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CAVITATION AND TWO-PHASE FLOW CHARACTERISTICS OF SRPR (SAVANNAH RIVER PLANT REACTOR) PUMP

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ABSTRACT

The possible head degradation of the SRPR pumps may be attributable to two independent phenomena, one due to the inception of cavitation and the other due to the two-phase flow phenomena. The head degradation due to the appearance of cavitation on the pump blade is hardly likely in the conventional pressurized water reactor (PWR) since the coolant circulating line is highly pressurized so that the cavitation is difficult to occur even at LOCA (loss of coolant accident) conditions. (Note that the line pressure at PWR is as high as 2500 psi., see the paper of Furuya(1985)).) On the other hand, the suction pressure of SRPR pump is order-of-magnitude smaller than that of PWR so that the cavitation phenomena may prevail, should LOCA occur, depending on the extent of LOCA condition. In this study, therefore, both cavitation phenomena and two-phase flow phenomena were investigated for the SRPR pump by using various analytical tools and the numerical results are presented herein.

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1. Introduction

The possible head degradation of the SRPR pumps may be attributable to two independent phenomena, one due to the inception of cavitation and the other due to the two-phase flow phenomena. The head degradation due to the appearance of cavitation on the pump blade is hardly likely in the conventional pressurized water reactor (PWR) since the coolant circulating line is highly pressurized so that the cavitation is difficult to occur even at LOCA (loss of coolant accident) conditions. (Note that the line pressure at PWR is as high as 2500 psi., see the paper of Furuya(1985)).) On the other hand, the suction pressure of SRPR pump is order-of-magnitude smaller than that of PWR so that the cavitation phenomena may prevail, should LOCA occur, depending on the extent of LOCA condition. In this study, therefore, both cavitation phenomena and two-phase flow phenomena were investigated for the SRPR pump by using various analytical tools and the numerical results are presented herein. In the following the contents of each section will be briefly described.

Section 2:

The objective of Task 2, Task 6, Task 13 and Task 14 is therefore to determine the performance of the SRPR pump operating under the cavitating conditions. The tasks involved are therefore i) to identify the type of pump used for the SRPR since the type of the analytical tool varies, depending on the geometry of the pump. Then, ii) a theory is developed to analyze the performance of the SRPR pump operating under the cavitating condition with the intention to conduct a numerical analysis based on the theory developed herein.

It has been found however that numerical difficulties existed with the analytical method so that a computational method was employed to determine the performance of the cavitating pump including both the head and torque. The contents included herein correspond to Task 2a (a theory development), Task 2b (the head calculation for the AC motor operation), Task 6 (that for the DC motor operation), Task 13 (the torque calculation for the AC motor operation) and Task 14 (that for the DC motor operation).

Section 3:

Under the hypothetical loss of coolant accident (LOCA) conditions, there is a possibility that the water level of the coolant tank becomes so low that air may be ingested into the water line. The coolant pump then experiences the air/water flow going through the blades. As has been demonstrated by experiments conducted by Babcock & Wilcox (1977) and Creare (1982) as well as the

theory of Furuya (1985), the head of the pump operating under the air/water two-phase flow condition severely degrades as the inlet void fraction reaches about 20% or higher (although this threshold point for the degradation varies depending on the type of pump and operational conditions). It is crucial from the reactor safety viewpoints to determine the extent of the pump head degradation either theoretically or experimentally. However, this type of experiments is too costly and time consuming.

The objective of Task 3, Task 9 and Task 15 is therefore to theoretically determine the head and torque degradation of the SRPR pump operating under the air/water two-phase flow conditions for various physical, hydrodynamic and mechanical conditions. The parameters which represent such conditions include the inlet void fraction, static pressure at upstream, flow rate and pump rotational speed. During the normal cooling operation, the SRPR pump is driven by the AC motor at 1,000 rpm as the rated speed, while under the emergency condition, it is operated by the DC motor at 300 rpm as its rated speed. The head vs. flow rate curves between these two operations are quite different.

Two types of pump flow configurations were used for the present work. One is the pump configuration normally used for the single flow design and analysis where the pump blade flow passage is used and the diffuser effect is ignored or treated empirically in terms of the head loss and torque change (Tasks 3 and 9). The other is the pump configuration with diffuser section added. (Task 15)

In Tasks 3 and 9 the air/water flow pump performance under the AC motor operation were calculated without diffuser over a range of the line static pressure of 0.05, 1, 2 and 3 atm, inlet void fraction of 0.00 to 0.98 and normalized flow parameter of 0.4 to 1.4. The normalized head and torque are presented in the form of figures as well as of tables. Furthermore, the detailed data obtained as the results of the pump calculations are provided, including the void fraction, static pressure and water/air relative flow velocities at exit of the pump blade.

In Task 15 similar calculations were made with the pump diffuser incorporated over a range of the line static pressure of 0.5, 1, 2 and 3 atm, inlet void fraction of 0.00 to 0.98 and normalized flow parameter of 0.02 to 1.4. The static pressure increase, liquid velocity, gas velocity and void fraction at the discharge flange section were obtained and presented in tabular form.

Section 4:

In Task 7 and Task 9, the air/water flow pump performance including the head and torque degradation under the DC motor operation without the diffuser section was calculated over a range of the line static pressure of 0.05, 1, 2 and 3 atm, inlet void fraction of 0.00 to 0.98 and normalized flow parameter of 0.4 to 1.4. In Task 16, similar calculations were made with the pump diffuser section incorporated for the same parameters as those used above except for the static pressure of 0.5 atm instead of 0.05 and the homologous parameter of 0.2 added. The normalized head is presented both in the form of figures as well as of tables for Task 7 and only tables are provided for Task 16. Furthermore, for Task 7, the detailed data obtained as the results of the pump calculations are provided, including the void fraction, static pressure and water/air relative flow velocities at exit of the pump blade.

Section 5:

The objective of Tasks 4, 8, 11 and 12 is to theoretically determine the head and torque degradation of the SRPR pump operating with both AC and DC motors under the steam/water two-phase flow conditions for various physical, hydrodynamic and mechanical conditions. The parameters which represent such conditions include the inlet void fraction, static pressure at upstream, flow rate and pump rotational speed. During the normal cooling operation, the SRPR pump is driven by the AC motor at 1,000 rpm as the rated speed, while under the emergency condition, it is operated by the DC motor at 300 rpm as its rated speed.

The mathematical formula for analyzing the steam/water two-phase flow pump performance was developed some time ago and has been used many times for the purpose of comparing the calculated results with existing experimental results. The correlations obtained to date were found out to be good. The major difference between the previous calculations and the present case lies in the fact that the static line pressure of the previous cases was in a range of 2000 psi since the coolant pumps are for the pressurized water reactor, whereas that of the SRPRP case is 0.05 atm (0.7 psi) to 3 atms (44 psi). This large difference in the static pressure made the numerical computations extremely unstable since the enthalpy changes so abruptly as a function of the pressure for the latter case.

The results of computations showed fair stability for the AC motor operation while those for the DC motor operation showed total instability for lower pressure cases.

The causes for such instability were investigated, but no definite conclusions have been made to date, requiring further investigation for stabilizing the numerical calculations for the low pressure two-phase flow cases.

2. Cavitating Flow Performance of SRPR (Savannah River Plant Reactor) Pumps (Tasks 2, 6, 13 and 14)

2.1 Objectives

The possible head degradation of the SRPR pumps may be attributable to two independent phenomena, one due to the inception of cavitation and the other due to the two-phase flow phenomena. The head degradation due to the appearance of cavitation on the pump blade is hardly likely in the conventional pressurized water reactor (PWR) since the coolant circulating line is highly pressurized so that the cavitation is difficult to occur even at LOCA (loss of coolant accident) conditions. (Note that the line pressure at PWR is as high as 2500 psi., see the paper of Furuya(1985)).) On the other hand, the suction pressure of SRPR pump is order-of-magnitude smaller than that of PWR so that the cavitation phenomena may prevail, should LOCA occur, depending on the extent of LOCA condition.

The objective of Tasks 2, 6, 13 and 14 is therefore to determine the extent of head degradation of SRPR pump when the pump starts cavitating. More specifically, when the suction pressure comes down to the atmospheric pressure, is there still any positive head generated by the pump? In order to answer these questions, a proper analytical tool needs to be developed or selected.

The first task is therefore to identify the type of pump used for the SRPR since the type of the analytical tool varies, depending on the geometry of the pump. Once the type of the SRPR pump is identified, an analytical or numerical method is developed or selected to determine the cavitation characteristics of the pump.

2.2 Development of Analytical Model

2.2.1 Identification of Type of Pump Used for SRPR

Based on the available hardware data, the radii of various blade points along the hub (called the "inner radii" and indicated by "RI") and those along the tip (called the "outer radii" and indicated by "RO") were measured as a function of the angle. The results are shown in Table 2.2.1-1 and Figure 2.2.1-2 (see also Figure 2.2.1-1 which shows a schematic diagram of the plan and side views of the pump

blade).

If this blade profile shape is made as a well-known logarithmic spiral, the angular coordinate θ and radius r should satisfy the following relationship

$$\theta = \cot \beta \cdot \ln r/r_1 \quad (2.2.1-1)$$

where the definitions of θ , β , r and r_1 are shown in Figure 2.2.1-2.

Using r_1 and r_2 (i.e., the innermost radius and outermost radius) in Eqn. (2.2.1-1) for both RI and RO, β can be calculated as follows;

	RI	RO
r_1 (inch)	7.05	9.78
r_2 (inch)	20.5	21.0
β (degree)	15.071°	10.790°

With this β value used, the angle, θ , was recalculated by using Eqn. (2.2.1-1). If this blade profile is made truly in a logarithmic spiral shape, the calculated angle should match with the measured one exactly. The last two columns of Table 2.2.1-1 show such results, indicating that the blade profile shape along the hub of the SRPR pump is made exactly in a logarithmic spiral form with $\beta = 15.071^\circ$. Figure 2.2.1-3 shows the plottings of the angle as a function of station number: the straight line actually consists of the measured and calculated values based on the radius along the hub (RI) which totally match with each other. On the other hand, the calculated value based on the radius along the shroud (RO) forms a curved line which somewhat deviates from the straight line. This fact indicates that the blade shape along the hub is made exactly in a logarithmic spiral shape while that along the shroud slightly deviates from it. However, it is considered to be a fair assumption that the SRPR pump is essentially designed in a logarithmic spiral profile shape so that very little error will be generated by using this assumption for the cavity flow analysis.

