flow Conditions



112-3152

Fig. 13. Theoretical Prediction of Two-phase Critical-flow Rates for Rubidium

Figure 14 clearly indicates the large difference obtained in critical-flow rates when using a slip model and the homogeneous-flow model. It is to be expected that large slip ratios exist for liquid-metal systems for the large pressure gradients prevailing under critical-flow conditions. Since the ratio of the densities of the liquid state to the vapor state is usually large for metallic fluids, it is reasonable to conclude that the lighter phase will be accelerated significantly more than the heavier phase when large pressure drops are occurring. As the calculations show, the momentum due to forced convection are smaller for slip than for no-slip flow. Consequently, for a given Δp, a larger total flow rate is obtained for slip than for no-slip flow.

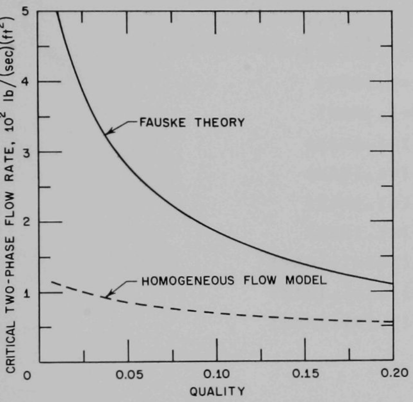


Fig. 14

Comparison of Flow Rates Calculated from Fauske Theory and Homogeneous-equilibrium Theory for Rubidium at 5 psia

As a final remark, although the theory has been proven satisfactorily for steam-water systems, the numerical results given herein must be considered estimates, and experimental verification of the theory for critical flow of liquid metals is needed.

APPENDIX A

FORTRAN LISTING PROGRAM

```
C     FAUSKE THEORY FOR LIQUID METAL SYSTEMS
C     J.ZAPATKA  JUNE 24,1963
      DIMENSION RECORD(12),X(20),VG(20),VF(20),SG(20),SF(20),
     XDVGDP(20),DSGDP(20),DSFDP(20),P(20),XK(20),DXDP(20),G(20),A(20)
    1 FORMAT(2I4)
    2 FORMAT(6E12.6)
    3 FORMAT(12A6)
    4 READ INPUT TAPE 7,3,(RECORD(J),J=1,12)
    5 READ INPUT TAPE 7,1,IMAX,JMAX
    6 READ INPUT TAPE 7,2,(X(J),J=1,JMAX)
    7 READ INPUT TAPE 7,2,(VG(I),I=1,IMAX)
    8 READ INPUT TAPE 7,2,(VF(I),I=1,IMAX)
    9 READ INPUT TAPE 7,2,(SG(I),I=1,IMAX)
   10 READ INPUT TAPE 7,2,(SF(I),I=1,IMAX)
   11 READ INPUT TAPE 7,2,(DVGDP(I),I=1,IMAX)
   12 READ INPUT TAPE 7,2,(DSGDP(I),I=1,IMAX)
   13 READ INPUT TAPE 7,2,(DSFDP(I),I=1,IMAX)
   14 READ INPUT TAPE 7,2,(P(I),I=1,IMAX)
   16 WRITE OUTPUT TAPE 6,3,(RECORD(J),J=1,12)
   17 WRITE OUTPUT TAPE 6,51
   18 WRITE OUTPUT TAPE 6,52,(P(I),I=1,IMAX)
   19 WRITE OUTPUT TAPE 6,53
   20 WRITE OUTPUT TAPE 6,52,(X(J),J=1,JMAX)
   21 WRITE OUTPUT TAPE 6,54
   22 WRITE OUTPUT TAPE 6,52,(VG(I),I=1,IMAX)
   23 WRITE OUTPUT TAPE 6,55
   24 WRITE OUTPUT TAPE 6,52,(VF(I),I=1,IMAX)
   25 WRITE OUTPUT TAPE 6,56
   26 WRITE OUTPUT TAPE 6,52,(SG(I),I=1,IMAX)
   27 WRITE OUTPUT TAPE 6,57
   28 WRITE OUTPUT TAPE 6,52,(SF(I),I=1,IMAX)
   29 WRITE OUTPUT TAPE 6,58
   30 WRITE OUTPUT TAPE 6,52,(DVGDP(I),I=1,IMAX)
   31 WRITE OUTPUT TAPE 6,59
   32 WRITE OUTPUT TAPE 6,52,(DSGDP(I),I=1,IMAX)
   33 WRITE OUTPUT TAPE 6,60
   34 WRITE OUTPUT TAPE 6,52,(DSFDP(I),I=1,IMAX)
   35 GC = 32.2
   36 DO48I=1,IMAX
      L = I-1
   37 XK(I) = SQRTF(VG(I)/VF(I))
   38 DO41J=1,JMAX
   39 DXDP(J) = -(1./(SG(I)-SF(I)))*((1.-X(J))*DSFDP(I)+X(J)*DSGDP(I))
   40 G(J) = SQRTF((-144.*XK(I)*GC)/((1.-X(J)+XK(I)*X(J))*X(J)*DVGDP(I)
     1+(VG(I)*(1.+2.*XK(I)*X(J)-2.*X(J))+VF(I)*(2.*XK(I)*X(J)-2.*XK(I)
     2-2.*XK(I)*XK(I)*X(J)+XK(I)*XK(I)))*DXDP(J)))
   41 A(J) = 1./(1.+(1./XK(I))*(1./X(J)-1.))
      IF(L-3*(L/3))1000,44,45
   44 WRITE OUTPUT TAPE 6,3,(RECORD(K),K=1,12)
   45 WRITE OUTPUT TAPE 6,61,P(I)
   46 WRITE OUTPUT TAPE 6,62,XK(I)
   72 WRITE OUTPUT TAPE 6,63
   73 WRITE OUTPUT TAPE 6,64,(X(J),DXDP(J),A(J),G(J),J=1,JMAX)
   48 CONTINUE
   49 GO TO 4
 1000 WRITE OUTPUT TAPE 6,65
      CALL SYSTEM
   51 FORMAT(40X,19HPRESSURE INPUT DATA)
   52 FORMAT(6E15.6)
   53 FORMAT(40X,18HQUALITY INPUT DATA)
   54 FORMAT(40X,13HVG INPUT DATA)
   55 FORMAT(40X,13HVF INPUT DATA)
   56 FORMAT(40X,13HSG INPUT DATA)
   57 FORMAT(40X,13HSF INPUT DATA)
   58 FORMAT(40X,16HDVGDP INPUT DATA)
   59 FORMAT(40X,16HDSGDP INPUT DATA)
   60 FORMAT(40X,16HDSFDP INPUT DATA)
   61 FORMAT(1H0,41X,16HPRESSURE,PSIA = E12.6)
   62 FORMAT(1H ,41X,15HSLIP RATIO K = E13.6)
   63 FORMAT(1H0,61X,4HVOID,11X,4HMASS/1H ,28X,9HQUALITY,X,
     X8X,5HDX/DP,8X,10HFRACTION,A,5X,10HVELOCITY,G)
   64 FORMAT(1H ,23X,E15.6,1X,E15.6,E15.6,E15.6)
   65 FORMAT(1H0,5HERROR)
      END  (  1,  1,  0,  1,  0  )
```

APPENDIX B

COMPUTER OUTPUT PRINT OUTS OF CRITICAL FLOW FOR LIQUID METALS

Table 1

COMPUTER INPUT DATA FOR RUBIDIUM

		PRESSURE INPUT DATA			
0.100000E 01	0.500000E 01	0.100000E 02	0.200000E 02	0.300000E 02	0.500000E 02
0.100000E 03	0.150000E 03	0.200000E 03	0.300000E 03		
		QUALITY INPUT DATA			
1.000000E-02	0.300000E-01	0.500000E-01	1.000000E-01	0.200000E-00	0.300000E-00
0.400000E-00	0.500000E 00	0.600000E 00	0.700000E 00	0.800000E 00	0.900000E 00
0.950000E 00					
		VG INPUT DATA			
0.159000E 03	0.380000E 02	0.200000E 02	0.107000E 02	0.725000E 01	0.465000E 01
0.250000E 01	0.172000E 01	0.135000E 01	0.980000E 00		
		VF INPUT DATA			
0.117330E-01	0.119850E-01	0.121210E-01	0.122800E-01	0.123850E-01	0.125350E-01
0.127760E-01	0.129440E-01	0.130780E-01	0.132830E-01		
		SG INPUT DATA			
0.584200E 00	0.556000E 00	0.543000E 00	0.530800E 00	0.523600E 00	0.515000E 00
0.504400E 00	0.498400E-00	0.494500E-00	0.489300E-00		
		SF INPUT DATA			
0.315600E-00	0.328100E-00	0.334200E-00	0.340900E-00	0.345000E-00	0.350500E-00
0.358900E-00	0.364100E-00	0.368200E-00	0.374100E-00		
		DVGDP INPUT DATA			
-0.127500E 03	-0.750000E 01	-0.200000E 01	-0.475000E-00	-0.225000E-00	-0.850000E-01
-0.240000E-01	-1.000000E-02	-0.550000E-02	-0.312500E-02		
		DSGDP INPUT DATA			
-0.180000E-01	-0.338000E-02	-0.200000E-02	-0.800000E-03	-0.560000E-03	-0.300000E-03
-0.160000E-03	-1.000000E-04	-0.700000E-04	-0.350000E-04		
		DSFDP INPUT DATA			
0.750000E-02	0.180000E-02	0.900000E-03	0.500000E-03	0.350000E-03	0.220000E-03
0.125000E-03	0.900000E-04	0.725000E-04	0.525000E-04		

Table 2

CRITICAL FLOW DATA FOR RUBIDIUM

PRESSURE,PSIA = 0.100000E 01
SLIP RATIO K = 0.116411E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.269732E-01	0.540413E 00	0.160077E 03
0.300000E-01	-0.250745E-01	0.782625E 00	0.101548E 03
0.500000E-01	-0.231757E-01	0.859686E 00	0.763354E 02
1.000000E-01	-0.184289E-01	0.928236E 00	0.481558E 02
0.200000E-00	-0.893522E-02	0.966780E 00	0.281342E 02
0.300000E-00	0.558451E-03	0.980350E 00	0.199492E 02
0.400000E-00	0.100521E-01	0.987279E 00	0.154684E 02
0.500000E 00	0.195458E-01	0.991483E 00	0.126358E 02
0.600000E 00	0.290395E-01	0.994306E 00	0.106817E 02
0.700000E 00	0.385331E-01	0.996332E 00	0.925188E 01
0.800000E 00	0.480268E-01	0.997857E 00	0.816003E 01
0.900000E 00	0.575205E-01	0.999046E 00	0.729889E 01
0.950000E 00	0.622673E-01	0.999548E 00	0.693312E 01

PRESSURE,PSIA = 0.500000E 01
SLIP RATIO K = 0.563083E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.767091E-02	0.362558E-00	0.509487E 03
0.300000E-01	-0.721632E-02	0.635236E 00	0.358554E 03
0.500000E-01	-0.676174E-02	0.747704E 00	0.280741E 03
1.000000E-01	-0.562527E-02	0.862192E 00	0.184855E 03
0.200000E-00	-0.335235E-02	0.933674E 00	0.111209E 03
0.300000E-00	-0.107942E-02	0.960210E 00	0.797994E 02
0.400000E-00	0.119351E-02	0.974052E 00	0.622811E 02
0.500000E 00	0.346643E-02	0.982551E 00	0.510872E 02
0.600000E 00	0.573936E-02	0.988299E 00	0.433109E 02
0.700000E 00	0.801229E-02	0.992446E 00	0.375923E 02
0.800000E 00	0.102852E-01	0.995580E 00	0.332093E 02
0.900000E 00	0.125581E-01	0.998031E 00	0.297425E 02
0.950000E 00	0.136946E-01	0.999066E 00	0.282673E 02