2.2.2 Theory Development

A radial pump of logarithmic spiral blades can be conveniently mapped into a linear cascade by a well-known mapping function. A conformal mapping method combined with the mixed boundary value problem solution method will be used for the development of a supercavitating pump flow theory.

Boundary Conditions

The Bernoulli equation in the rotating frame gives the following relationship

$$\rho (w^2 - u^2)/2 + p = p_t \text{ (constant)} \quad (2.2.2-1)$$

where u is the circumferential velocity, w the relative velocity, ρ the liquid density, p the static pressure and p_t the total pressure which is constant along the flow. The static pressure p inside or on the boundaries of the cavity is assumed to be that of the vapor pressure of the liquid p_v , therefore,

$$w_u = u_2 \sqrt{\sigma + (r/r_2)^2} \quad (2.2.2-2)$$

where σ is defined as the cavitation number

$$\begin{aligned} \sigma &= (p_t - p_v) / (\frac{1}{2} \rho u_2^2) \\ &= [\rho (w_1^2 - u_1^2)/2 + p_1 - p_v] / (\frac{1}{2} \rho u_2^2). \end{aligned} \quad (2.2.2-3)$$

Under the assumption that the cavity boundary is close to the blade,

$$w_c = w_s \quad (2.2.2-4)$$

where w_s is the relative flow velocity tangent to the blade surface. The flow tangency condition is then applied to the blade surface:

$$w_n = 0 \quad (2.2.2-5)$$

It should be noted that the relative flow velocities in the rotating machinery, w_n and w_s , consist of four separate components, i.e., the blade through flow due to the flow rate Q , the prerotation Γ_1 , the rotation of blade (Ω) and the perturbation components (v_n' , v_s') due to the existence of blade and cavity,

$$w_n = (Q/2\pi r) \cos \beta - (r\Omega - \Gamma_1/2\pi r) \sin \beta + v_n' \quad (2.2.2-6)$$

$$w_s = (Q/2\pi r) \sin \beta + (r\Omega - \Gamma_1/2\pi r) \cos \beta + v_s' \quad (2.2.2-7)$$

v_n' and v_s' in these equations are the irrotational components so that all the tools available for the potential theory are conveniently employed. In terms of these potential flow components, the boundary conditions on the blade and cavity are now written:

i) on the blade:

$$v_n' = - (Q/2\pi r) \cos \beta + (r\Omega - \Gamma_1/2\pi r) \sin \beta \quad (2.2.2-8)$$

ii) on the cavity boundary:

$$\begin{aligned} v_s' = u_2 \sqrt{\sigma + (r/r_2)^2} - (Q/2\pi r) \sin \beta \\ - (r\Omega - \Gamma_1/2\pi r) \cos \beta \end{aligned} \quad (2.2.2-9)$$

Conformal Mappings

The blades of logarithmic spiral profile shape in the physical plane are first mapped to a linear cascade plane ω , which is then mapped to the upper half of a mixed-boundary value problem plane ζ . The first mapping is achieved by

$$\omega = N e^{-i\gamma} \ln (z/r_1) \quad (2.2.2-10)$$

where $\omega = \phi + i\psi$, which maps N logarithmic spiral blades shown in Figure 2.2.2-1 to a linear cascade of stagger angle γ having a spacing of 2π (see Figure 2.2.2-2) and ω is defined in Figure 2-2-2-3. The normal and tangential velocity components, v_n' and v_s' , in the z -plane are related to those in the ω -plane through the following equations

$$v = - (r/N) v_n' \quad (2.2.2-11)$$

$$u = (r/N) v_\theta' \quad (2.2.2-12)$$

where the complex potential F in the z - and ω -plane has been utilized as follows:

$$dF/d\omega = u - iv$$

$$dF/dz e^{i\theta} = v_r - i v_\theta$$

$$= (v_n - i v_\theta) e^{i\beta}$$

$$dF/d\omega = (dF/dz) (dz/d\omega). \quad (2.2.2-13)$$

The second mapping is performed through the following mapping function (see the paper of Sutherland and Cohen (1958))

$$\begin{aligned} \omega = & e^{i\gamma} \ln[(1-\zeta/\zeta_1)/(1-\zeta/\zeta_2)] \\ & + e^{-i\gamma} \ln[(1-\zeta/\zeta_1^*)/(1-\zeta/\zeta_2^*)] \end{aligned} \quad (2.2.2-14)$$

where

$$\zeta_1 = e^{i(\pi/2-\omega)}, \quad \zeta_2 = a e^{i(\pi/2+\omega)} \quad (2.2.2-15)$$

ζ_1^*, ζ_2^* are the complex conjugates of ζ_1 and ζ_2

and the mapping parameters a and ω are determined through the scaling between the two planes as follows;

$$\tan \omega = [(a-1)/(a+1)] \tan \gamma \quad (2.2.2-16)$$

$$\ell/2\pi = (\cos \gamma \cdot \ln a + 2 \omega \sin \gamma) / \pi. \quad (2.2.2-17)$$

ζ_1 and ζ_2 in the ζ -plane correspond to the points at the upstream and downstream infinities in the ω -plane where the end point of cavity, ω_T is now mapped to the infinity point in the ζ -plane (see Figure 2.2.2-3). The coordinate relationship between the ζ - and ω -planes is given

$$\begin{aligned} \phi(\xi) = & \cos \gamma \cdot [\ln (1 + \xi^2 - 2\xi \cdot \sin \omega) - \\ & \ln (1 + (\xi/a)^2 + 2 (\xi/a) \sin \omega)] + \\ & 2 \sin \gamma \cdot \tan^{-1} [((a-1) \xi \cos \omega + \xi^2 \sin 2\omega) / \\ & (a-(a-1) \xi \sin \omega + \xi^2 \cos 2\omega)] . \end{aligned} \quad (2.2.2-18)$$

Mixed-Type Boundary Value Problem

The velocity potential $W(\omega) = W(\zeta)$ is defined

$$W(\omega) = W(\zeta) = u - i v . \quad (2.2.2-19)$$

Through an analytical continuation of $W(\zeta)$ into the lower half of the ζ -plane

$$W(\zeta^*) = -W(\zeta)^* = -u - i v , \quad (2.2.2-20)$$

the boundary conditions are now written either by the real or imaginary part of $W(\zeta)$, i.e., u or v , in the following form;

$$W^+ + W^- = -2iv$$

$$W^+ - W^- = 2u.$$

where the superscript "+" or "-" indicates the limiting value of W approaching from the positive or negative (or upper or lower) side of the ξ -axis. Therefore, on the real axis of the ζ -plane, i.e., ξ -axis,

$$-\infty < \xi < -b ; W^+ - W^- = 2u \quad (2.2.2-21)$$

$$-b < \xi < 0 ; W^+ + W^- = -2iv \quad (2.2.2-22)$$

$$0 < \xi < \infty ; W^+ - W^- = 2u \quad (2.2.2-23)$$

This mixed type boundary value problem may be solved by applying the Plemelj's theory (see the text of Muskeleshville (1946)). First, the $W(\xi)$ is written by the product of the homogeneous solution $H(\xi)$ and the general solution $G(\xi)$

$$W(\xi) = H(\xi) G(\xi). \quad (2.2.2-24)$$

By assuming the singularity at the leading edge and no singularity at the trailing edge of the blade, the following form of the homogeneous solution is selected

$$H(\xi) = \sqrt{(\xi + b)/\xi} \quad (2.2.2-25)$$

where the branch cut on the real axis ξ from $-b$ to 0 has been introduced. It is noted however that although no singularity was specifically selected for the cavity end point at this stage, the mapping function automatically provides a quarter root singularity at the cavity end similar to that of the leading edge of the blade. The homogeneous function has the following characteristics on the real axis of ξ -plane

$$-\infty < \xi < -b ; H^+(\xi) = \sqrt{(\xi + b)/\xi} = H^-(\xi)$$

$$-b < \xi < 0 ; H^+(\xi) = \sqrt{-(\xi + b)/\xi/i} = -H^-(\xi)$$

$$0 < \xi < \infty ; H^+(\xi) = \sqrt{(\xi + b)/\xi} = H^-(\xi).$$

In terms of $G(\xi)$,

$$\begin{aligned} G^+ - G^- &= (W/H)^+ - (W/H)^- \\ &= (W^+ - W^-)/H^+ = 2u / \sqrt{(\xi + b)/\xi}, \quad -\infty < \xi < -b \\ &= (W^+ + W^-)/H^+ = 2v / \sqrt{-(\xi + b)/\xi}, \quad -b < \xi < 0 \end{aligned}$$

$$= (W^+ - W^-)/H^+ = 2u/\sqrt{(\xi + b)/\xi}, \quad 0 < \xi < \infty.$$

The application of the Plemelj's theorem yields to

$$\begin{aligned} W(\zeta) &= H(\zeta) G(\zeta) \\ &= \sqrt{(\zeta + b)/\zeta} \left[(1/2\pi i) \int_{-\infty}^{\infty} (G^+ - G^-) d\xi' / (\xi' - \zeta) + P(\zeta) \right] \\ &= \sqrt{(\zeta + b)/\zeta} \left[(1/2\pi i) \int_{-\infty}^b 2u/\sqrt{(\xi' + b)/\xi'} d\xi' / (\xi' - \zeta) + \right. \\ &\quad \left. (1/2\pi i) \int_b^0 2v/\sqrt{-(\xi' + b)/\xi'} d\xi' / (\xi' - \zeta) + \right. \\ &\quad \left. (1/2\pi i) \int_0^{\infty} 2u/\sqrt{(\xi' + b)/\xi'} d\xi' / (\xi' - \zeta) \right. \\ &\quad \left. + P(\zeta) \right] \end{aligned} \tag{2.2.2-26}$$

where $P(\zeta) = \sum C_n \zeta^n$ ($n = -\infty$ to $+\infty$).