PRESSURE,PSIA = 0.100000E 02
SLIP RATIO K = 0.406205E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.417146E-02	0.290935E-00	0.859168E 03
0.300000E-01	-0.389368E-02	0.556798E 00	0.637263E 03
0.500000E-01	-0.361590E-02	0.681318E 00	0.511944E 03
1.000000E-01	-0.292146E-02	0.818624E 00	0.347696E 03
0.200000E-00	-0.153257E-02	0.910355E 00	0.214249E 03
0.300000E-00	-0.143678E-03	0.945678E 00	0.155355E 03
0.400000E-00	0.124521E-02	0.964388E 00	0.121973E 03
0.500000E 00	0.263410E-02	0.975973E 00	0.100436E 03
0.600000E 00	0.402299E-02	0.983853E 00	0.853783E 02
0.700000E 00	0.541188E-02	0.989560E 00	0.742535E 02
0.800000E 00	0.680077E-02	0.993883E 00	0.656970E 02
0.900000E 00	0.818966E-02	0.997272E 00	0.589106E 02
0.950000E 00	0.888410E-02	0.998706E 00	0.560179E 02

PRESSURE,PSIA = 0.200000E 02
SLIP RATIO K = 0.295184E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.256451E-02	0.229682E-00	0.135774E 04
0.300000E-01	-0.242759E-02	0.477244E-00	0.106989E 04
0.500000E-01	-0.229068E-02	0.608396E 00	0.890743E 03
1.000000E-01	-0.194839E-02	0.766345E 00	0.636233E 03
0.200000E-00	-0.126382E-02	0.880663E 00	0.410557E 03
0.300000E-00	-0.579252E-03	0.926744E 00	0.304507E 03
0.400000E-00	0.105319E-03	0.951642E 00	0.242349E 03
0.500000E 00	0.789889E-03	0.967233E 00	0.201385E 03
0.600000E 00	0.147446E-02	0.977914E 00	0.172316E 03
0.700000E 00	0.215903E-02	0.985689E 00	0.150605E 03
0.800000E 00	0.284360E-02	0.991602E 00	0.133764E 03
0.900000E 00	0.352817E-02	0.996250E 00	0.120318E 03
0.950000E 00	0.387046E-02	0.998220E 00	0.114562E 03

Table 2 (Contd.)

PRESSURE,PSIA = 0.300000E 02
SLIP RATIO K = 0.241947E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.190873E-02	0.196394E-00	0.177872E 04
0.300000E-01	-0.180683E-02	0.428013E-00	0.144083E 04
0.500000E-01	-0.170493E-02	0.560132E 00	0.121912E 04
1.000000E-01	-0.145017E-02	0.728873E 00	0.890088E 03
0.200000E-00	-0.940650E-03	0.858130E 00	0.585293E 03
0.300000E-00	-0.431131E-03	0.912043E 00	0.437959E 03
0.400000E-00	0.783874E-04	0.941622E 00	0.350382E 03
0.500000E 00	0.587906E-03	0.960309E 00	0.292166E 03
0.600000E 00	0.109742E-02	0.973185E 00	0.250612E 03
0.700000E 00	0.160694E-02	0.982595E 00	0.219442E 03
0.800000E 00	0.211646E-02	0.989773E 00	0.195186E 03
0.900000E 00	0.262598E-02	0.995429E 00	0.175769E 03
0.950000E 00	0.288074E-02	0.997829E 00	0.167444E 03

PRESSURE,PSIA = 0.500000E 02
SLIP RATIO K = 0.192604E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.130578E-02	0.162864E-00	0.247147E 04
0.300000E-01	-0.124255E-02	0.373308E-00	0.206692E 04
0.500000E-01	-0.117933E-02	0.503402E 00	0.178520E 04
1.000000E-01	-0.102128E-02	0.681533E 00	0.134361E 04
0.200000E-00	-0.705167E-03	0.828034E 00	0.909306E 03
0.300000E-00	-0.389058E-03	0.891944E 00	0.690304E 03
0.400000E-00	-0.729483E-04	0.927747E 00	0.557166E 03
0.500000E 00	0.243161E-03	0.950643E 00	0.467389E 03
0.600000E 00	0.559271E-03	0.966545E 00	0.402662E 03
0.700000E 00	0.875380E-03	0.978233E 00	0.353747E 03
0.800000E 00	0.119149E-02	0.987186E 00	0.315465E 03
0.900000E 00	0.150760E-02	0.994264E 00	0.284679E 03
0.950000E 00	0.166565E-02	0.997275E 00	0.271440E 03

PRESSURE,PSIA = 0.100000E 03
SLIP RATIO K = 0.139885E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.839519E-03	0.123805E-00	0.372484E 04
0.300000E-01	-0.800344E-03	0.301986E-00	0.324387E 04
0.500000E-01	-0.761168E-03	0.424043E-00	0.288221E 04
1.000000E-01	-0.663230E-03	0.608501E 00	0.226927E 04
0.200000E-00	-0.467354E-03	0.777636E 00	0.160833E 04
0.300000E-00	-0.271478E-03	0.857043E 00	0.125128E 04
0.400000E-00	-0.756014E-04	0.903154E 00	0.102572E 04
0.500000E 00	0.120275E-03	0.933282E 00	0.869735E 03
0.600000E 00	0.316151E-03	0.954510E 00	0.755243E 03
0.700000E 00	0.512027E-03	0.970273E 00	0.667546E 03
0.800000E 00	0.707904E-03	0.982442E 00	0.598184E 03
0.900000E 00	0.903780E-03	0.992120E 00	0.541931E 03
0.950000E 00	0.100172E-02	0.996252E 00	0.517607E 03

PRESSURE,PSIA = 0.150000E 03
SLIP RATIO K = 0.115274E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.655994E-03	0.104294E-00	0.473071E 04
0.300000E-01	-0.627699E-03	0.262818E-00	0.422839E 04
0.500000E-01	-0.599404E-03	0.377608E-00	0.383332E 04
1.000000E-01	-0.528667E-03	0.561561E 00	0.312822E 04
0.200000E-00	-0.387193E-03	0.742390E 00	0.231327E 04
0.300000E-00	-0.245719E-03	0.831658E 00	0.184603E 04
0.400000E-00	-0.104244E-03	0.884858E 00	0.153956E 04
0.500000E 00	0.372301E-04	0.920175E 00	0.132195E 04
0.600000E 00	0.178704E-03	0.945328E 00	0.115900E 04
0.700000E 00	0.320179E-03	0.964154E 00	0.103221E 04
0.800000E 00	0.461653E-03	0.978773E 00	0.930669E 03
0.900000E 00	0.603127E-03	0.990453E 00	0.847454E 03
0.950000E 00	0.673864E-03	0.995455E 00	0.811226E 03

Table 2 (Contd.)

PRESSURE,PSIA = 0.200000E 03
SLIP RATIO K = 0.101601E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.562747E-03	0.930749E-01	0.550349E 04
0.300000E-01	-0.540182E-03	0.239097E-00	0.499705E 04
0.500000E-01	-0.517617E-03	0.348424E-00	0.458799E 04
1.000000E-01	-0.461203E-03	0.530273E 00	0.383400E 04
0.200000E-00	-0.348377E-03	0.717515E 00	0.292221E 04
0.300000E-00	-0.235550E-03	0.813235E 00	0.237765E 04
0.400000E-00	-0.122724E-03	0.871356E 00	0.201056E 04
0.500000E 00	-0.989707E-05	0.910395E 00	0.174453E 04
0.600000E 00	0.102930E-03	0.938424E 00	0.154214E 04
0.700000E 00	0.215756E-03	0.959525E 00	0.138263E 04
0.800000E 00	0.328583E-03	0.975985E 00	0.125350E 04
0.900000E 00	0.441409E-03	0.989182E 00	0.114673E 04
0.950000E 00	0.497823E-03	0.994846E 00	0.109997E 04

PRESSURE,PSIA = 0.300000E 03
SLIP RATIO K = 0.858944E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.448134E-03	0.798354E-01	0.677143E 04
0.300000E-01	-0.432943E-03	0.209894E-00	0.620154E 04
0.500000E-01	-0.417752E-03	0.311331E-00	0.572880E 04
1.000000E-01	-0.379774E-03	0.488329E-00	0.483098E 04
0.200000E-00	-0.303819E-03	0.682273E 00	0.370686E 04
0.300000E-00	-0.227865E-03	0.786379E 00	0.302060E 04
0.400000E-00	-0.151910E-03	0.851330E 00	0.255386E 04
0.500000E 00	-0.759549E-04	0.895719E 00	0.221436E 04
0.600000E 00	-0.592119E-11	0.927975E 00	0.195570E 04
0.700000E 00	0.759549E-04	0.952476E 00	0.175178E 04
0.800000E 00	0.151910E-03	0.971718E 00	0.158675E 04
0.900000E 00	0.227865E-03	0.987229E 00	0.145037E 04
0.950000E 00	0.265842E-03	0.993910E 00	0.139068E 04

Table 3

COMPUTER INPUT DATA FOR LITHIUM

PRESSURE INPUT DATA

0.200000E 01	0.500000E 01	0.100000E 02	0.200000E 02	0.300000E 02	0.500000E 02
0.100000E 03					

QUALITY INPUT DATA

1.000000E-02	0.300000E-01	0.500000E-01	1.000000E-01	0.200000E-00	0.300000E-00
0.400000E-00	0.500000E 00	0.600000E 00	0.700000E 00	0.800000E 00	0.900000E 00
0.950000E 00					

VG INPUT DATA

0.180000E 04	0.740000E 03	0.390000E 03	0.205000E 03	0.138500E 03	0.870000E 02
0.460000E 02					

VF INPUT DATA

0.367900E-01	0.373500E-01	0.378480E-01	0.384150E-01	0.387800E-01	0.342750E-01
0.401400E-01					

SG INPUT DATA

0.624700E 01	0.600100E 01	0.583400E 01	0.566700E 01	0.557400E 01	0.546700E 01
0.531100E 01					

SF INPUT DATA

0.268680E 01	0.276280E 01	0.281880E 01	0.287730E 01	0.291440E 01	0.296250E 01
0.302900E 01					

DVGDP INPUT DATA

-0.850000E 03	-0.137500E 03	-0.400000E 02	-0.100000E 02	-0.425000E 01	-0.800000E 00
-0.450000E-00					

DSGDP INPUT DATA

-0.120000E-00	-0.500000E-01	-0.250000E-01	-0.112000E-01	-0.800000E-02	-0.460000E-02
-0.200000E-02					

DSFDP INPUT DATA

0.320000E-01	0.165000E-01	0.770000E-02	0.460000E-02	0.300000E-02	0.180000E-02
0.102500E-02					

Table 4

CRITICAL FLOW DATA FOR LITHIUM

PRESSURE,PSIA = 0.200000E 01
SLIP RATIO K = 0.221193E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.856132E-02	0.690811E 00	0.904168E 02
0.300000E-01	-0.770743E-02	0.872466E 00	0.503835E 02
0.500000E-01	-0.685355E-02	0.920897E 00	0.356857E 02
1.000000E-01	-0.471884E-02	0.960902E 00	0.209092E 02
0.200000E-00	-0.449413E-03	0.982237E 00	0.115194E 02
0.300000E-00	0.382001E-02	0.989561E 00	0.796127E 01
0.400000E-00	0.808943E-02	0.993264E 00	0.608450E 01
0.500000E 00	0.123589E-01	0.995499E 00	0.492434E 01
0.600000E 00	0.166283E-01	0.996995E 00	0.413596E 01
0.700000E 00	0.208977E-01	0.998066E 00	0.356527E 01
0.800000E 00	0.251671E-01	0.998871E 00	0.313302E 01
0.900000E 00	0.294365E-01	0.999498E 00	0.279427E 01
0.950000E 00	0.315713E-01	0.999762E 00	0.265097E 01