However, $P(\zeta)$ cannot have any stronger singularity at $\zeta = 0$, only the form $P(\zeta)$ can take is

$$P(\zeta) = A\zeta + B$$

where A and B are real constants to be determined. Further, it should be noted that the mapping function between the ω - and ζ -planes provides the following relationship as has been mentioned earlier

$$\zeta \approx 1/(\omega - e')^{1/2}; \quad \zeta \rightarrow \infty$$

where e' is the cavity length in the ω -plane.

2.2.3 Solution Method and Head

In the previous section, the perturbed complex velocities, $W = u - iv$, have been obtained with the boundary conditions assumed to be known. In this expression there exist three unknown parameters, i.e., b , A and B . b represents the coordinate for the cavity length so that, if the cavity length in the physical plane z is given, b can be calculated through the mapping functions. These three unknown parameters are uniquely determined by three independent boundary conditions; two of them are provided from the perturbed flow velocities at the upstream infinity and the third one is provided by the cavity closure condition:

$$W(\zeta_1) = 0 + i \cdot 0 \quad (\text{two equations}) \quad (2.2.3-1)$$

$$\text{Re}[W(\zeta_2) e^{-i\gamma}] = 0 \quad (\text{one equation}) \quad (2.2.3-2)$$

See Appendix 2A for the detailed expressions for Eqns. (2.2.3-1) and (2.2.3-2) and Appendix 2B for the derivation of the cavity closure condition.

The three equations obtained above are linear in terms of A and B , but nonlinear in terms of b .

The objective of the present study is to determine the maximum cavity length when the static pressure at inlet drops to the vapor pressure and then to obtain the corresponding head. Therefore, the problem is posed in the following manner. By assuming $p_1 = p_v$, the cavitation number is determined based on the given flow rate Q and pump rotation speed Ω . The three equations obtained above are solved for b , A and B by using the Newton's iterative procedure (see Appendix 2C for the more explicit explanation for the Newton's method). The head is then obtained at this limiting condition by balancing the angular momentum

$$H = \text{Im}[W(\zeta_2) e^{-i\gamma}] N\Omega/g. \quad (2.2.3-3)$$

Appendix 2D provides the detailed derivation of this formula.

2.2.4 References

Furuya, O., 1975, "Exact Supercavitating Cascade Theory", J. of Fluids Eng., ASME, vol. 97, no.4, 419-429.

Furuya, O., 1980, "Nonlinear Theory for Partially Cavitating Cascade Flows", Proc. 10th Symp. of IAHR, Tokyo, 221-241.

Furuya, O., 1985, "An Analytical Model for Prediction of Two-Phase (Noncondensable) Flow Pump Performance", J. of Fluids Eng., ASME, vol. 109, 139-147.

Muskhelishvili, N. I., 1946, Singular Integral Equations, P. Noordhoff Ltd., Gronigen, Holland.

Sutherland, C. D. and Cohen, H., 1958, "Finite Cavity Cascade Flow", Proc. 3rd. Nat'l Congress of Applied Mechanics, 837-845.

2.2.5 Nomenclature

- a:** one of two mapping parameters between the ω -plane and ζ -plane
- b:** the ξ -coordinate representing the blade trailing edge
- c, c':** the blade chord length in the physical and the linea cascade plane, respectively
- F:** complex potential ($dF/d\omega = u - i v$)
- g:** the gravitational acceleration
- G:** the general solution to the Riemann-Hilbert boundary problem
- H:** the hydrodynamic head; also used as the homogeneous solution to the present Riemann-Hilbert boundary value problem
- L, L' :** length of cavity in the physical (z -) and ω -plane, respectively
- p:** the static pressure
- p_t :** the total pressure (see Equation 2.2.2-1)
- p_v :** the vapor pressure
- Q:** flow rate
- r:** the radial coordinate in the physical (z -)plane
- Re, Im:** the real and imaginary parts of the complex quantities, respectively
- u, v:** the perturbed velocities in the physical (z -)plane
- u', v' :** the perturbed velocities in the mapped (ω -)plane
- u_1, u_2 :** the circumferential velocities at inlet and exit of the blade, respectively
- v_r, v_θ :** the radial and circumferential velocities in the physical (z -)plane, respectively
- w_1, w_2 :** the relative flow velocities at inlet and exit of the blade in the rotating frame
- W:** the velocity potential in the ζ -plane ($= u - i v$)
- z:** the physical plane ($= x + i y$)

- β : the blade angle (see Figure 2.2.2-1 and Equation 2.2.1-1)
- γ : the complementary blade angle ($= \pi/2 - \beta$)
- Γ_1 : the strength of the pre-swirl at inlet of the pump
- ζ : the mapped plane ($= \xi + i \eta$)
- ζ_1, ζ_2 : the ζ coordinates corresponding to the upstream and downstream infinity points, respectively
- σ : cavitation number (see Equation 2.2.2-3)
- ω : one of two mapping parameters for the mapping between the ω -plane and ζ -plane
- ω : mapped plane ($= \phi + i \psi$)
- Ω : pump rotational speed

Superscripts and Subscripts:

- 1,2: the quantities at inlet and exit of the pump, respectively
- c: the quantity related to the cavity
- n: the quantity normal to the blade surface
- s: the quantity parallel to the blade surface

2.3 Computational Method

As an alternative to the potential theory described above, the computational method may be considered to determine the performance of the cavity flow of the SRPR pump. In this method the discrete vortex γ is distributed over the entire flow boundaries including the pump blade and cavity boundaries. The induced velocities u and v will then be expressed

$$(u - iv)(z) = Q / 2\pi z + \sum_{n=1}^N 1/2\pi \int i\gamma_n(s) ds / (z - \zeta_n(s)) \quad (2.3.1-1)$$

where ζ_n is the coordinate on the boundaries and $\gamma_n(s)$ is the strength of the vortex. The first term of Eqn. (2.3.1-1) is the contribution of the source of the flow similar to those in Eqns. (2.2.2-6) and (2.2.2-7). The boundary conditions on the solid boundary and the cavity remain the same as those used for the potential flow theory in Section 2.2

2.4 Numerical Results--Head and Torque Calculations

In order to determine the performance of the SRPR pump operating under the cavitating conditions, either of the methods described above may be used. However, due to the numerical difficulties expected with the potential theory, the computational method was used herein to obtain the results.

The torque of the cavitating pump has been calculated through the conventional input-power-to-hydraulic-energy relationship,

$$T = (\rho g Q H) / (\eta \omega)$$

where the pump efficiency of the single-phase flow provided in the report of E.I. du Pont, Savannah River Laboratory, No. DPST-88-777 has been used. The power loss caused by the form drag due to the cavitation was not include since the loss of head is so rapid and the power increase due to such term will not play any essential role in the system hydraulic analysis.

Figure 2.4.1 and Figure 2.4.2 show the head in terms of feet vs. cavitation number with the flow rate as a parameter for the AC motor of 1000 rpm and the DC motor of 300 rpm, respectively. The

conversion from the cavitation number σ to the line static pressure p is readily made by use of the following relation:

$$\sigma = (p_t - p_v) / (\frac{1}{2} \rho u_2^2) \quad (2.4-1)$$

where

$$p_t = p + \rho v_r^2 / 2 \text{ (total head at inlet of the pump)} \quad p = \text{line static pressure (pounds / ft}^2\text{)}$$

$$v_r = Q \times 0.00223 / (4\pi r_1 b_1)$$

$$Q = \text{flow rate (gpm)}$$

$$r_1 = \text{the inner radius of the blade (16.25/2/12 in feet)}$$

$$b_1 = \text{the flow channel width at inlet (5.7/12 in feet)}$$

$$\rho = \text{the density of the heavy water (slug / ft}^3\text{)} \quad (2.4-2)$$

$$p_v = \text{the vapor pressure of the heavy water (which is the function of temperature, pounds / ft}^2\text{)}$$

$$u_2 = 2 \pi \Omega r_2$$

$$\Omega = \text{pump rotational speed in rps (rounds per second, i.e., for the AC motor } \Omega = 1000/60 \text{ and for the DC motor } \Omega = 300/60 \text{)}$$

$$r_2 = \text{the outer radius of the blade (39.5/2/12 in feet)}$$

Tables 2.4.1a through 2.4.1f provide the detail data for the head in terms of feet and the torque in terms of lbf-ft vs. cavitation number for both the AC motor and DC motor cases with the flow rate as a parameter.

2.5 Correlation between the Calculated Results and Experimental Results for Cavitation Inception of Savannah River Reactor Pump

The cavitation number σ is defined as

$$\sigma = (p_t - p_v) / (\frac{1}{2} \rho u_2^2) \quad (2.5-1)$$

where

$$p_t = p + \rho v_r^2 / 2$$

$$p = \text{line static pressure}$$

$$v_r = \text{flow velocity at inlet of blade}$$

$$= Q \times 0.00223 / (4 \pi r_1 b_1)$$

$$Q = \text{flow rate in gpm}$$

$$p_v = \text{vapor pressure}$$

r_1 = the inner radius of the blade (16.25/2/12 in feet)

b_1 = the flow channel width at inlet (5.7/12 in feet)

$\rho(T)$ = the density of the heavy water

$$u_2 = 2 \pi \Omega r_2$$

Ω = pump rotational speed in rps (rounds per second,
i.e., for the AC motor $\Omega = 1000/60$)

r_2 = the outlet radius of the pump (39.5/2/12 in feet).

On the other hand, NPSH used in EG&G Report No. EGG-EAST-8148 (1988) was defined

$$\text{NPSH} = (p - p_v) / \gamma(T) + v_{ps}^2 / 2g \quad (2.5-2)$$

where

NPSH = net positive suction head, feet

v_{ps} = average cross sectional velocity at pump suction,
feet/sec. (= $Q \times 0.00223 / \pi (23.25/12/2)^2$)

$\gamma(T)$ = specific weight of the liquid (= $\rho(T) g$).

From Equations (2.5-1) and (2.5-2), the relationship between the cavitation number and NPSH is given,

$$\text{NPSH} = \sigma u_2^2 / 2g + (v_{ps}^2 - v_r^2) / 2g. \quad (2.5-3)$$

By using Equation (2.5-3), the calculated cavitation numbers σ for inception shown in the OF Tech report mentioned above are converted into NPSH and shown in Table 2.5-1 below.

The experimental data for the NPSH where the head starts degrading are read from the Figure F2 at page 235 of the EG&G report mentioned above and are shown in Table 2.5-2.

Table 2.5-1 NPSH vs Cavitation Inception Number σ
as a Function of Flow Rate

Q (gpm)	σ	NPSH in feet (calc.)
9,391	0.008	4.19
15,652	0.0130	7.25
18,782	0.0150	8.66
25,043	0.0125	8.65
28,173	0.1150	58.21
34,434	0.3800	186.16

These two results are plotted in Figure 2.5-1, indicating that the first four points of the $(NPSH)_{calc}$ values smoothly blend into those of the experimental data. It seems to be quite reasonable to utilize both the calculated results for the low flow rate range and the experimental data for the high flow rate range for determining the threshold points for head degradation. More specifically, the first four data points of calculation and all four experimental data points were used to determine the best fitted polynomial equation of third order:

$$NPSH_i = a_0 + a_1 Q + a_2 Q^2 + a_3 Q^3 + \Delta NPSH_i (T) \quad , \quad \Omega = 1000\text{rpm} \quad (2.5-4)$$

where

$NPSH_i$ = net positive suction head at which the cavitation occurs or the head degradation starts occurring (feet)

Q = flow rate in Kgpm

a_0 = -35.3366

a_1 = 7.57104

a_2 = -0.441945

a_3 = 0.00868303

$\Delta NPSH_i (T)$ = correction term due to the fluid temperature (feet)

$$= b_0 + b_1 (T-95) + b_2 (T-95)^2 + b_3 (T-95)^3$$

$$b_0 = 0.$$

$$b_1 = -0.0908805$$

$$b_2 = -0.000745422$$

$$b_3 = -1.337E-06$$

$$T = \text{temperature in } ^\circ\text{C}.$$

Table 2.5-2 NPSH-expt. as a Function of Flow Rate
at $T = 95^\circ\text{C}$

Q (gpm)	NPSH in feet (expt.)
22,000	11.5
25,000	14.5
28,000	18.0
30,000	30.0

The correction term for the fluid temperature for the NPSH_i value was obtained from Figure F3 of the EG&G report which shows the effect of the fluid temperature on the cavitation inception or the NPSH value at which the head starts degrading. The procedure for determining the $\Delta\text{NPSH}_i(T)$ was that first the difference of NPSH values from those at 95°C were plotted as a function of the fluid temperature for all the flow rate data (see Figure 2.5-2) and the best fitted polynomial curve was obtained.

Equation 2.5-4 now can be used as the threshold point where the head starts degrading. The slope of degradation may be determined by following the slope shown in Figure F of EG&G report for the flow rate of 22 Kgpm or higher and that of dropping almost vertically to a degree as long as numerical stability is guaranteed for the lower flow rate.

It should be noted that when NPSH value hits 0 as the flow rate Q becomes small (defining this Q as Q_c), $\text{NPSH} = 0$ should be used for the flow rate equal to Q_c or smaller.

For the rotational speed different from the AC motor rated speed, i.e., $\Omega = 1000$ rpm, the following step should be applied for determining $(NPSH)_i$.

1) Step 1:

Find the geometrically similar flow rate Q_g from the following relationship:

$$Q_g = (1000/\Omega) Q$$

where Ω is the rotational speed at which the pump is operated and Q is the flow rate.

2) Step 2:

Use Equation (2.5-4) to find the corresponding $NPSH_g$ at which the pump would cavitate if it were at $\Omega = 1000$.

3) Step 3:

Calculate the equivalent cavitation number σ_g by using Equation (2.5-3) with $\Omega = 1000$ and Q_g used.

4) Step 4:

Recalculate $NPSH$ ($= NPSH_i$) by using Equation (2.5-4) again with now real Ω and Q for $NPSH_i$ to be obtained.

Table 2.2.1-1

Representative Geometric Data of SRPR Pump

Station No.	Angle from left (degree)	Angle from right (degree)	Outer Radius (inch) RO	Inner Radius (inch) RI	Logarithmic Spiral Fitting based on	
					RO	RI
1.0	0.0	232.5	21.00	20.50	232.50	232.50
1.5	7.5	225.0	20.25	19.80	221.44	224.93
2.0	15.0	217.5	19.58	19.11	211.20	217.21
2.5	22.5	210.0	18.90	18.47	200.44	209.79
3.0	30.0	202.5	18.21	17.83	189.13	202.10
3.5	37.5	195.0	17.61	17.23	178.94	194.65
4.0	45.0	187.5	16.98	16.63	167.85	186.93
4.5	52.5	180.0	16.40	16.10	157.28	179.87
5.0	60.0	172.5	15.84	15.55	146.71	172.30
5.5	67.5	165.0	15.30	15.00	136.15	164.46
6.0	75.0	157.5	14.78	14.52	125.63	157.37
7.0	90.0	142.5	13.83	13.57	105.42	142.64
8.0	105.0	127.5	12.94	12.62	85.18	126.83
9.0	120.0	112.5	12.18	11.76	66.77	111.45
10.0	135.0	97.5	11.52	11.00	49.82	96.90
11.0	150.0	82.5	10.98	10.28	35.21	82.16
12.0	165.0	67.5	10.60	9.60	24.50	67.25
13.0	180.0	52.5	10.30	8.95	15.76	51.98
14.0	195.0	37.5	10.03	8.35	7.68	36.86
15.0	210.0	22.5	9.87	7.78	2.79	21.46
16.0	225.0	7.5	9.80	7.27	0.62	6.69
16.5	232.5	0.0	9.78	7.05	0.00	0.00

Table 2.4.1a

Head vs. Cavitation No. of SRPR Pump
with Flow Rate as a Parameter for both
AC Motor (1,000rpm) and DC Motor (300rpm) Operations

Cavitation No. (sigma)	AC Motor (Q=9,391gpm)		DC Motor (Q=2,817gpm)	
	Head (feet)	Torque (lbf-ft)	Head (feet)	Torque (lbf-ft)
0.0600	530	11,583	46.9	1,025
0.0500	530	11,583	46.9	1,025
0.0400	534	11,670	47.3	1,034
0.0300	543	11,867	48.1	1,051
0.0200	554	12,107	49.1	1,073
0.0180	557	12,173	49.4	1,080
0.0160	560	12,238	49.6	1,084
0.0140	563	12,304	49.9	1,091
0.0120	565	12,348	50.1	1,095
0.0100	566	12,396	50.2	1,097
0.0080	564	12,326	50.0	1,097
0.0070	96	2,098	7.9	173
0.0069	0	0	0.0	0

Table 2.4.1b

The Same as Table 2.4.1a except for Different Flow Rates

Cavitation No. (sigma)	AC Motor (Q=15,652gpm)		DC Motor (Q=4,696gpm)	
	Head (feet)	Torque (lbf-ft)	Head (feet)	Torque (lbf-ft)
0.1000	505	14,079	46.8	1,305
0.0850	510	14,218	47.3	1,319
0.0645	515	14,358	47.7	1,330
0.0600	522	14,553	48.4	1,349
0.0580	524	14,609	48.5	1,352
0.0500	526	14,664	48.7	1,358
0.0400	528	14,720	48.9	1,363
0.0300	530	14,776	49.1	1,369
0.0200	531	14,804	49.2	1,372
0.0165	532	14,832	49.3	1,374
0.0130	533	14,860	49.4	1,377
0.0120	136	3,792	13.7	382
0.0119	0	0	0.0	0

Table 2.4.1c

The Same as Table 2.4.1a except for Different Flow Rates

Cavitation No. (sigma)	AC Motor (Q=18,782gpm)		DC Motor (Q=5,635gpm)	
	Head (feet)	Torque (lbf-ft)	Head (feet)	Torque (lbf-ft)
0.0700	486	15,241	46.9	1,471
0.0600	486	15,241	46.9	1,471
0.0500	486	15,241	46.9	1,471
0.0450	489	15,335	47.1	1,477
0.0400	494	15,492	47.6	1,493
0.0300	508	15,931	48.8	1,530
0.0200	520	16,307	49.9	1,565
0.0180	524	16,433	50.3	1,577
0.0160	527	16,527	50.5	1,584
0.0150	529	16,589	50.7	1,590
0.0145	243	7,620	25.0	784
0.0144	0	0	0.0	0

Table 2.4.1d

The Same as Table 2.4.1a except for Different Flow Rates

Cavitation No. (sigma)	AC Motor (Q=25,043gpm)		DC Motor (Q=7,513gpm)	
	Head (feet)	Torque (lbf-ft)	Head (feet)	Torque (lbf-ft)
0.0600	429	17,349	47.2	1,909
0.0500	429	17,349	47.2	1,909
0.0400	430	17,389	47.3	1,913
0.0300	431	17,430	47.4	1,917
0.0250	432	17,470	47.5	1,921
0.0200	433	17,511	47.6	1,925
0.0180	435	17,591	47.8	1,933
0.0160	439	17,753	48.1	1,945
0.0145	441	17,834	48.3	1,953
0.0125	442	17,874	48.4	1,957
0.0120	299	12,092	35.5	1,436
0.0119	0	0	0.0	0