PRESSURE,PSIA = 0.500000E 01
SLIP RATIO K = 0.140757E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.489006E-02	0.587082E 00	0.178320E 03
0.300000E-01	-0.447934E-02	0.813200E 00	0.108344E 03
0.500000E-01	-0.406862E-02	0.881070E 00	0.797286E 02
1.000000E-01	-0.304181E-02	0.939903E 00	0.489077E 02
0.200000E-00	-0.988203E-03	0.972368E 00	0.279042E 02
0.300000E-00	0.106541E-02	0.983693E 00	0.195735E 02
0.400000E-00	0.311902E-02	0.989456E 00	0.150831E 02
0.500000E 00	0.517263E-02	0.992946E 00	0.122714E 02
0.600000E 00	0.722624E-02	0.995286E 00	0.103443E 02
0.700000E 00	0.927985E-02	0.996964E 00	0.894077E 01
0.800000E 00	0.113335E-01	0.998227E 00	0.787285E 01
0.900000E 00	0.133871E-01	0.999211E 00	0.703295E 01
0.950000E 00	0.144139E-01	0.999626E 00	0.667683E 01

PRESSURE,PSIA = 0.100000E 02
SLIP RATIO K = 0.101510E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.244528E-02	0.506260E 00	0.320271E 03
0.300000E-01	-0.222838E-02	0.758425E 00	0.200326E 03
0.500000E-01	-0.201148E-02	0.842337E 00	0.148265E 03
1.000000E-01	-0.146922E-02	0.918560E 00	0.910763E 02
0.200000E-00	-0.384717E-03	0.962089E 00	0.518487E 02
0.300000E-00	0.699788E-03	0.977530E 00	0.363103E 02
0.400000E-00	0.178429E-02	0.985438E 00	0.279506E 02
0.500000E 00	0.286880E-02	0.990245E 00	0.227235E 02
0.600000E 00	0.395330E-02	0.993475E 00	0.191449E 02
0.700000E 00	0.503781E-02	0.995796E 00	0.165407E 02
0.800000E 00	0.612231E-02	0.997543E 00	0.145604E 02
0.900000E 00	0.720682E-02	0.998907E 00	0.130038E 02
0.950000E 00	0.774907E-02	0.999482E 00	0.123440E 02

PRESSURE,PSIA = 0.200000E 02
SLIP RATIO K = 0.730511E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.159229E-02	0.424589E-00	0.514442E 03
0.300000E-01	-0.147901E-02	0.693187E 00	0.345392E 03
0.500000E-01	-0.136574E-02	0.793593E 00	0.264457E 03
1.000000E-01	-0.108255E-02	0.890312E 00	0.169448E 03
0.200000E-00	-0.516185E-03	0.948086E 00	0.997576E 02
0.300000E-00	0.501846E-04	0.969048E 00	0.708981E 02
0.400000E-00	0.616554E-03	0.979880E 00	0.550314E 02
0.500000E 00	0.118292E-02	0.986496E 00	0.449804E 02
0.600000E 00	0.174929E-02	0.990957E 00	0.380387E 02
0.700000E 00	0.231566E-02	0.994167E 00	0.329553E 02
0.800000E 00	0.288203E-02	0.996589E 00	0.290715E 02
0.900000E 00	0.344840E-02	0.998481E 00	0.260072E 02
0.950000E 00	0.373158E-02	0.999280E 00	0.247053E 02

Table 4 (Contd.)

PRESSURE,PSIA = 0.300000E 02
SLIP RATIO K = 0.597614E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.108663E-02	0.376423E-00	0.718114E 03
0.300000E-01	-0.100391E-02	0.648912E 00	0.500158E 03
0.500000E-01	-0.921191E-03	0.758765E 00	0.389673E 03
1.000000E-01	-0.714393E-03	0.869113E 00	0.255035E 03
0.200000E-00	-0.300797E-03	0.937266E 00	0.152699E 03
0.300000E-00	0.112799E-03	0.962423E 00	0.109338E 03
0.400000E-00	0.526395E-03	0.975515E 00	0.852322E 02
0.500000E 00	0.939991E-03	0.983542E 00	0.698584E 02
0.600000E 00	0.135359E-02	0.988968E 00	0.591921E 02
0.700000E 00	0.176718E-02	0.992880E 00	0.513556E 02
0.800000E 00	0.218078E-02	0.995834E 00	0.453536E 02
0.900000E 00	0.259438E-02	0.998144E 00	0.406088E 02
0.950000E 00	0.280117E-02	0.999120E 00	0.385904E 02

PRESSURE,PSIA = 0.500000E 02
SLIP RATIO K = 0.503815E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.693152E-03	0.337267E-00	0.111312E 04
0.300000E-01	-0.642044E-03	0.609099E 00	0.839759E 03
0.500000E-01	-0.590936E-03	0.726152E 00	0.691615E 03
1.000000E-01	-0.463166E-03	0.848438E 00	0.497431E 03
0.200000E-00	-0.207626E-03	0.926446E 00	0.331536E 03
0.300000E-00	0.479137E-04	0.955737E 00	0.252426E 03
0.400000E-00	0.303454E-03	0.971088E 00	0.204852E 03
0.500000E 00	0.558994E-03	0.980538E 00	0.172761E 03
0.600000E 00	0.814534E-03	0.986940E 00	0.149537E 03
0.700000E 00	0.107007E-02	0.991565E 00	0.131905E 03
0.800000E 00	0.132561E-02	0.995062E 00	0.118040E 03
0.900000E 00	0.158115E-02	0.997799E 00	0.106841E 03
0.950000E 00	0.170892E-02	0.998956E 00	0.102010E 03

PRESSURE,PSIA = 0.100000E 03
SLIP RATIO K = 0.338525E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.435911E-03	0.254812E-00	0.164960E 04
0.300000E-01	-0.409400E-03	0.511476E 00	0.125675E 04
0.500000E-01	-0.382888E-03	0.640509E 00	0.102365E 04
1.000000E-01	-0.316608E-03	0.789977E 00	0.707067E 03
0.200000E-00	-0.184049E-03	0.894327E 00	0.441373E 03
0.300000E-00	-0.514899E-04	0.935518E 00	0.321837E 03
0.400000E-00	0.810692E-04	0.957570E 00	0.253478E 03
0.500000E 00	0.213628E-03	0.971308E 00	0.209144E 03
0.600000E 00	0.346188E-03	0.980687E 00	0.178040E 03
0.700000E 00	0.478747E-03	0.987498E 00	0.155003E 03
0.800000E 00	0.611306E-03	0.992669E 00	0.137251E 03
0.900000E 00	0.743865E-03	0.996729E 00	0.123152E 03
0.950000E 00	0.810145E-03	0.998448E 00	0.117137E 03

Table 5

COMPUTER INPUT DATA FOR MERCURY

PRESSURE INPUT DATA

0.100000E 01	0.500000E 01	0.100000E 02	0.200000E 02	0.300000E 02	0.500000E 02
0.100000E 03	0.200000E 03	0.300000E 03	0.500000E 03	0.700000E 03	0.100000E 04
0.150000E 04	0.200000E 04				

QUALITY INPUT DATA

1.000000E-02	0.300000E-01	0.500000E-01	1.000000E-01	0.200000E-00	0.300000E-00
0.400000E-00	0.500000E 00	0.600000E 00	0.700000E 00	0.800000E 00	0.900000E 00
0.950000E 00					

VG INPUT DATA

0.590000E 02	0.112000E 02	0.590000E 01	0.300000E 01	0.220000E 01	0.150000E 01
0.700000E 00	0.390000E-00	0.279000E-00	0.179000E-00	0.133000E-00	0.980000E-01
0.700000E-01	0.540000E-01				

VF INPUT DATA

0.122980E-02	0.124640E-02	0.125370E-02	0.126170E-02	0.126720E-02	0.127740E-02
0.128970E-02	0.130400E-02	0.131380E-02	0.132800E-02	0.133850E-02	0.135100E-02
0.136600E-02	0.137830E-02				

SG INPUT DATA

0.247600E-00	0.233700E-00	0.229400E-00	0.224300E-00	0.221300E-00	0.217700E-00
0.212800E-00	0.208300E-00	0.205700E-00	0.202400E-00	0.200400E-00	0.198500E-00
0.196400E-00	0.194900E-00				

SF INPUT DATA

0.108500E-00	0.112890E-00	0.114540E-00	0.116410E-00	0.117700E-00	0.119310E-00
0.121620E-00	0.124240E-00	0.125870E-00	0.128100E-00	0.129690E-00	0.131500E-00
0.133670E-00	0.135380E-00				

DVGDP INPUT DATA

-0.163500E 02	-0.160000E 01	-0.550000E 00	-0.160000E-00	-0.400000E-01	-0.300000E-01
-0.667000E-02	-0.150000E-02	-0.800000E-03	-0.320000E-03	-0.170000E-03	-0.900000E-04
-0.400000E-04	-0.250000E-04				

DSGDP INPUT DATA

-0.600000E-02	-0.187500E-02	-0.750000E-03	-0.375000E-03	-0.250000E-03	-0.137500E-03
-0.625000E-04	-0.325000E-04	-0.212500E-04	-0.125000E-04	-0.875000E-05	-0.562500E-05
-0.400000E-05	-0.250000E-05				

DSFDP INPUT DATA

0.175000E-02	0.625000E-03	0.275000E-03	0.150000E-03	0.108000E-03	0.667000E-04
0.375000E-04	0.200000E-04	0.137500E-04	0.875000E-05	0.725000E-05	0.531000E-05
0.375000E-05	0.312500E-05				

Table 6

CRITICAL FLOW DATA FOR MERCURY

PRESSURE,PSIA = 0.100000E 01
SLIP RATIO K = 0.219033E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.120237E-01	0.688711E 00	0.450168E 03
0.300000E-01	-0.109094E-01	0.871369E 00	0.275693E 03
0.500000E-01	-0.979511E-02	0.920179E 00	0.208230E 03
1.000000E-01	-0.700935E-02	0.960532E 00	0.134600E 03
0.200000E-00	-0.143781E-02	0.982065E 00	0.813683E 02
0.300000E-00	0.413372E-02	0.989459E 00	0.588252E 02
0.400000E-00	0.970525E-02	0.993198E 00	0.461743E 02
0.500000E 00	0.152768E-01	0.995455E 00	0.380369E 02
0.600000E 00	0.208483E-01	0.996966E 00	0.323520E 02
0.700000E 00	0.264198E-01	0.998047E 00	0.281520E 02
0.800000E 00	0.319914E-01	0.998860E 00	0.249205E 02
0.900000E 00	0.375629E-01	0.999493E 00	0.223563E 02
0.950000E 00	0.403487E-01	0.999760E 00	0.212629E 02

PRESSURE,PSIA = 0.500000E 01
SLIP RATIO K = 0.947939E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.496648E-02	0.489148E-00	0.134126E 04
0.300000E-01	-0.455260E-02	0.745662E 00	0.879769E 03
0.500000E-01	-0.413873E-02	0.833031E 00	0.670706E 03
1.000000E-01	-0.310405E-02	0.913290E 00	0.430218E 03
0.200000E-00	-0.103468E-02	0.959512E 00	0.254692E 03
0.300000E-00	0.103468E-02	0.975977E 00	0.181668E 03
0.400000E-00	0.310405E-02	0.984423E 00	0.141343E 03
0.500000E 00	0.517341E-02	0.989561E 00	0.115716E 03
0.600000E 00	0.724278E-02	0.993016E 00	0.979738E 02
0.700000E 00	0.931214E-02	0.995499E 00	0.849573E 02
0.800000E 00	0.113815E-01	0.997370E 00	0.749980E 02
0.900000E 00	0.134509E-01	0.998829E 00	0.671311E 02
0.950000E 00	0.144856E-01	0.999445E 00	0.637862E 02

PRESSURE,PSIA = 0.100000E 02
SLIP RATIO K = 0.686008E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.230498E-02	0.409311E-00	0.242392E 04
0.300000E-01	-0.212650E-02	0.679659E 00	0.159626E 04
0.500000E-01	-0.194802E-02	0.783107E 00	0.120335E 04
1.000000E-01	-0.150183E-02	0.884022E 00	0.752111E 03
0.200000E-00	-0.609438E-03	0.944904E 00	0.432548E 03
0.300000E-00	0.282953E-03	0.967106E 00	0.304031E 03
0.400000E-00	0.117534E-02	0.978602E 00	0.234476E 03
0.500000E 00	0.206773E-02	0.985632E 00	0.190846E 03
0.600000E 00	0.296013E-02	0.990375E 00	0.160915E 03
0.700000E 00	0.385252E-02	0.993791E 00	0.139104E 03
0.800000E 00	0.474491E-02	0.996369E 00	0.122502E 03
0.900000E 00	0.563730E-02	0.998383E 00	0.109441E 03
0.950000E 00	0.608349E-02	0.999233E 00	0.103903E 03

PRESSURE,PSIA = 0.200000E 02
SLIP RATIO K = 0.487621E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.134164E-02	0.330004E-00	0.401657E 04
0.300000E-01	-0.124432E-02	0.601293E 00	0.276993E 04
0.500000E-01	-0.114700E-02	0.719607E 00	0.212770E 04
1.000000E-01	-0.903698E-03	0.844189E 00	0.135527E 04
0.200000E-00	-0.417091E-03	0.924188E 00	0.788628E 03
0.300000E-00	0.695152E-04	0.954334E 00	0.556717E 03
0.400000E-00	0.556122E-03	0.970156E 00	0.430321E 03
0.500000E 00	0.104273E-02	0.979904E 00	0.350733E 03
0.600000E 00	0.152934E-02	0.986513E 00	0.296002E 03
0.700000E 00	0.201594E-02	0.991288E 00	0.256053E 03
0.800000E 00	0.250255E-02	0.994899E 00	0.225607E 03
0.900000E 00	0.298916E-02	0.997727E 00	0.201634E 03
0.950000E 00	0.323246E-02	0.998922E 00	0.191462E 03

Table 6 (Contd.)

PRESSURE,PSIA = 0.300000E 02
SLIP RATIO K = 0.416667E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.100791E-02	0.296209E-00	0.538953E 04
0.300000E-01	-0.938803E-03	0.563063E 00	0.407859E 04
0.500000E-01	-0.869691E-03	0.686813E 00	0.333261E 04
1.000000E-01	-0.696911E-03	0.822368E 00	0.233516E 04
0.200000E-00	-0.351351E-03	0.912409E 00	0.149151E 04
0.300000E-00	-0.579151E-05	0.946970E 00	0.110326E 04
0.400000E-00	0.339768E-03	0.965251E 00	0.877210E 03
0.500000E 00	0.685328E-03	0.976563E 00	0.728658E 03
0.600000E 00	0.103089E-02	0.984252E 00	0.623388E 03
0.700000E 00	0.137645E-02	0.989819E 00	0.544816E 03
0.800000E 00	0.172201E-02	0.994036E 00	0.483898E 03
0.900000E 00	0.206757E-02	0.997340E 00	0.435268E 03
0.950000E 00	0.224035E-02	0.998738E 00	0.414452E 03

PRESSURE,PSIA = 0.500000E 02
SLIP RATIO K = 0.342675E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.657160E-03	0.257133E-00	0.733845E 04
0.300000E-01	-0.615652E-03	0.514520E 00	0.543409E 04
0.500000E-01	-0.574144E-03	0.643310E 00	0.433667E 04
1.000000E-01	-0.470373E-03	0.791992E 00	0.289889E 04
0.200000E-00	-0.262832E-03	0.895473E 00	0.175174E 04
0.300000E-00	-0.552902E-04	0.936249E 00	0.125682E 04
0.400000E-00	0.152251E-03	0.958062E 00	0.980306E 03
0.500000E 00	0.359793E-03	0.971645E 00	0.803633E 03
0.600000E 00	0.567334E-03	0.980916E 00	0.680960E 03
0.700000E 00	0.774875E-03	0.987648E 00	0.590798E 03
0.800000E 00	0.982417E-03	0.992757E 00	0.521730E 03
0.900000E 00	0.118996E-02	0.996768E 00	0.467126E 03
0.950000E 00	0.129373E-02	0.998466E 00	0.443899E 03

PRESSURE,PSIA = 0.100000E 03
SLIP RATIO K = 0.232973E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.400307E-03	0.190497E-00	0.121023E 05
0.300000E-01	-0.378372E-03	0.418785E-00	0.956772E 04
0.500000E-01	-0.356438E-03	0.550798E 00	0.793570E 04
1.000000E-01	-0.301601E-03	0.721339E 00	0.558805E 04
0.200000E-00	-0.191928E-03	0.853465E 00	0.352638E 04
0.300000E-00	-0.822549E-04	0.908963E 00	0.257962E 04
0.400000E-00	0.274183E-04	0.939509E 00	0.203445E 04
0.500000E 00	0.137091E-03	0.958843E 00	0.167978E 04
0.600000E 00	0.246765E-03	0.972180E 00	0.143052E 04
0.700000E 00	0.356438E-03	0.981937E 00	0.124572E 04
0.800000E 00	0.466111E-03	0.989383E 00	0.110324E 04
0.900000E 00	0.575784E-03	0.995253E 00	0.990014E 03
0.950000E 00	0.630621E-03	0.997746E 00	0.941696E 03

PRESSURE,PSIA = 0.200000E 03
SLIP RATIO K = 0.172939E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.231680E-03	0.148709E-00	0.192924E 05
0.300000E-01	-0.219189E-03	0.348476E-00	0.161665E 05
0.500000E-01	-0.206698E-03	0.476496E-00	0.139552E 05
1.000000E-01	-0.175470E-03	0.657716E 00	0.104559E 05
0.200000E-00	-0.113015E-03	0.812153E 00	0.701105E 04
0.300000E-00	-0.505591E-04	0.881118E 00	0.528727E 04
0.400000E-00	0.118963E-04	0.920187E 00	0.424746E 04
0.500000E 00	0.743517E-04	0.945337E 00	0.355069E 04
0.600000E 00	0.136807E-03	0.962882E 00	0.305085E 04
0.700000E 00	0.199262E-03	0.975818E 00	0.267464E 04
0.800000E 00	0.261718E-03	0.985750E 00	0.238117E 04
0.900000E 00	0.324173E-03	0.993616E 00	0.214581E 04
0.950000E 00	0.355401E-03	0.996966E 00	0.204477E 04

Table 6 (Contd.)

PRESSURE,PSIA = 0.300000E 03
SLIP RATIO K = 0.145726E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.167857E-03	0.128311E-00	0.249942E 05
0.300000E-01	-0.159088E-03	0.310677E-00	0.212160E 05
0.500000E-01	-0.150319E-03	0.434063E-00	0.184601E 05
1.000000E-01	-0.128398E-03	0.618201E 00	0.139770E 05
0.200000E-00	-0.845547E-04	0.784629E 00	0.944433E 04
0.300000E-00	-0.407115E-04	0.861982E 00	0.714243E 04
0.400000E-00	0.313165E-05	0.906674E 00	0.574562E 04
0.500000E 00	0.469748E-04	0.935785E 00	0.480681E 04
0.600000E 00	0.908180E-04	0.956253E 00	0.413215E 04
0.700000E 00	0.134661E-03	0.971431E 00	0.362378E 04
0.800000E 00	0.178504E-03	0.983134E 00	0.322690E 04
0.900000E 00	0.222347E-03	0.992433E 00	0.290844E 04
0.950000E 00	0.244269E-03	0.996401E 00	0.277169E 04

PRESSURE,PSIA = 0.500000E 03
SLIP RATIO K = 0.116099E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.114906E-03	0.104962E-00	0.345408E 05
0.300000E-01	-0.109186E-03	0.264202E-00	0.300167E 05
0.500000E-01	-0.103466E-03	0.379285E-00	0.265628E 05
1.000000E-01	-0.891655E-04	0.563316E 00	0.206638E 05
0.200000E-00	-0.605653E-04	0.743752E 00	0.143433E 05
0.300000E-00	-0.319650E-04	0.832654E 00	0.109949E 05
0.400000E-00	-0.336474E-05	0.885582E 00	0.891721E 04
0.500000E 00	0.252355E-04	0.920697E 00	0.750114E 04
0.600000E 00	0.538358E-04	0.945696E 00	0.647370E 04
0.700000E 00	0.824361E-04	0.964400E 00	0.569407E 04
0.800000E 00	0.111036E-03	0.978921E 00	0.508218E 04
0.900000E 00	0.139637E-03	0.990520E 00	0.458911E 04
0.950000E 00	0.153937E-03	0.995487E 00	0.437682E 04

PRESSURE,PSIA = 0.700000E 03
SLIP RATIO K = 0.996820E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.100269E-03	0.914780E-01	0.406290E 05
0.300000E-01	-0.957432E-04	0.235646E-00	0.360579E 05
0.500000E-01	-0.912176E-04	0.344108E-00	0.324367E 05
1.000000E-01	-0.799038E-04	0.525522E 00	0.259727E 05
0.200000E-00	-0.572762E-04	0.713635E 00	0.186226E 05
0.300000E-00	-0.346486E-04	0.810322E 00	0.145338E 05
0.400000E-00	-0.120209E-04	0.869204E 00	0.119231E 05
0.500000E 00	0.106067E-04	0.908827E 00	0.101097E 05
0.600000E 00	0.332343E-04	0.937313E 00	0.877616E 04
0.700000E 00	0.558620E-04	0.958778E 00	0.775395E 04
0.800000E 00	0.784896E-04	0.975534E 00	0.694531E 04
0.900000E 00	0.101117E-03	0.988976E 00	0.628957E 04
0.950000E 00	0.112431E-03	0.994748E 00	0.600609E 04

PRESSURE,PSIA = 0.100000E 04
SLIP RATIO K = 0.851697E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.776216E-04	0.792152E-01	0.506323E 05
0.300000E-01	-0.743575E-04	0.208492E-00	0.455039E 05
0.500000E-01	-0.710933E-04	0.309517E-00	0.413366E 05
1.000000E-01	-0.629328E-04	0.486213E-00	0.336699E 05
0.200000E-00	-0.466119E-04	0.680434E 00	0.246021E 05
0.300000E-00	-0.302910E-04	0.784952E 00	0.193987E 05
0.400000E-00	-0.139701E-04	0.850254E 00	0.160175E 05
0.500000E 00	0.235075E-05	0.894925E 00	0.136421E 05
0.600000E 00	0.186716E-04	0.927407E 00	0.118813E 05
0.700000E 00	0.349925E-04	0.952091E 00	0.105236E 05
0.800000E 00	0.513134E-04	0.971484E 00	0.944467E 04
0.900000E 00	0.676343E-04	0.987122E 00	0.856656E 04
0.950000E 00	0.757948E-04	0.993858E 00	0.818606E 04

Table 6 (Contd.)