Table 2.4.1e

The Same as Table 2.4.1a except for Different Flow Rates

Cavitation No. (sigma)	AC Motor (Q=28,173gpm)		DC Motor (Q=8,452gpm)	
	Head (feet)	Torque (lbf-ft)	Head (feet)	Torque (lbf-ft)
0.3500	387	18,144	47.5	2,227
0.3000	387	18,144	47.5	2,227
0.2500	388	18,191	47.6	2,232
0.2250	389	18,238	47.7	2,236
0.2000	391	18,332	47.9	2,245
0.1750	396	18,566	48.3	2,265
0.1500	401	18,801	48.8	2,288
0.1250	402	18,848	48.9	2,293
0.1200	404	18,942	49.1	2,302
0.1150	403	18,895	49.0	2,297
0.1100	242	11,346	34.5	1,618
0.1090	0	0	0.0	0

Table 2.4.1f

The Same as Table 2.4.1a except for Different Flow Rates

Cavitation No. (sigma)	AC Motor (Q=34,434gpm)		DC Motor (Q=10,330pm)	
	Head (feet)	Torque (lbf-ft)	Head (feet)	Torque (lbf-ft)
0.7000	267	18,033	48.3	3,262
0.6000	267	18,033	48.3	3,262
0.5500	267	18,033	48.3	3,262
0.4500	277	18,709	49.2	3,323
0.4000	281	18,979	49.6	3,350
0.3850	286	19,316	50.0	3,377
0.3800	277	18,709	49.2	3,323
0.3750	92	6,214	32.6	2,202
0.3740	0	0	0.0	0

Figure 2.2.1-1
Typical Plan and Side Views of a Radial Pump

Figure 2.2.1-2

INNER AND OUTER RADIUS OF SRP PUMP

Figure 2.2.1-3

PROOF OF LOGARITHMIC SPIRALNESS OF SRP PUMP

Figure 2.2.2-3
Mixed Boundary Value Plane $\zeta = \xi + i \eta$

Figure 2.4.1

Cavitation Characteristics of SRPR Pump Performance
(AC Motor Operation, 1,000 rpm)
(See Section 2.4 for Conversion from
Cavitation No. σ to Static Pressure p)

Figure 2.4.2

Cavitation Characteristics of SRPR Pump Performance
(DC Motor Operation, 300 rpm)

Figure 2.5.1

NPSH vs. Flow Rate for SRP Pump

(*: Calculated Results of OF Tech
■: Experimental Result of Bingham
from EG&G Report No. EGG-EAST-8148)

Figure 2.5.2

Difference in NPSH₁ as a Function of Temperature
(from Figure F3 of EGG-EAST-8148)

APPENDIX 2A

Explicit Expressions For Eqs. (2.2.3-1) and (2.2.3-2)

Substituting ζ_1 together with Eqn. (2.2.3-) yields to the following expressions

$$\begin{aligned}
 0 + 0 \cdot i = & \sqrt{(\zeta_1 + b)/\zeta_1} \left[(1/2\pi i) \int_{-\infty}^b 2u / \sqrt{(\xi' + b)/\xi'} d\xi' / (\xi' - \zeta_1) + \right. \\
 & (1/2\pi i) \int_{-b}^0 2v / \sqrt{(b - \xi')/\xi'} d\xi' / (\xi' - \zeta_1) + \\
 & (1/2\pi i) \int_0^{\infty} 2u / \sqrt{(\xi' + b)/\xi'} d\xi' / (\xi' - \zeta_1) \\
 & \left. + A \zeta_1 + B \right] \quad (2A-1)
 \end{aligned}$$

where $\zeta_1 = e^{i(\pi/2 - \omega)}$. In order for the computations to be carried out, Eqn. (2A-1) should be separated into the real and imaginary parts as follows.

i) $\sqrt{(\zeta_1 + b)/\zeta_1} :$

$$\zeta_1 + b = [(\sin \omega + b)^2 + (\cos \omega)^2]^{1/2} e^{i\omega_1}$$

$$= (1 + 2b \sin \omega + b^2)^{1/2} e^{i\omega_1}$$

where

$$\tan \omega_1 = \cos \omega / (\sin \omega + b)$$

$$\zeta_1 = e^{i(\pi/2 - \omega)}$$

Therefore,

$$[(\zeta_1 + b)/\zeta_1]^{1/2} = R_0 + i I_0$$

$$R_0 = (1 + 2b \sin \omega + b^2)^{1/4} \cos [(\omega_1 + \omega - \pi/2)/2]$$

$$I_0 = (1 + 2b \sin \omega + b^2)^{1/4} \sin [(\omega_1 + \omega - \pi/2)/2]$$

ii) $1 / (\xi' - \zeta_1) :$

$$1 / (\xi' - \zeta_1) = R_1(\xi) + i I_1(\xi)$$

where

$$R_1(\xi) = (\xi' - \sin \omega) / (\xi'^2 - 2\xi' \sin \omega + 1)$$

$$I_1(\xi) = \cos \omega / (\xi'^2 - 2\xi' \sin \omega + 1)$$

iii) $A \zeta_1 + B:$

$$A \zeta_1 + B = R_2 + i I_2$$

where

$$R_2 = A \sin \omega + B$$

$$I_2 = B \cos \omega$$

Therefore, Eqn. (2A-1) is written

$$0 + 0 \cdot i = (R_0 + i I_0) [(-i/2\pi) \int_{-\infty}^b 2u / \sqrt{(\xi' + b)/\xi'} (R_1(\xi') + i I_1(\xi')) d\xi' +$$

$$\begin{aligned}
& (-i/2\pi) \int_{-b}^0 2v / \sqrt{(b - \xi')/\xi'} (R_1(\xi') + i I_1(\xi')) d\xi' + \\
& (-i/2\pi) \int_0^\infty 2u / \sqrt{(\xi' + b)/\xi'} (R_1(\xi') + i I_1(\xi')) d\xi' \\
& + R_2 + i I_2] .
\end{aligned}$$

By defining the real and imaginary parts in the square brackets by R_{sum} and I_{sum} , Eqn. (2A-1) is now reduced to the following two equations,

$$R_0 R_{sum} - I_0 I_{sum} = 0 \quad (2A-2)$$

$$R_0 I_{sum} + I_0 R_{sum} = 0 \quad (2A-3)$$

The closure condition of Eqn. (2.2.3-2) is also explicitly expressed in a manner similar to that used above.

$$\begin{aligned}
0 = \text{Re}[W(\zeta_2) e^{-i\gamma}] = \text{Re}(e^{-i\gamma} [& \sqrt{(\zeta_2 + b)/\zeta_2} (1/2\pi i) \int_{-\infty}^b 2u / \sqrt{(\xi' + b)/\xi'} d\xi' / (\xi' - \zeta_2) + \\
& (1/2\pi i) \int_{-b}^0 2v / \sqrt{(b - \xi')/\xi'} d\xi' / (\xi' - \zeta_2) + \\
& (1/2\pi i) \int_0^\infty 2u / \sqrt{(\xi' + b)/\xi'} d\xi' / (\xi' - \zeta_2) \\
& + A \zeta_2 + B]) \quad (2A-4)
\end{aligned}$$

$$\text{iv) } \sqrt{(\zeta_2 + b)/\zeta_2} :$$

$$\sqrt{(\zeta_2 + b)/\zeta_2} = R_{01} + i I_{01}$$

where

$$R_{01} = (a^2 - 2ab \sin \omega + b^2)^{1/4} \cos \omega_2$$

$$I_{01} = (a^2 - 2ab \sin \omega + b^2)^{1/4} \sin \omega_2$$

$$\tan \omega_2 = a \cos \omega / (b - a \sin \omega), \quad b - a \sin \omega > 0,$$

$$\omega_2 = \pi / 2, \quad b - a \sin \omega = 0,$$

$$\omega_2 = \pi - \omega_2', \quad b - a \sin \omega < 0,$$

$$\tan \omega_2' = |a \cos \omega / (b - a \sin \omega)|$$

v) $1 / (\xi' - \zeta_2) :$

$$1 / (\xi' - \zeta_2) = R_3(\xi) + i I_3(\xi)$$

where

$$R_3(\xi) = (\xi' + a \sin \omega) / (\xi'^2 + a^2 + 2 a \xi' \sin \omega)$$

$$I_3(\xi) = a \cos \omega / (\xi'^2 + a^2 + 2 a \xi' \sin \omega)$$

vi) $A \zeta_2 + B :$

$$A \zeta_2 + B = R_4 + i I_4$$

where

$$R_4 = -a \sin \omega + B$$

$$I_4 = a \cos \omega$$

Now defining the real and imaginary parts in the square brackets in Eqn. (2A-4) by R_{sumc} and I_{sumc} ,
Eqn. (2A-4) becomes

$$(R_{01} R_{sumc} - I_{01} I_{sumc}) \cos \gamma$$

$$+ (R_{01} R_{sumc} + I_{01} I_{sumc}) \sin \gamma = 0 \quad (2A-5)$$

APPENDIX 2B

Derivation of the Cavity Closure Condition

The cavity closure condition may be obtained by formally calculating the two streamlines which go through the leading edge of the blade and forcing these two streamlines going along the top and the bottom of the blade and cavity system to match at the end of the cavity. However, it is readily shown that this geometric condition is equivalent to that of having no source inside the cavity-body closure system. In terms of the perturbed velocities, i.e., u and v , in the ω -plane, this condition provides the condition of having zero net mass flow increase across the blade so that

$$(u \cos \gamma - v \sin \gamma) \text{ at the downstream infinity} = 0. \quad (2B-1)$$

In the ζ -plane, Eqn. (2B-1) is written

$$\text{Real} [W(\zeta_2) e^{-i\gamma}] = 0. \quad (2B-2)$$

A more explicit expression of this relationship has already been given in Appendix A.

where the derivatives are taken along the arc length "s" along the flow passage or the stream surface and "A" denotes the cross section area of the blade passage normal to the direction of "s". All other symbols are summarized in the section above (Section 3.2.1 Nomenclature).