PRESSURE,PSIA = 0.150000E 04
SLIP RATIO K = 0.715853E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.585446E-04	0.674324E-01	0.647781E 05
0.300000E-01	-0.560736E-04	0.181266E-00	0.593503E 05
0.500000E-01	-0.536027E-04	0.273659E-00	0.547829E 05
1.000000E-01	-0.474255E-04	0.443019E-00	0.459901E 05
0.200000E-00	-0.350709E-04	0.641530E 00	0.348815E 05
0.300000E-00	-0.227164E-04	0.754175E 00	0.281251E 05
0.400000E-00	-0.103619E-04	0.826760E 00	0.235722E 05
0.500000E 00	0.199267E-05	0.877429E 00	0.202926E 05
0.600000E 00	0.143472E-04	0.914805E 00	0.178163E 05
0.700000E 00	0.267017E-04	0.943513E 00	0.158799E 05
0.800000E 00	0.390563E-04	0.966255E 00	0.143239E 05
0.900000E 00	0.514108E-04	0.984716E 00	0.130460E 05
0.950000E 00	0.575881E-04	0.992701E 00	0.124890E 05

PRESSURE,PSIA = 0.200000E 04
SLIP RATIO K = 0.625929E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.515583E-04	0.594654E-01	0.747955E 05
0.300000E-01	-0.496682E-04	0.162189E-00	0.690530E 05
0.500000E-01	-0.477781E-04	0.247801E-00	0.641415E 05
1.000000E-01	-0.430528E-04	0.410195E-00	0.544857E 05
0.200000E-00	-0.336022E-04	0.610109E 00	0.419199E 05
0.300000E-00	-0.241515E-04	0.728449E 00	0.340839E 05
0.400000E-00	-0.147009E-04	0.806683E 00	0.287236E 05
0.500000E 00	-0.525034E-05	0.862245E 00	0.248234E 05
0.600000E 00	0.420027E-05	0.903744E 00	0.218575E 05
0.700000E 00	0.136509E-04	0.935918E 00	0.195255E 05
0.800000E 00	0.231015E-04	0.961593E 00	0.176437E 05
0.900000E 00	0.325521E-04	0.982558E 00	0.160930E 05
0.950000E 00	0.372774E-04	0.991662E 00	0.154157E 05

Table 7

COMPUTER INPUT DATA FOR POTASSIUM

PRESSURE INPUT DATA

0.100000E 01	0.500000E 01	0.100000E 02	0.200000E 02	0.300000E 02	0.500000E 02
0.100000E 03	0.150000E 03	0.200000E 03	0.250000E 03		

QUALITY INPUT DATA

1.000000E-02	0.300000E-01	0.500000E-01	1.000000E-01	0.200000E-00	0.300000E-00
0.400000E-00	0.500000E 00	0.600000E 00	0.700000E 00	0.800000E 00	0.900000E 00
0.950000E 00					

VG INPUT DATA

0.417000E 03	0.920000E 02	0.470000E 02	0.244000E 02	0.170000E 02	0.109000E 02
0.580000E 01	0.401000E 01	0.315000E 01	0.260000E 01		

VF INPUT DATA

0.225000E-01	0.233600E-01	0.238400E-01	0.243500E-01	0.247200E-01	0.252200E-01
0.260600E-01	0.265800E-01	0.270000E-01	0.273500E-01		

SG INPUT DATA

0.123360E 01	0.116700E 01	0.113720E 01	0.111030E 01	0.109440E 01	0.107550E 01
0.105060E 01	0.103640E 01	0.102730E 01	0.102020E 01		

SF INPUT DATA

0.618400E 00	0.645000E 00	0.657100E 00	0.670600E 00	0.679500E 00	0.690100E 00
0.708000E 00	0.719800E 00	0.728500E 00	0.736000E 00		

DVGDP INPUT DATA

-0.375000E 03	-0.170000E 02	-0.400000E 01	-0.102500E 01	-0.525000E 00	-0.200000E-00
-0.450000E-01	-0.250000E-01	-0.125000E-01	-0.875000E-02		

DSGDP INPUT DATA

-0.400000E-01	-0.900000E-02	-0.390000E-02	-0.192500E-02	-0.125000E-02	-0.750000E-03
-0.350000E-03	-0.220000E-03	-0.162500E-03	-0.125000E-03		

DSFDP INPUT DATA

0.150000E-01	0.350000E-02	0.185000E-02	0.105000E-02	0.710000E-03	0.490000E-03
0.300000E-03	0.195000E-03	0.167500E-03	0.150000E-03		

Table 8

CRITICAL FLOW DATA FOR POTASSIUM

PRESSURE,PSIA = 0.100000E 01
SLIP RATIO K = 0.136137E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.234883E-01	0.578969E 00	0.107581E 03
0.300000E-01	-0.217003E-01	0.808077E 00	0.653840E 02
0.500000E-01	-0.199122E-01	0.877528E 00	0.480583E 02
1.000000E-01	-0.154421E-01	0.937990E 00	0.294098E 02
0.200000E-00	-0.650195E-02	0.971457E 00	0.167388E 02
0.300000E-00	0.243823E-02	0.983149E 00	0.117277E 02
0.400000E-00	0.113784E-01	0.989102E 00	0.903104E 01
0.500000E 00	0.203186E-01	0.992708E 00	0.734421E 01
0.600000E 00	0.292588E-01	0.995127E 00	0.618893E 01
0.700000E 00	0.381990E-01	0.996862E 00	0.534796E 01
0.800000E 00	0.471391E-01	0.998167E 00	0.470833E 01
0.900000E 00	0.560793E-01	0.999184E 00	0.420542E 01
0.950000E 00	0.605494E-01	0.999614E 00	0.399223E 01

PRESSURE,PSIA = 0.500000E 01
SLIP RATIO K = 0.627563E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.646552E-02	0.387968E-00	0.366304E 03
0.300000E-01	-0.598659E-02	0.659970E 00	0.252970E 03
0.500000E-01	-0.550766E-02	0.767602E 00	0.196303E 03
1.000000E-01	-0.431034E-02	0.874576E 00	0.127862E 03
0.200000E-00	-0.191571E-02	0.940081E 00	0.762680E 02
0.300000E-00	0.478927E-03	0.964152E 00	0.545206E 02
0.400000E-00	0.287356E-02	0.976656E 00	0.424601E 02
0.500000E 00	0.526820E-02	0.984315E 00	0.347800E 02
0.600000E 00	0.766283E-02	0.989489E 00	0.294570E 02
0.700000E 00	0.100575E-01	0.993217E 00	0.255491E 02
0.800000E 00	0.124521E-01	0.996032E 00	0.225576E 02
0.900000E 00	0.148467E-01	0.998233E 00	0.201937E 02
0.950000E 00	0.160441E-01	0.999162E 00	0.191885E 02

PRESSURE,PSIA = 0.100000E 02
SLIP RATIO K = 0.444013E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.373360E-02	0.309630E-00	0.612210E 03
0.300000E-01	-0.349406E-02	0.578634E 00	0.450308E 03
0.500000E-01	-0.325453E-02	0.700322E 00	0.360751E 03
1.000000E-01	-0.265570E-02	0.831465E 00	0.244672E 03
0.200000E-00	-0.145803E-02	0.917358E 00	0.150903E 03
0.300000E-00	-0.260362E-03	0.950073E 00	0.109534E 03
0.400000E-00	0.937305E-03	0.967321E 00	0.860635E 02
0.500000E 00	0.213497E-02	0.977974E 00	0.709071E 02
0.600000E 00	0.333264E-02	0.985208E 00	0.603019E 02
0.700000E 00	0.453031E-02	0.990440E 00	0.524620E 02
0.800000E 00	0.572797E-02	0.994401E 00	0.464290E 02
0.900000E 00	0.692564E-02	0.997504E 00	0.416420E 02
0.950000E 00	0.752447E-02	0.998816E 00	0.396010E 02

PRESSURE,PSIA = 0.200000E 02
SLIP RATIO K = 0.316552E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.232033E-02	0.242281E-00	0.967943E 03
0.300000E-01	-0.218501E-02	0.494701E-00	0.755355E 03
0.500000E-01	-0.204969E-02	0.624915E 00	0.625511E 03
1.000000E-01	-0.171139E-02	0.778626E 00	0.443711E 03
0.200000E-00	-0.103480E-02	0.887814E 00	0.284722E 03
0.300000E-00	-0.358199E-03	0.931349E 00	0.210642E 03
0.400000E-00	0.318399E-03	0.954758E 00	0.167399E 03
0.500000E 00	0.994997E-03	0.969377E 00	0.138970E 03
0.600000E 00	0.167159E-02	0.979374E 00	0.118829E 03
0.700000E 00	0.234819E-02	0.986642E 00	0.103804E 03
0.800000E 00	0.302479E-02	0.992164E 00	0.921604E 02
0.900000E 00	0.370139E-02	0.996502E 00	0.828703E 02
0.950000E 00	0.403969E-02	0.998340E 00	0.788951E 02

Table 8 (Contd.)

PRESSURE,PSIA = 0.300000E 02
SLIP RATIO K = 0.262241E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.166402E-02	0.209417E-00	0.127568E 04
0.300000E-01	-0.156953E-02	0.447835E-00	0.101581E 04
0.500000E-01	-0.147505E-02	0.579870E 00	0.849654E 03
1.000000E-01	-0.123885E-02	0.744493E 00	0.609205E 03
0.200000E-00	-0.766450E-03	0.867655E 00	0.393266E 03
0.300000E-00	-0.294047E-03	0.918293E 00	0.291427E 03
0.400000E-00	0.178356E-03	0.945895E 00	0.231744E 03
0.500000E 00	0.650759E-03	0.963268E 00	0.192439E 03
0.600000E 00	0.112316E-02	0.975208E 00	0.164570E 03
0.700000E 00	0.159557E-02	0.983920E 00	0.143769E 03
0.800000E 00	0.206797E-02	0.990557E 00	0.127645E 03
0.900000E 00	0.254037E-02	0.995781E 00	0.114778E 03
0.950000E 00	0.277657E-02	0.997997E 00	0.109272E 03

PRESSURE,PSIA = 0.500000E 02
SLIP RATIO K = 0.207893E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.123923E-02	0.173549E-00	0.170395E 04
0.300000E-01	-0.117488E-02	0.391346E-00	0.141102E 04
0.500000E-01	-0.111053E-02	0.522485E 00	0.121090E 04
1.000000E-01	-0.949663E-03	0.697879E 00	0.902748E 03
0.200000E-00	-0.627919E-03	0.838640E 00	0.605509E 03
0.300000E-00	-0.306175E-03	0.899089E 00	0.457633E 03
0.400000E-00	0.155682E-04	0.932703E 00	0.368370E 03
0.500000E 00	0.337312E-03	0.954106E 00	0.308447E 03
0.600000E 00	0.659055E-03	0.968929E 00	0.265378E 03
0.700000E 00	0.980799E-03	0.979801E 00	0.232905E 03
0.800000E 00	0.130254E-02	0.988118E 00	0.207535E 03
0.900000E 00	0.162429E-02	0.994684E 00	0.187162E 03
0.950000E 00	0.178516E-02	0.997475E 00	0.178409E 03

PRESSURE,PSIA = 0.100000E 03
SLIP RATIO K = 0.149186E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.856684E-03	0.130958E-00	0.249925E 04
0.300000E-01	-0.818739E-03	0.315724E-00	0.218612E 04
0.500000E-01	-0.780794E-03	0.439835E-00	0.195243E 04
1.000000E-01	-0.685931E-03	0.623723E 00	0.155741E 04
0.200000E-00	-0.496205E-03	0.788567E 00	0.112793E 04
0.300000E-00	-0.306480E-03	0.864749E 00	0.891500E 03
0.400000E-00	-0.116754E-03	0.908640E 00	0.739446E 03
0.500000E 00	0.729714E-04	0.937180E 00	0.632708E 03
0.600000E 00	0.262697E-03	0.957224E 00	0.553375E 03
0.700000E 00	0.452423E-03	0.972075E 00	0.491971E 03
0.800000E 00	0.642148E-03	0.983519E 00	0.442975E 03
0.900000E 00	0.831874E-03	0.992607E 00	0.402941E 03
0.950000E 00	0.926737E-03	0.996484E 00	0.385543E 03

PRESSURE,PSIA = 0.150000E 03
SLIP RATIO K = 0.122827E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.602811E-03	0.110374E-00	0.330303E 04
0.300000E-01	-0.576595E-03	0.275298E-00	0.291783E 04
0.500000E-01	-0.550379E-03	0.392636E-00	0.261993E 04
1.000000E-01	-0.484839E-03	0.577122E 00	0.209934E 04
0.200000E-00	-0.353759E-03	0.754341E 00	0.151634E 04
0.300000E-00	-0.222678E-03	0.840358E 00	0.119205E 04
0.400000E-00	-0.915982E-04	0.891168E 00	0.983737E 03
0.500000E 00	0.394820E-04	0.924714E 00	0.838080E 03
0.600000E 00	0.170562E-03	0.948518E 00	0.730312E 03
0.700000E 00	0.301642E-03	0.966284E 00	0.647265E 03
0.800000E 00	0.432723E-03	0.980052E 00	0.581270E 03
0.900000E 00	0.563803E-03	0.991035E 00	0.527541E 03
0.950000E 00	0.629343E-03	0.995733E 00	0.504252E 03

Table 8 (Contd.)

PRESSURE,PSIA = 0.200000E 03
SLIP RATIO K = 0.108012E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.549531E-03	0.983708E-01	0.373680E 04
0.300000E-01	-0.527443E-03	0.250408E-00	0.337875E 04
0.500000E-01	-0.505355E-03	0.362443E-00	0.309275E 04
1.000000E-01	-0.450134E-03	0.545483E 00	0.257206E 04
0.200000E-00	-0.339692E-03	0.729752E 00	0.195162E 04
0.300000E-00	-0.229250E-03	0.822352E 00	0.158481E 04
0.400000E-00	-0.118809E-03	0.878061E 00	0.133875E 04
0.500000E 00	-0.836680E-05	0.915263E 00	0.116092E 04
0.600000E 00	0.102075E-03	0.941867E 00	0.102586E 04
0.700000E 00	0.212517E-03	0.961836E 00	0.919531E 03
0.800000E 00	0.322958E-03	0.977378E 00	0.833522E 03
0.900000E 00	0.433400E-03	0.989818E 00	0.762443E 03
0.950000E 00	0.488621E-03	0.995151E 00	0.731322E 03

PRESSURE,PSIA = 0.250000E 03
SLIP RATIO K = 0.975008E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.518121E-03	0.896558E-01	0.407343E 04
0.300000E-01	-0.498768E-03	0.231685E-00	0.371826E 04
0.500000E-01	-0.479416E-03	0.339132E-00	0.342898E 04
1.000000E-01	-0.431034E-03	0.520002E 00	0.289019E 04
0.200000E-00	-0.334272E-03	0.709093E 00	0.222862E 04
0.300000E-00	-0.237509E-03	0.806898E 00	0.182771E 04
0.400000E-00	-0.140746E-03	0.866668E 00	0.155462E 04
0.500000E 00	-0.439831E-04	0.906977E 00	0.135512E 04
0.600000E 00	0.527797E-04	0.936000E 00	0.120234E 04
0.700000E 00	0.149543E-03	0.957895E 00	0.108127E 04
0.800000E 00	0.246305E-03	0.975000E 00	0.982805E 03
0.900000E 00	0.343068E-03	0.988732E 00	0.901062E 03
0.950000E 00	0.391450E-03	0.994631E 00	0.865165E 03

Table 9

COMPUTER INPUT DATA FOR CESIUM

PRESSURE INPUT DATA

0.100000E 01	0.500000E 01	0.100000E 02	0.200000E 02	0.300000E 02	0.500000E 02
0.100000E 03	0.150000E 03	0.200000E 03	0.300000E 03		

QUALITY INPUT DATA

1.000000E-02	0.300000E-01	0.500000E-01	1.000000E-01	0.200000E-00	0.300000E-00
0.400000E-00	0.500000E 00	0.600000E 00	0.700000E 00	0.800000E 00	0.900000E 00
0.950000E 00					

VG INPUT DATA

0.100000E 03	0.231000E 02	0.124000E 02	0.670000E 01	0.454000E 01	0.293000E 01
0.159000E 01	0.111000E 01	0.860000E 00	0.620000E 00		

VF INPUT DATA

0.924200E-02	0.940200E-02	0.948400E-02	0.959000E-02	0.966100E-02	0.976000E-02
0.991600E-02	0.100260E-01	0.101160E-01	0.102550E-01		

SG INPUT DATA

0.386000E-00	0.366300E-00	0.358100E-00	0.350400E-00	0.346000E-00	0.340600E-00
0.333900E-00	0.330300E-00	0.327900E-00	0.324800E-00		

SF INPUT DATA

0.216350E-00	0.224500E-00	0.228700E-00	0.233100E-00	0.235850E-00	0.239700E-00
0.245340E-00	0.248940E-00	0.251660E-00	0.255850E-00		

DVGDP INPUT DATA

-0.100000E 03	-0.400000E 01	-0.110000E 01	-0.300000E-00	-0.135000E-00	-0.510000E-01
-0.140000E-01	-0.700000E-02	-0.350000E-02	-0.175000E-02		

DSGDP INPUT DATA

-0.120000E-01	-0.230000E-02	-0.120000E-02	-0.550000E-03	-0.367000E-03	-0.210000E-03
-0.900000E-04	-0.600000E-04	-0.400000E-04	-0.225000E-04		

DSFDP INPUT DATA

0.500000E-02	0.120000E-02	0.600000E-03	0.350000E-03	0.225000E-03	0.160000E-03
0.900000E-04	0.650000E-04	0.487500E-04	0.337500E-04		

Table 10

CRITICAL FLOW DATA FOR CESIUM

PRESSURE,PSIA = 0.100000E 01
SLIP RATIO K = 0.104020E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.284704E-01	0.512363E 00	0.189163E 03
0.300000E-01	-0.264663E-01	0.762871E 00	0.119605E 03
0.500000E-01	-0.244621E-01	0.845554E 00	0.892438E 02
1.000000E-01	-0.194518E-01	0.920368E 00	0.555033E 02
0.200000E-00	-0.943118E-02	0.962970E 00	0.319518E 02
0.300000E-00	0.589449E-03	0.978061E 00	0.224915E 02
0.400000E-00	0.106101E-01	0.985785E 00	0.173644E 02
0.500000E 00	0.206307E-01	0.990478E 00	0.141441E 02
0.600000E 00	0.306513E-01	0.993632E 00	0.119326E 02
0.700000E 00	0.406720E-01	0.995897E 00	0.103197E 02
0.800000E 00	0.506926E-01	0.997602E 00	0.909120E 01
0.900000E 00	0.607132E-01	0.998933E 00	0.812421E 01
0.950000E 00	0.657235E-01	0.999494E 00	0.771399E 01

PRESSURE,PSIA = 0.500000E 01
SLIP RATIO K = 0.495674E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.821580E-02	0.333636E-00	0.612834E 03
0.300000E-01	-0.772214E-02	0.605213E 00	0.446328E 03
0.500000E-01	-0.722849E-02	0.722900E 00	0.356589E 03
1.000000E-01	-0.599436E-02	0.846331E 00	0.241771E 03
0.200000E-00	-0.352609E-02	0.925328E 00	0.149518E 03
0.300000E-00	-0.105783E-02	0.955042E 00	0.108761E 03
0.400000E-00	0.141044E-02	0.970627E 00	0.855831E 02
0.500000E 00	0.387870E-02	0.980224E 00	0.705870E 02
0.600000E 00	0.634697E-02	0.986729E 00	0.600779E 02
0.700000E 00	0.881523E-02	0.991428E 00	0.522997E 02
0.800000E 00	0.112835E-01	0.994982E 00	0.463083E 02
0.900000E 00	0.137518E-01	0.997763E 00	0.415506E 02
0.950000E 00	0.149859E-01	0.998939E 00	0.395209E 02

PRESSURE,PSIA = 0.100000E 02
SLIP RATIO K = 0.361589E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.449768E-02	0.267529E-00	0.101903E 04
0.300000E-01	-0.421947E-02	0.527927E 00	0.778167E 03
0.500000E-01	-0.394127E-02	0.655541E 00	0.636532E 03
1.000000E-01	-0.324575E-02	0.800704E 00	0.444075E 03
0.200000E-00	-0.185471E-02	0.900396E 00	0.280811E 03
0.300000E-00	-0.463679E-03	0.939382E 00	0.206289E 03
0.400000E-00	0.927357E-03	0.960169E 00	0.163250E 03
0.500000E 00	0.231839E-02	0.973089E 00	0.135144E 03
0.600000E 00	0.370943E-02	0.981897E 00	0.115324E 03
0.700000E 00	0.510046E-02	0.988286E 00	0.100588E 03
0.800000E 00	0.649150E-02	0.993134E 00	0.891990E 02
0.900000E 00	0.788253E-02	0.996937E 00	0.801306E 02
0.950000E 00	0.857805E-02	0.998547E 00	0.762555E 02

PRESSURE,PSIA = 0.200000E 02
SLIP RATIO K = 0.264319E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.290708E-02	0.210727E-00	0.155362E 04
0.300000E-01	-0.275362E-02	0.449788E-00	0.124986E 04
0.500000E-01	-0.260017E-02	0.581791E 00	0.105446E 04
1.000000E-01	-0.221654E-02	0.745991E 00	0.768439E 03
0.200000E-00	-0.144928E-02	0.868559E 00	0.505879E 03
0.300000E-00	-0.682012E-03	0.918884E 00	0.379154E 03
0.400000E-00	0.852515E-04	0.946298E 00	0.303739E 03
0.500000E 00	0.852515E-03	0.963546E 00	0.253536E 03
0.600000E 00	0.161978E-02	0.975398E 00	0.217654E 03
0.700000E 00	0.238704E-02	0.984045E 00	0.190708E 03
0.800000E 00	0.315431E-02	0.990630E 00	0.169720E 03
0.900000E 00	0.392157E-02	0.995814E 00	0.152904E 03
0.950000E 00	0.430520E-02	0.998013E 00	0.145690E 03

Table 10 (Contd.)