The momentum equation for the gas bubble is written

$$\begin{aligned} \frac{d}{ds} (\rho_g \alpha w_g^2 A) + C_{Vm} \rho_l w_g \frac{d}{ds} [(w_g - w_l) \alpha A] \\ = - \frac{dp}{ds} \cdot \alpha A + \rho_g \alpha A r \omega^2 \frac{dr}{ds} + \frac{C_d}{r_g} \cdot \frac{3}{8} \cdot \rho_l \alpha A (w_g - w_l) \cdot |w_g - w_l| \end{aligned} \quad (3.2.1-3)$$

It should be noted that the second term on the left hand side of Equation (3.2.1-3) is the added (virtual) mass term, and the second and third terms on the right hand side are the centrifugal force term and the drag force term between the two phases acting on the bubble wall, respectively. The added mass (or virtual mass) coefficient C_{Vm} is theoretically determined to be 0.5 for the case of the bubble having spherical shape (see Landau and Lifshitz (1959)).

On the other hand, the momentum equation for the two-phase flow mixture is provided

$$\begin{aligned} \frac{d}{ds} (\rho_g \alpha w_g^2 A) + \frac{d}{ds} [\rho_l (1 - \alpha) w_l^2 A] \\ = - \frac{dp}{ds} \cdot A + [\rho_g \alpha + \rho_l (1 - \alpha)] r \omega^2 \frac{dr}{ds} \end{aligned} \quad (3.2.1-4)$$

Finally, the polytropic process for the gas phase is expressed by

$$p / \rho_g^\gamma = \text{constant.} \quad (3.2.1-5)$$

3.2.3 Solution Method---Homologous Head (Task 3)

There are five unknown parameters on the present equations, i.e., α , ρ_g , w_1 , w_g and p for the five equations, Equations (3.2.1-1) to (3.2.1-5). The initial values for these unknown parameters are readily determined by selecting the flow rate, pump rotational speed, inlet void fraction and static pressure together with the pump geometry and the geometry of the flow stream surface. These four nonlinear ordinary differential equations, (3.2.1-1) to (3.2.1-4), with one functional equation (3.2.1-5) can be solved by a typical numerical method such as the Runge-Kutta method, the predictor-corrector method, etc. The accuracy of the numerical computations are tested by changing the number of control points covering the inlet to the exit of the pump. As the results of the computations, these five solution parameters at the exit of the pump are obtained and used to calculate various pump characteristics such as the head and the void fraction at the exit.

3.2.4 Two-Phase Flow Head of Pump (Task 3)

The head of the pump operating under the two-phase flow condition is defined from the energy balance between the inlet and the exit of the pump

$$H_{2\phi} = \frac{p_2 - p_1}{\rho_l g} (1 - x) + \int_1^2 \frac{dp}{\rho_g g} \cdot x$$

$$+ \frac{1}{2g} (v_{l2}^2 - v_{l1}^2) (1 - x) + \frac{1}{2g} (v_{g2}^2 - v_{g1}^2) \cdot x \quad (3.2.4-1)$$

If the density of the gas phase should remain constant (i.e., for example, in the case of solid particle/water flow), then the above equation may be written

$$H_{2\phi} = \frac{p_2 - p_1}{\rho_l g} (1 - x) + \left(\frac{p_2}{\rho_{g2} g} - \frac{p_1}{\rho_{g1} g} \right) \cdot x + \frac{1}{2g} (v_{l2}^2 - v_{l1}^2) (1 - x) + \frac{1}{2g} (v_{g2}^2 - v_{g1}^2) \cdot x \quad (3.2.4-1a)$$

The formula for the head given in Equation (3.2.4-1a) can be reduced to the conventional form if $v_{l1} = v_{l2} = v_{g1} = v_{g2}$ and $\rho_{g1} = \rho_{g2}$, i.e., the assumption of the homogeneous flow and incompressibility,

$$H_{1\phi} = \frac{p_2 - p_1}{\rho g} \quad (3.2.4-2)$$

The complexity in the definition of the two-phase flow head stems from the following two factors:

- i) the change of the gas density between the inlet and exit due to the compressibility, and
- ii) the velocity slip between two-phases, i.e., $v_{l2} \neq v_{g2}$.

It is proved that the sum of the static head at the upstream (or inlet) of the pump between the liquid and the gas phases becomes that of the two-phase mixture flow, which is expressed in a more conventional form, i.e.,

$$\frac{p_1}{\rho_l g} (1 - x) + \frac{p_1}{\rho_{g1} g} x = \frac{p_1}{\rho_{2\phi1} g} \quad (3.2.4-3)$$

where

$$\rho_{2\phi 1} = (1 - \alpha_1) \rho_1 + \alpha_1 \rho_{g1} \quad (3.2.4-4)$$

and the following relationships for x and $(1 - x)$ have been used for the derivation of the right hand side of Equation (3.2.4-4):

$$\begin{aligned} x &= m_g / m \\ 1 - x &= m_l / m \\ m &= m_g + m_l \\ m_g &= A (1 - \alpha_1) w_{l1} \rho_1 \\ m_l &= A \alpha_1 w_{g1} \rho_{g1} \\ w_{l1} &= w_{g1} . \end{aligned}$$

However, the sum of the downstream (or exit) static pressure is expressed somewhat different from the conventional expression, i.e., $p_2 / (\rho_{2\phi 2} g)$ even if $\rho_g = \text{constant}$:

$$\frac{p_2}{\rho_1 g} (1 - x) + \frac{p_2}{\rho_{g2} g} x = \frac{p_2}{\rho_{2\phi 2}^* g} \quad (3.2.4-5)$$

where

$$\rho_{2\phi 2}^* = \frac{(1 - \alpha_2) w_{l2} \rho_1 + \alpha_2 w_{g2} \rho_{g2}}{(1 - \alpha_2) w_{l2} + \alpha_2 w_{g2}} \quad (3.2.4-6)$$

Of course, if $w_{l2} = w_{g2}$,

$$\rho_{2\phi 2}^* = (1 - \alpha_1) \rho_1 + \alpha_2 \rho_{g2} = \rho_{2\phi 2} \quad (3.2.4-7)$$

thus the total static head of the two-phase flow would be written

$$H_{2\phi \text{ conventional}} = \frac{p_2}{\rho_{2\phi 2} g} - \frac{p_1}{\rho_{2\phi 1} g} \quad (3.2.4-8)$$

A similar argument also applies to the dynamic head part of Equation (3.2.4-1a). If $v_{l2} = v_{g2} = v_2$, then the dynamic head part would be written

$$\text{Dynamic Head Part of Equation (3.2.4-1a)} = \frac{1}{2g} (v_2^2 - v_1^2) \quad (3.2.4-9)$$

It has been demonstrated that the head defined for the two-phase flow is clearly different from that of the single-phase flow case due to the existence of the slip between two-phases.

With the understanding of the facts described above, the head of the SRPR pump operating under the air/water two-phase flow conditions will be provided in the form of Equation (3.2.4-1). However, in order for the user to be able to perform various analyses of the pump or the subsequent hydraulic system, the detailed data at the exit of the pump are also necessary, including the void fraction α_2 , the relative flow speeds of liquid and gas, w_{l2} and w_{g2} , and the static pressure p_2 .

One of the important features of the SRPR pump system is that the inlet (or suction) and exit (or discharge) pipe diameters of the pump are different, i.e., 20" and 16". As has been explained above, even if these pipe diameters are the same, the liquid and gas (or air in this case) flow velocities are different due to the slip. Due to this additional complexity, i.e., the difference in the pipe diameters of the SRPR pump system, it is readily seen that providing the so-called flange-to-flange head is meaningless. It should be noted that the present two-phase flow pump model only calculates the flow behavior between the inlet and exit of the pump and the head provided in the following section is only that between these two points. From the exit of the pump blade, these two-phase flow still needs to go through the diffuser section before reaching the discharge pipe section having the diameter of 16". The thermohydraulic calculations of the diffuse part of the pump are therefore left for the system analysis code in consideration of this section being one part of the primary coolant system. It is for this reason that the detailed data at the pump blade exit point are also provided as part of the present calculations.

3.2.5 Theoretical Basis---Homologous Torque (Task-9)

Nomenclature

g :	gravitational acceleration
h :	normalized head ($\equiv H/H_R$)
H :	head in feet
N :	pump rotational speed (rpm)
p :	static pressure
Q :	volumetric flow rate
T :	Torque (lbf-ft)
α :	void fraction
α_N :	normalized rotational speed ($= N/N_R$)
α_Q :	normalized flow rate ($= Q/Q_R$)
ρ :	density
$\rho_{2\phi 1}$:	two-phase flow density at inlet ($= \rho_l (1-\alpha_1) + \rho_{g1} \alpha_1$)
$\rho_{2\phi 2}$:	two-phase flow density at outlet ($= \rho_l (1-\alpha_2) + \rho_{g2} \alpha_2$)
$\rho_{2\phi 12}$:	average two-phase flow density between inlet and outlet ($= (\rho_{2\phi 1} + \rho_{2\phi 2})/2$)
ω :	angular velocity of pump rotor ($= 2\pi N/60$)

Subscripts:

g, l :	denotes the quantities related to the gas and liquid phases, respectively
$1, 2$:	denotes the quantities related to the inlet and exit of the pump, respectively
R :	denotes the quantities at the pump rated condition
2ϕ :	two-phase flow quantities
1ϕ :	single-phase flow quantities

The single-phase and two-two-phase torque will be written, respectively,

$$T_{1\phi} \omega = (H_{1\phi} + \Delta H_{1\phi}) Q \rho_{1\phi} g$$

$$T_{2\phi} \omega = (H_{2\phi} + \Delta H_{1\phi}) Q \rho_{2\phi 12} g$$

By eliminating $\Delta H_{1\phi}$ from these equations and dividing both sides by H_R and ω , one obtains

$$T_{2\phi}\omega/(\rho_{2\phi}gQH_R) - T_{1\phi}\omega/(\rho_{1\phi}gQH_R) = h_{2\phi} - h_{1\phi}.$$