PRESSURE,PSIA = 0.300000E 02
SLIP RATIO K = 0.216779E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.198892E-02	0.179634E-00	0.211750E 04
0.300000E-01	-0.188143E-02	0.401359E-00	0.174615E 04
0.500000E-01	-0.177394E-02	0.532916E 00	0.149491E 04
1.000000E-01	-0.150522E-02	0.706629E 00	0.111117E 04
0.200000E-00	-0.967771E-03	0.844224E 00	0.743758E 03
0.300000E-00	-0.430322E-03	0.902823E 00	0.561702E 03
0.400000E-00	0.107127E-03	0.935283E 00	0.451978E 03
0.500000E 00	0.644576E-03	0.955904E 00	0.378378E 03
0.600000E 00	0.118202E-02	0.970164E 00	0.325503E 03
0.700000E 00	0.171947E-02	0.980613E 00	0.285649E 03
0.800000E 00	0.225692E-02	0.988599E 00	0.254518E 03
0.900000E 00	0.279437E-02	0.994901E 00	0.229523E 03
0.950000E 00	0.306310E-02	0.997578E 00	0.218785E 03

PRESSURE,PSIA = 0.500000E 02
SLIP RATIO K = 0.173264E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.154906E-02	0.148947E-00	0.276042E 04
0.300000E-01	-0.147572E-02	0.348903E-00	0.236045E 04
0.500000E-01	-0.140238E-02	0.476965E-00	0.207292E 04
1.000000E-01	-0.121903E-02	0.658138E 00	0.160603E 04
0.200000E-00	-0.852329E-03	0.812439E 00	0.112410E 04
0.300000E-00	-0.485629E-03	0.881314E 00	0.870363E 03
0.400000E-00	-0.118930E-03	0.920325E 00	0.711794E 03
0.500000E 00	0.247770E-03	0.945434E 00	0.602760E 03
0.600000E 00	0.614470E-03	0.962949E 00	0.522991E 03
0.700000E 00	0.981169E-03	0.975862E 00	0.462020E 03
0.800000E 00	0.134787E-02	0.985776E 00	0.413864E 03
0.900000E 00	0.171457E-02	0.993628E 00	0.374848E 03
0.950000E 00	0.189792E-02	0.996972E 00	0.357988E 03

PRESSURE,PSIA = 0.100000E 03
SLIP RATIO K = 0.126628E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.995935E-03	0.113402E-00	0.414739E 04
0.300000E-01	-0.955285E-03	0.281420E-00	0.367654E 04
0.500000E-01	-0.914634E-03	0.399927E-00	0.331307E 04
1.000000E-01	-0.813008E-03	0.584542E 00	0.267733E 04
0.200000E-00	-0.609756E-03	0.759945E 00	0.196008E 04
0.300000E-00	-0.406504E-03	0.844405E 00	0.155598E 04
0.400000E-00	-0.203252E-03	0.894089E 00	0.129342E 04
0.500000E 00	-0.	0.926809E 00	0.110808E 04
0.600000E 00	0.203252E-03	0.949986E 00	0.969871E 03
0.700000E 00	0.406504E-03	0.967263E 00	0.862673E 03
0.800000E 00	0.609756E-03	0.980639E 00	0.777015E 03
0.900000E 00	0.813008E-03	0.991302E 00	0.706953E 03
0.950000E 00	0.914634E-03	0.995861E 00	0.676489E 03

PRESSURE,PSIA = 0.150000E 03
SLIP RATIO K = 0.105220E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.783555E-03	0.960719E-01	0.520516E 04
0.300000E-01	-0.752827E-03	0.245523E-00	0.469378E 04
0.500000E-01	-0.722099E-03	0.356412E-00	0.428429E 04
1.000000E-01	-0.645280E-03	0.538981E 00	0.353814E 04
0.200000E-00	-0.491642E-03	0.724556E 00	0.265240E 04
0.300000E-00	-0.338004E-03	0.818493E 00	0.213357E 04
0.400000E-00	-0.184366E-03	0.875229E 00	0.178889E 04
0.500000E 00	-0.307276E-04	0.913209E 00	0.154198E 04
0.600000E 00	0.122911E-03	0.940416E 00	0.135590E 04
0.700000E 00	0.276549E-03	0.960863E 00	0.121039E 04
0.800000E 00	0.430187E-03	0.976792E 00	0.109338E 04
0.900000E 00	0.583825E-03	0.989550E 00	0.997175E 03
0.950000E 00	0.660644E-03	0.995023E 00	0.955203E 03

Table 10 (Contd.)

PRESSURE,PSIA = 0.200000E 03
SLIP RATIO K = 0.922029E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.627787E-03	0.851993E-01	0.629261E 04
0.300000E-01	-0.604505E-03	0.221889E-00	0.576475E 04
0.500000E-01	-0.581224E-03	0.326726E-00	0.533065E 04
1.000000E-01	-0.523019E-03	0.506045E 00	0.451308E 04
0.200000E-00	-0.406611E-03	0.697435E 00	0.349527E 04
0.300000E-00	-0.290202E-03	0.798043E 00	0.287236E 04
0.400000E-00	-0.173793E-03	0.860078E 00	0.244594E 04
0.500000E 00	-0.573846E-04	0.902155E 00	0.213350E 04
0.600000E 00	0.590241E-04	0.932571E 00	0.189379E 04
0.700000E 00	0.175433E-03	0.955583E 00	0.170360E 04
0.800000E 00	0.291842E-03	0.973602E 00	0.154879E 04
0.900000E 00	0.408250E-03	0.988093E 00	0.142019E 04
0.950000E 00	0.466455E-03	0.994324E 00	0.136369E 04

PRESSURE,PSIA = 0.300000E 03
SLIP RATIO K = 0.777549E 01

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.481327E-03	0.728210E-01	0.792526E 04
0.300000E-01	-0.465011E-03	0.193860E-00	0.734790E 04
0.500000E-01	-0.448695E-03	0.290396E-00	0.685958E 04
1.000000E-01	-0.407904E-03	0.463503E-00	0.590790E 04
0.200000E-00	-0.326323E-03	0.660311E 00	0.466782E 04
0.300000E-00	-0.244743E-03	0.769179E 00	0.388061E 04
0.400000E-00	-0.163162E-03	0.838284E 00	0.333003E 04
0.500000E 00	-0.815809E-04	0.886046E 00	0.292082E 04
0.600000E 00	-0.329766E-11	0.921031E 00	0.260361E 04
0.700000E 00	0.815808E-04	0.947761E 00	0.234995E 04
0.800000E 00	0.163162E-03	0.968849E 00	0.214217E 04
0.900000E 00	0.244743E-03	0.985911E 00	0.196870E 04
0.950000E 00	0.285533E-03	0.993277E 00	0.189224E 04

Table 11

COMPUTER INPUT DATA FOR SODIUM

		PRESSURE INPUT DATA			
0.500000E-01	1.000000E-01	0.500000E 00	0.100000E 01	0.500000E 01	0.100000E 02
0.200000E 02	0.300000E 02	0.500000E 02	0.100000E 03	0.150000E 03	
		QUALITY INPUT DATA			
1.000000E-02	0.300000E-01	0.500000E-01	1.000000E-01	0.200000E-00	0.300000E-00
0.400000E-00	0.500000E 00	0.600000E 00	0.700000E 00	0.800000E 00	0.900000E 00
0.950000E 00					
		VG INPUT DATA			
0.178000E 05	0.615000E 04	0.140000E 04	0.700000E 03	0.165000E 03	0.845000E 02
0.450000E 02	0.305000E 02	0.193000E 02	0.100000E 02	0.700000E 01	
		VF INPUT DATA			
0.192800E-01	0.195200E-01	0.199600E-01	0.202400E-01	0.209900E-01	0.213900E-01
0.218300E-01	0.221100E-01	0.225100E-01	0.231400E-01	0.235400E-01	
		SG INPUT DATA			
0.226400E 01	0.219500E 01	0.206900E 01	0.201500E 01	0.189600E 01	0.185100E 01
0.179900E 01	0.177300E 01	0.174000E 01	0.169800E 01	0.167500E 01	
		SF INPUT DATA			
0.894800E 00	0.906500E 00	0.941000E 00	0.956100E 00	0.994000E 00	0.101250E 01
0.103320E 01	0.104570E 01	0.106300E 01	0.108970E 01	0.110600E 01	
		DVGDP INPUT DATA			
-0.350000E 06	-0.525000E 05	-0.250000E 04	-0.500000E 03	-0.350000E 02	-0.775000E 01
-0.200000E 01	-0.104000E 01	-0.400000E-00	-1.000000E-01	-0.375000E-01	
		DSGDP INPUT DATA			
-0.235000E 01	-0.850000E 00	-0.160000E-00	-0.700000E-01	-0.130000E-01	-0.700000E-02
-0.320000E-02	-0.220000E-02	-0.130000E-02	-0.590000E-03	-0.400000E-03	
		DSFDP INPUT DATA			
0.350000E-00	0.167000E-00	0.450000E-01	0.220000E-01	0.500000E-02	0.300000E-02
0.160000E-02	0.110000E-02	0.750000E-03	0.425000E-03	0.286000E-03	

Table 12

CRITICAL FLOW DATA FOR SODIUM

PRESSURE,PSIA = 0.500000E-01
SLIP RATIO K = 0.960852E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.235904E-00	0.906591E 00	0.594612E 01
0.300000E-01	-0.196465E-00	0.967445E 00	0.292419E 01
0.500000E-01	-0.157026E-00	0.980609E 00	0.198479E 01
1.000000E-01	-0.584283E-01	0.990720E 00	0.111308E 01
0.200000E-00	0.138767E-00	0.995854E 00	0.595687E 00
0.300000E-00	0.335963E-00	0.997577E 00	0.407060E-00
0.400000E-00	0.533158E 00	0.998441E 00	0.309227E-00
0.500000E 00	0.730353E 00	0.998960E 00	0.249325E-00
0.600000E 00	0.927549E 00	0.999307E 00	0.208872E-00
0.700000E 00	0.112474E 01	0.999554E 00	0.179716E-00
0.800000E 00	0.132194E 01	0.999740E 00	0.157703E-00
0.900000E 00	0.151914E 01	0.999884E 00	0.140496E-00
0.950000E 00	0.161773E 01	0.999945E 00	0.133228E-00

PRESSURE,PSIA = 1.000000E-01
SLIP RATIO K = 0.561303E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.121715E-00	0.850069E 00	0.139708E 02
0.300000E-01	-0.105929E-00	0.945533E 00	0.712889E 01
0.500000E-01	-0.901436E-01	0.967259E 00	0.490272E 01
1.000000E-01	-0.506791E-01	0.984219E 00	0.278774E 01
0.200000E-00	0.282499E-01	0.992924E 00	0.150575E 01
0.300000E-00	0.107179E-00	0.995860E 00	0.103265E 01
0.400000E-00	0.186108E-00	0.997335E 00	0.785969E 00
0.500000E 00	0.265037E-00	0.998222E 00	0.634473E 00
0.600000E 00	0.343966E-00	0.998814E 00	0.531961E 00
0.700000E 00	0.422895E-00	0.999237E 00	0.457975E-00
0.800000E 00	0.501824E 00	0.999555E 00	0.402061E-00
0.900000E 00	0.580753E 00	0.999802E 00	0.358317E-00
0.950000E 00	0.620217E 00	0.999906E 00	0.339831E-00

PRESSURE,PSIA = 0.500000E 00
SLIP RATIO K = 0.264840E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.380762E-01	0.727902E 00	0.507178E 02
0.300000E-01	-0.344415E-01	0.891197E 00	0.283757E 02
0.500000E-01	-0.308067E-01	0.933061E 00	0.202538E 02
1.000000E-01	-0.217199E-01	0.967134E 00	0.120160E 02
0.200000E-00	-0.354610E-02	0.985121E 00	0.669268E 01
0.300000E-00	0.146277E-01	0.991267E 00	0.464794E 01
0.400000E-00	0.328014E-01	0.994368E 00	0.356196E 01
0.500000E 00	0.509752E-01	0.996238E 00	0.288784E 01
0.600000E 00	0.691489E-01	0.997489E 00	0.242846E 01
0.700000E 00	0.873227E-01	0.998384E 00	0.209525E 01
0.800000E 00	0.105496E-00	0.999057E 00	0.184249E 01
0.900000E 00	0.123670E-00	0.999581E 00	0.164417E 01
0.950000E 00	0.132757E-00	0.999801E 00	0.156020E 01

PRESSURE,PSIA = 0.100000E 01
SLIP RATIO K = 0.185970E 03

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.199075E-01	0.652595E 00	0.961658E 02
0.300000E-01	-0.181698E-01	0.851888E 00	0.571587E 02
0.500000E-01	-0.164321E-01	0.907304E 00	0.419196E 02
1.000000E-01	-0.120880E-01	0.953839E 00	0.257249E 02
0.200000E-00	-0.339975E-02	0.978944E 00	0.147207E 02
0.300000E-00	0.528851E-02	0.987609E 00	0.103449E 02
0.400000E-00	0.139768E-01	0.991999E 00	0.798088E 01
0.500000E 00	0.226650E-01	0.994652E 00	0.649821E 01
0.600000E 00	0.313533E-01	0.996428E 00	0.548084E 01
0.700000E 00	0.400416E-01	0.997701E 00	0.473922E 01
0.800000E 00	0.487298E-01	0.998658E 00	0.417454E 01
0.900000E 00	0.574181E-01	0.999403E 00	0.373018E 01
0.950000E 00	0.617622E-01	0.999717E 00	0.354170E 01

Table 12 (Contd.)