Since $T_{1\phi}\omega/(\rho_{1\phi}gQH_R) = h_{1\phi}/\eta$ and the normalized torque is defined as $\beta_{2\phi} = T_{2\phi} \rho_R / (T_R \rho_{2\phi1})$, the equation above now becomes

$$\beta_{2\phi} (T_R\omega/\rho_{2\phi1}gQH_R)(\rho_{2\phi1}/\rho_R) = h_{2\phi} - h_{1\phi} + h_{1\phi}/\eta.$$

Use of $T_R\omega/(\rho_RgQH_R) = 1/\eta_R$, rearrangement of the terms and division of both sides by α_N^2 will finally lead to the formula for the homologous torque

$$\begin{aligned} \beta_{2\phi} / \alpha_N^2 &= ((h_{2\phi} - h_{1\phi}) + h_{1\phi}/\eta)(\rho_{2\phi12} / \rho_{2\phi1}) \\ &\bullet (\nu / \alpha_N) \eta_R / \alpha_N^2. \end{aligned} \quad (3.2.5-1)$$

The definitions of the various symbols used in this derivation are provide in the subsequent section. The two-phase flow homologous head in this equation has already been calculated for both the AC and DC operations and tabulated in the OF Technology Report No. 88-003 (AC Motor case) and 88-007). These will be utilized for the present calculations. The two-phase flow average density will be calculated by using the pressure and void fraction data at exit of the pump which have also been provided in the reports mentioned above. The rest of the terms in Equation (3.2.5-1) are obtained from the single-phase flow performance of the pump.

The efficiency of the pump is provided in the report of E.I. du Pont, Savannah River Laboratory, NO. DPST-88-777 as follows:

$$\begin{aligned} \eta &= c_1 + c_2 (q/\omega) + c_3 (q/\omega)^2 \\ c_1 &= .1321 \\ c_2 &= 2.980 \\ c_3 &= -2.966 \\ q &= \text{flow rate in ft}^3/\text{sec} \\ \omega &= \text{rotational speed in radian/sec.} \end{aligned}$$

3.3 Numerical Calculations---Without Diffuser (Task 3 and Task 9)

3.3.1 Parametric Range

1) Pump

The SRPR pump is a double suction, double-volute centrifugal pump manufactured by Bingham Corp. having the rated flow rate of 25,000 gpm (12,500 gpm/volute) with the total head of 420 feet at the rated rotational speed of 1,000 rpm. The specific speed N_s is 1,205 in the English units, indicating that the pump is a typical centrifugal pump:

$$\begin{aligned} N_s &= N Q^{1/2} / H^{3/4} \\ &= 1,000 \times 12,500^{1/2} / 420^{3/4} = 1,205 \end{aligned}$$

The head vs. flow rate curve driven by the AC motor at 1,000 rpm is given in Figure 3.3.1-1.

2) Line Static Pressure (p_1)

The following line static pressures were used for the present calculations:

0.05 atm
1.00 atm
2.00 atm
3.00 atm

3) Flow Rate (Q) and Pump Rotational Speed (N)

Since the pump performance only depends on the ratio between the flow rate and the rotational speed, the range of these parameters is expressed in terms of the homologous flow parameter defined by ν / α_N where

$$\nu = Q / Q_R$$

$$\alpha_N = N / N_R$$

The range of the homologous parameter used for the calculations is

$$\nu / \alpha_N = 0.4$$

$$0.6$$

$$0.8$$

$$1.0$$

$$1.2$$

$$1.4$$

With these homologous parameters, the range of the actual flow rate will be 10,000 gpm to 35,000 gpm assuming the constant rotational speed (i.e., 1,000 rpm).

4) Inlet Void Fraction (α_1)

$$\alpha_1 = 0.00 \text{ to } 0.98$$

3.3.2 Results---Homologous Head (Without Diffuser) (Task-3)

Figures 3.3.2-1a to 1d show the homologous head as the function of the inlet void fraction with the homologous flow parameter ν / α_N ranging from 0.04 to 1.4 at the static pressure $p_1 = 3 \text{ atm}$, 2 atm , 1 atm and 0.05 atm , respectively.

Tables 3.3.2-1a to 1d simply provide the homologous head data used for the figures above in terms of the numbers.

Tables 3.3.2-2 to 5 are the detailed pump hydraulic data as discussed in Section 3.2.4. Tables 3.3.2-2a to 2d provide the void fraction at the exit of the pump blade for the same inlet static pressure range while Tables 3.3.2-3a to 3d present the static pressure at the pump blade exit.

Tables 3.3.2-4a to 4d and 3.3.2-5a to 5d provide the relative flow velocities of water and air at the

blade exit of the pump, respectively. These relative flow velocities in these tables were normalized by the pump blade tip speed u_2 at the rated pump rotational speed of 1000 rpm:

$$\begin{aligned} u_2 \text{ at } 1000\text{rpm} &= 2 \pi N_R r_2 / 60 \\ &= 2 \pi \times 1000 \times 21'' / 12 / 60 \\ &= 183.26 \text{ ft/sec} \end{aligned}$$

The absolute velocities of water and air at the exit of the pump blade will be readily calculated from the velocity triangle with the blade angle at the exit $\beta = 17.071^\circ$ known (see the table at page 2-2 of the interim report for Task 2).

3.3.3 Results---Homologous Torque (Without Diffuser) (Task 9)

The following parameters were used in the Formula given in Equation (3.2.5-1) for the AC motor operation:

$$\begin{aligned} Q_R &= 25,000 \text{ gpm} \\ H_R &= 420 \text{ feet} \\ \rho_{Rg} &= 66.6 \text{ lbm/ft}^3 \text{ for the heavy water at 1 atm} \\ T_R &= 16,963 \text{ lbf-ft} \\ \eta_R &= 87.8 \% \\ \rho_{g1g} &= 0.00234 \times 32.17 \times p_1 / 14.7 \text{ lbm/ft}^3 \\ p_1 &= \text{line pressure at inlet in psi} \\ \alpha_N &= 1. (=1000/1000) \end{aligned}$$

Tables 3.3.2-6a to 6d provide the homologous head as the function of the inlet void fraction with the homologous flow parameter ν / α_N ranging from 0.4 to 1.4 at the static pressure $p_1 = 3 \text{ atm}$, 2 atm , 1 atm and 0.05 atm for the AC operation.

3.4 Theoretical Basis---With Diffuser (Task 15)

The diffuser section is mathematically treated in a manner similar to that for the pump blade section except that the centrifugal force is omitted from the momentum equations for both the liquid and gas

phases. Although incorporation of this portion into the existing computer code requires a substantial effort from the viewpoints of controlling various parameters, change is rather straightforward. The purpose of continuing the hydrodynamic computations through the diffuser portion is mainly to obtain the information of the detailed hydrodynamic parameters including the static pressure, liquid velocity, gas velocity and void fraction at the discharge flange. Unlike the single phase flow case, the Bernoulli's equation would not provide any such data since two phases slip in the diffuser section as well.

3.5 Numerical Calculations---With Diffuser (Task 15)

3.5.1 Parametric Range

1) Pump (The same as that of Section 3.3.1)

Rated Flow Rate Q_R : 25,000 gpm (12,500 gpm/volute)
Rated Head H_R : 402.9 feet (Experimental Interpolation)
Rotation Speed (AC Motor): 1,000 rpm

2) Line Static Pressure (p_1)

The following line static pressures were used for the present calculations:

0.5 atm
1.00 atm
2.00 atm
3.00 atm

3) Flow Rate (Q) and Pump Rotational Speed (N)

Since the pump performance only depends on the ratio between the flow rate and the rotational speed, the range of these parameters is expressed in terms of the homologous flow parameter defined by Q/N where

$$\nu = Q / Q_R$$

$$\alpha_N = N / N_R .$$

The range of the homologous parameter used for the calculations is

$$\nu / \alpha_N = 0.2$$

$$0.4$$

$$0.6$$

$$0.8$$

$$1.0$$

$$1.2$$

$$1.4$$

With these homologous parameters, the range of the actual flow rate will be 5,000 gpm to 35,000 gpm assuming the constant rotational speed (i.e., 1,000 rpm).

4) Inlet Void Fraction (α_1)

$$\alpha_1 = 0.00 \text{ to } 0.98$$

3.5.2 Results---Detailed Flow Parameters (Task 15)

Tables 3.5.2-1a to 1d show the static pressure increase ($= p_2 - p_1$) (or decrease in some cases), liquid flow velocity v_{l2} , gas flow velocity v_{g2} and void fraction α_2 at the discharge flange section as the function of the inlet void fraction with the homologous flow parameter ν / α_N ranging from 0.2 to 1.4 at the static pressure $p_1 = 3 \text{ atm}$, 2 atm , 1 atm and 0.5 atm , respectively.

3.6 References

Babcock & Wilcox, 1977, *One third scale air water pump program, Test program and pump performance*, EPRI NP-135, July.

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Landau, L.D. and Lifshitz, E.M., 1959, *Fluid Mechanics*, PERGAMON PRESS, London.