PRESSURE,PSIA = 0.500000E 01
SLIP RATIO K = 0.886616E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.534368E-02	0.472455E-00	0.323482E 03
0.300000E-01	-0.494457E-02	0.732771E 00	0.206216E 03
0.500000E-01	-0.454545E-02	0.823521E 00	0.153693E 03
1.000000E-01	-0.354767E-02	0.907845E 00	0.950687E 02
0.200000E-00	-0.155211E-02	0.956832E 00	0.543620E 02
0.300000E-00	0.443459E-03	0.974358E 00	0.381352E 02
0.400000E-00	0.243902E-02	0.983363E 00	0.293819E 02
0.500000E 00	0.443459E-02	0.988847E 00	0.239006E 02
0.600000E 00	0.643015E-02	0.992537E 00	0.201443E 02
0.700000E 00	0.842572E-02	0.995189E 00	0.174090E 02
0.800000E 00	0.104213E-01	0.997188E 00	0.153281E 02
0.900000E 00	0.124169E-01	0.998748E 00	0.136916E 02
0.950000E 00	0.134146E-01	0.999407E 00	0.129979E 02

PRESSURE,PSIA = 0.100000E 02
SLIP RATIO K = 0.628526E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.345856E-02	0.388332E-00	0.525237E 03
0.300000E-01	-0.322004E-02	0.660314E 00	0.364532E 03
0.500000E-01	-0.298151E-02	0.767875E 00	0.283923E 03
1.000000E-01	-0.238521E-02	0.874743E 00	0.186056E 03
0.200000E-00	-0.119261E-02	0.940167E 00	0.111656E 03
0.300000E-00	-0.347094E-10	0.964205E 00	0.800611E 02
0.400000E-00	0.119261E-02	0.976691E 00	0.624647E 02
0.500000E 00	0.238521E-02	0.984339E 00	0.512286E 02
0.600000E 00	0.357782E-02	0.989504E 00	0.434259E 02
0.700000E 00	0.477042E-02	0.993228E 00	0.376893E 02
0.800000E 00	0.596303E-02	0.996038E 00	0.332932E 02
0.900000E 00	0.715563E-02	0.998235E 00	0.298164E 02
0.950000E 00	0.775194E-02	0.999163E 00	0.283370E 02

PRESSURE,PSIA = 0.200000E 02
SLIP RATIO K = 0.454025E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.202664E-02	0.314416E-00	0.857260E 03
0.300000E-01	-0.190128E-02	0.584061E 00	0.630135E 03
0.500000E-01	-0.177592E-02	0.704980E 00	0.505042E 03
1.000000E-01	-0.146252E-02	0.834566E 00	0.343100E 03
0.200000E-00	-0.835727E-03	0.919032E 00	0.212116E 03
0.300000E-00	-0.208932E-03	0.951120E 00	0.154182E 03
0.400000E-00	0.417864E-03	0.968019E 00	0.121254E 03
0.500000E 00	0.104466E-02	0.978449E 00	0.999627E 02
0.600000E 00	0.167145E-02	0.985529E 00	0.850508E 02
0.700000E 00	0.229825E-02	0.990649E 00	0.740191E 02
0.800000E 00	0.292505E-02	0.994524E 00	0.655251E 02
0.900000E 00	0.355184E-02	0.997559E 00	0.587823E 02
0.950000E 00	0.386524E-02	0.998842E 00	0.559065E 02

PRESSURE,PSIA = 0.300000E 02
SLIP RATIO K = 0.371412E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.146707E-02	0.272814E-00	0.113915E 04
0.300000E-01	-0.137632E-02	0.534601E 00	0.855511E 03
0.500000E-01	-0.128558E-02	0.661567E 00	0.691485E 03
1.000000E-01	-0.105871E-02	0.804946E 00	0.472976E 03
0.200000E-00	-0.604977E-03	0.902774E 00	0.292933E 03
0.300000E-00	-0.151244E-03	0.940890E 00	0.212853E 03
0.400000E-00	0.302489E-03	0.961181E 00	0.167308E 03
0.500000E 00	0.756222E-03	0.973782E 00	0.137866E 03
0.600000E 00	0.120995E-02	0.982367E 00	0.117255E 03
0.700000E 00	0.166369E-02	0.988593E 00	0.102014E 03
0.800000E 00	0.211742E-02	0.993314E 00	0.902835E 02
0.900000E 00	0.257115E-02	0.997017E 00	0.809753E 02
0.950000E 00	0.279802E-02	0.998585E 00	0.770063E 02

Table 12 (Contd.)

PRESSURE,PSIA = 0.500000E 02
SLIP RATIO K = 0.292813E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.107755E-02	0.228259E-00	0.154791E 04
0.300000E-01	-0.101699E-02	0.475233E-00	0.121307E 04
0.500000E-01	-0.956425E-03	0.606473E 00	0.100524E 04
1.000000E-01	-0.805022E-03	0.764898E 00	0.711742E 03
0.200000E-00	-0.502216E-03	0.879813E 00	0.454547E 03
0.300000E-00	-0.199409E-03	0.926195E 00	0.335163E 03
0.400000E-00	0.103397E-03	0.951269E 00	0.265746E 03
0.500000E 00	0.406204E-03	0.966976E 00	0.220250E 03
0.600000E 00	0.709010E-03	0.977739E 00	0.188095E 03
0.700000E 00	0.101182E-02	0.985575E 00	0.164153E 03
0.800000E 00	0.131462E-02	0.991534E 00	0.145627E 03
0.900000E 00	0.161743E-02	0.996220E 00	0.130865E 03
0.950000E 00	0.176883E-02	0.998206E 00	0.124553E 03

PRESSURE,PSIA = 0.100000E 03
SLIP RATIO K = 0.207883E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.681983E-03	0.173542E-00	0.239885E 04
0.300000E-01	-0.648611E-03	0.391334E-00	0.198515E 04
0.500000E-01	-0.615239E-03	0.522472E 00	0.170267E 04
1.000000E-01	-0.531810E-03	0.697868E 00	0.126804E 04
0.200000E-00	-0.364951E-03	0.838633E 00	0.849411E 03
0.300000E-00	-0.198093E-03	0.899084E 00	0.641468E 03
0.400000E-00	-0.312346E-04	0.932700E 00	0.516079E 03
0.500000E 00	0.135624E-03	0.954104E 00	0.431967E 03
0.600000E 00	0.302482E-03	0.968927E 00	0.371547E 03
0.700000E 00	0.469341E-03	0.979800E 00	0.326012E 03
0.800000E 00	0.636199E-03	0.988117E 00	0.290450E 03
0.900000E 00	0.803058E-03	0.994684E 00	0.261901E 03
0.950000E 00	0.886487E-03	0.997475E 00	0.249637E 03

PRESSURE,PSIA = 0.150000E 03
SLIP RATIO K = 0.172443E 02

QUALITY,X	DX/DP	VOID FRACTION,A	MASS VELOCITY,G
1.000000E-02	-0.490580E-03	0.148345E-00	0.317004E 04
0.300000E-01	-0.466467E-03	0.347824E-00	0.271805E 04
0.500000E-01	-0.442355E-03	0.475780E-00	0.239239E 04
1.000000E-01	-0.382074E-03	0.657069E 00	0.186187E 04
0.200000E-00	-0.261511E-03	0.811714E 00	0.131103E 04
0.300000E-00	-0.140949E-03	0.880816E 00	0.101908E 04
0.400000E-00	-0.203866E-04	0.919976E 00	0.835726E 03
0.500000E 00	0.100176E-03	0.945188E 00	0.709167E 03
0.600000E 00	0.220738E-03	0.962779E 00	0.616300E 03
0.700000E 00	0.341301E-03	0.975750E 00	0.545144E 03
0.800000E 00	0.461863E-03	0.985710E 00	0.488831E 03
0.900000E 00	0.582425E-03	0.993598E 00	0.443131E 03
0.950000E 00	0.642706E-03	0.996957E 00	0.423360E 03

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REFERENCES

1. H. S. Isbin, J. E. Moy, and A. J. R. Cruz, Two-phase, Steam-Water Critical Flow, A.I.Ch.E. Journal, 3, 361-365 (1957).
2. D. W. Faletti, Two-phase Critical Flow of Steam-Water Mixtures, Ph.D. Thesis, University of Washington (1959).
3. D. W. Faletti and R. W. Moulton, Two-phase Critical Flow of Steam-Water Mixtures, A.I.Ch.E. Journal, 9, 247-253 (1963).
4. H. K. Fauske, Critical Two-phase, Steam-Water Flows, 1961 Proc. Heat Transfer and Fluid Mech. Inst., Stanford University Press, Stanford, p. 79 (1961).
5. H. K. Fauske, Contribution to the Theory of Two-phase, One-component Critical Flow, ANL-6633 (Oct 1962).
6. F. R. Zaloudek, The Low Pressure Critical Discharge of Steam-Water Mixtures from Pipes, HW-68934 Rev. (March 1961).
7. R. James, Steam-Water Critical Flow through Pipes, Proc. of the Institution of Mechanical Engineers, Thermodynamics and Fluid Mechanics Group, 176(26) (1962).
8. R. S. Pyle, STDY-3, A Program for the Thermal Analysis of a Pressurized Water Nuclear Reactor during Steady-state Operation, Westinghouse Electric Corp, Bettis Atomic Power Laboratory, Pittsburgh, Pa. (June 1961).
9. W. A. Massena, Steam-Water Pressure Drop and Critical Discharge Flow, A Digital Computer Program, HW-65706 (June 1960).
10. A. N. Nahavandi and M. P. Rashevsky, A Digital Computer Program for Critical Flow Discharge of Two-phase Steam-Water Mixtures, CVNA-128 (Feb 1962).
11. W. D. Weatherford, Jr., J. C. Tyler, and P. M. Ku, Properties of Inorganic Energy-Conversion and Heat Transfer Fluids for Space Applications, WADD TR 61-96 (Nov 1961).

NOMENCLATURE

G	mass flow rate, $lb_m/(sec)(ft^2)$
g	gravitational constant, 32.2 ft/sec^2
g_c	conversion factor, 32.2 lb_m-$ft/(lb_f)(sec^2)$
k	$\bar{u}_g/\bar{u}_f$ - slip ratio, dimensionless
p	static pressure, lb_f/ft^2
s	entropy, Btu/lb
u	velocity, ft/sec
$\bar{u}$	average velocity, ft/sec
v	specific volume, ft^3/lb_m
x	length in direction of flow, ft

Greek Letters

α	void fraction, dimensionless
ρ	density, lb_m/ft^3
τ	shear force, lb_f/ft^2
χ	quality, dimensionless

Subscripts

f	refers to liquid phase
g	refers to vapor phase
fg	change in properties between the vapor and liquid state
i	refers to the ith phase
s	refers to differentiation under conditions of constant entropy