Figure 3.3.1-1

Figure 3.3.1-2

Figure 3.3.2-1a ($p_1 = 3 \text{ atm}$)

Figure 3.3.2-1b (P₁ = 2 atm)

Figure 3.3.2-1c ($p_1 = 1 \text{ atm}$)

Figure 3.3.2-1d ($p_1 = 0.05 \text{ atm}$)

Table 3.3.2-1a ($p_1 = 3 \text{ atm}$)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
AC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.230	1.186	1.119	1.000	0.796	0.453
0.02	1.221	1.184	1.116	0.999	0.795	0.453
0.04	1.212	1.175	1.113	0.999	0.795	0.454
0.06	1.203	1.169	1.109	0.997	0.795	0.454
0.08	1.193	1.164	1.106	0.995	0.794	0.455
0.10	1.184	1.157	1.102	0.993	0.794	0.455
0.12	1.175	1.151	1.097	0.990	0.793	0.455
0.14	1.165	1.144	1.093	0.987	0.791	0.455
0.16	1.155	1.138	1.088	0.984	0.790	0.454
0.18	1.146	1.130	1.083	0.981	0.788	0.454
0.20	1.136	1.123	1.077	0.977	0.786	0.453
0.22	1.126	1.116	1.071	0.973	0.784	0.453
0.24	1.115	1.108	1.065	0.969	0.781	0.452
0.26	0.289	1.099	1.059	0.964	0.778	0.450
0.28	0.254	0.723	1.051	0.959	0.775	0.449
0.30	0.224	0.653	0.861	0.952	0.771	0.447
0.32	0.198	0.584	0.820	0.915	0.755	0.441
0.34	0.176	0.518	0.774	0.868	0.740	0.435
0.36	0.157	0.456	0.722	0.762	0.718	0.427
0.38	0.140	0.400	0.665	0.727	0.675	0.416
0.40	0.125	0.350	0.603	0.688	0.606	0.400
0.42	0.112	0.306	0.539	0.642	0.578	0.353
0.44	0.101	0.267	0.476	0.592	0.546	0.338
0.46	0.091	0.234	0.417	0.536	0.510	0.320
0.48	0.082	0.205	0.362	0.478	0.469	0.300
0.50	0.074	0.180	0.314	0.419	0.423	0.277
0.52	0.068	0.159	0.272	0.364	0.374	0.251
0.54	0.062	0.141	0.235	0.313	0.325	0.222
0.56	0.057	0.125	0.204	0.269	0.279	0.192
0.58	0.052	0.112	0.178	0.230	0.238	0.163
0.60	0.048	0.100	0.156	0.197	0.201	0.137
0.62	0.045	0.090	0.137	0.170	0.171	0.115
0.64	0.042	0.082	0.121	0.147	0.145	0.095
0.66	0.040	0.075	0.108	0.128	0.123	0.080
0.68	0.038	0.069	0.097	0.112	0.106	0.067
0.70	0.036	0.064	0.088	0.100	0.092	0.056
0.72	0.035	0.060	0.080	0.089	0.080	0.048
0.74	0.034	0.057	0.074	0.081	0.071	0.041
0.76	0.033	0.054	0.069	0.074	0.063	0.036
0.78	0.033	0.052	0.065	0.068	0.058	0.032
0.80	0.033	0.051	0.063	0.064	0.053	0.029
0.82	0.033	0.050	0.060	0.061	0.050	0.026
0.84	0.033	0.050	0.059	0.059	0.047	0.025
0.86	0.035	0.050	0.059	0.058	0.046	0.023
0.88	0.036	0.051	0.059	0.057	0.045	0.023
0.90	0.039	0.053	0.060	0.058	0.045	0.023
0.92	0.043	0.056	0.063	0.060	0.047	0.023
0.94	0.050	0.063	0.068	0.064	0.050	0.025
0.96	0.065	0.074	0.079	0.073	0.056	0.028
0.98	0.105	0.112	0.111	0.101	0.076	0.039

Table 3.3.2-1b ($p_1 = 2 \text{ atm}$)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
AC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.230	1.186	1.119	1.000	0.796	0.453
0.02	1.223	1.180	1.118	1.001	0.796	0.454
0.04	1.216	1.179	1.116	1.002	0.798	0.456
0.06	1.208	1.174	1.114	1.002	0.799	0.457
0.08	1.201	1.170	1.112	1.002	0.800	0.458
0.10	1.193	1.166	1.110	1.001	0.801	0.459
0.12	1.185	1.161	1.107	1.000	0.801	0.460
0.14	1.177	1.156	1.104	0.999	0.801	0.461
0.16	1.168	1.150	1.101	0.997	0.801	0.462
0.18	1.160	1.145	1.097	0.996	0.801	0.462
0.20	1.151	1.139	1.094	0.994	0.801	0.463
0.22	1.142	1.133	1.090	0.991	0.800	0.463
0.24	1.132	1.126	1.085	0.989	0.799	0.463
0.26	0.298	1.119	1.080	0.986	0.797	0.463
0.28	0.261	0.782	1.074	0.982	0.795	0.462
0.30	0.229	0.708	1.040	0.977	0.793	0.461
0.32	0.202	0.633	0.877	0.957	0.783	0.459
0.34	0.179	0.560	0.836	0.938	0.774	0.453
0.36	0.159	0.491	0.787	0.907	0.763	0.449
0.38	0.141	0.428	0.731	0.787	0.747	0.443
0.40	0.126	0.371	0.668	0.752	0.722	0.435
0.42	0.112	0.322	0.598	0.710	0.633	0.424
0.44	0.101	0.279	0.527	0.661	0.605	0.406
0.46	0.090	0.243	0.458	0.605	0.572	0.358
0.48	0.082	0.211	0.394	0.541	0.533	0.340
0.50	0.074	0.185	0.338	0.473	0.487	0.319
0.52	0.067	0.162	0.289	0.407	0.433	0.293
0.54	0.061	0.142	0.247	0.346	0.376	0.263
0.56	0.056	0.126	0.213	0.292	0.319	0.228
0.58	0.051	0.112	0.183	0.247	0.267	0.192
0.60	0.047	0.100	0.159	0.209	0.222	0.159
0.62	0.044	0.090	0.139	0.178	0.185	0.130
0.64	0.041	0.081	0.122	0.152	0.154	0.106
0.66	0.039	0.074	0.108	0.131	0.129	0.086
0.68	0.037	0.068	0.097	0.114	0.109	0.071
0.70	0.035	0.063	0.087	0.100	0.093	0.058
0.72	0.033	0.059	0.079	0.089	0.081	0.049
0.74	0.032	0.055	0.073	0.080	0.071	0.042
0.76	0.031	0.053	0.068	0.073	0.063	0.036
0.78	0.031	0.051	0.064	0.067	0.057	0.031
0.80	0.030	0.049	0.061	0.063	0.052	0.028
0.82	0.030	0.048	0.058	0.059	0.048	0.026
0.84	0.031	0.047	0.057	0.057	0.046	0.024
0.86	0.031	0.047	0.056	0.055	0.044	0.022
0.88	0.033	0.048	0.056	0.055	0.043	0.022
0.90	0.034	0.049	0.056	0.055	0.043	0.021
0.92	0.037	0.051	0.058	0.056	0.044	0.022
0.94	0.043	0.056	0.062	0.059	0.046	0.023
0.96	0.053	0.065	0.070	0.066	0.051	0.025
0.98	0.085	0.094	0.095	0.087	0.067	0.034

Table 3.3.2-1c ($p_1 = 1 \text{ atm}$)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
AC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.230	1.186	1.119	1.000	0.796	0.453
0.02	1.226	1.185	1.120	1.004	0.798	0.455
0.04	1.221	1.184	1.121	1.007	0.802	0.457
0.06	1.217	1.182	1.122	1.009	0.805	0.461
0.08	1.212	1.180	1.122	1.011	0.808	0.464
0.10	1.207	1.178	1.122	1.013	0.811	0.466
0.12	1.201	1.176	1.122	1.015	0.814	0.468
0.14	1.195	1.174	1.122	1.016	0.816	0.471
0.16	1.189	1.171	1.121	1.017	0.819	0.473
0.18	1.183	1.168	1.120	1.018	0.821	0.475
0.20	1.176	1.164	1.119	1.019	0.822	0.476
0.22	1.170	1.161	1.118	1.019	0.824	0.478
0.24	1.162	1.156	1.116	1.019	0.825	0.480
0.26	0.323	1.152	1.114	1.018	0.826	0.481
0.28	0.279	1.146	1.111	1.018	0.827	0.482
0.30	0.243	0.825	1.107	1.016	0.827	0.483
0.32	0.213	0.747	1.086	1.007	0.826	0.483
0.34	0.187	0.664	1.068	0.999	0.819	0.480
0.36	0.165	0.580	1.031	0.991	0.815	0.479
0.38	0.146	0.501	0.861	0.978	0.809	0.477
0.40	0.129	0.429	0.805	0.959	0.802	0.474
0.42	0.115	0.366	0.737	0.922	0.791	0.470
0.44	0.102	0.313	0.657	0.793	0.775	0.465
0.46	0.091	0.267	0.570	0.747	0.749	0.457
0.48	0.082	0.230	0.484	0.689	0.651	0.446
0.50	0.074	0.198	0.406	0.617	0.615	0.428
0.52	0.067	0.171	0.339	0.532	0.569	0.372
0.54	0.060	0.149	0.284	0.445	0.511	0.349
0.56	0.055	0.130	0.238	0.366	0.439	0.319
0.58	0.050	0.115	0.201	0.299	0.361	0.279
0.60	0.046	0.101	0.171	0.244	0.290	0.230
0.62	0.043	0.090	0.146	0.201	0.231	0.181
0.64	0.040	0.081	0.127	0.167	0.184	0.140
0.66	0.037	0.074	0.111	0.140	0.148	0.108
0.68	0.035	0.067	0.098	0.119	0.121	0.084
0.70	0.033	0.062	0.087	0.103	0.100	0.067
0.72	0.032	0.057	0.079	0.090	0.084	0.053
0.74	0.030	0.054	0.072	0.080	0.072	0.044
0.76	0.029	0.051	0.066	0.072	0.063	0.037
0.78	0.028	0.048	0.062	0.066	0.056	0.032
0.80	0.028	0.047	0.059	0.061	0.051	0.028
0.82	0.028	0.045	0.056	0.057	0.047	0.025
0.84	0.028	0.044	0.054	0.055	0.044	0.023
0.86	0.028	0.044	0.053	0.053	0.042	0.021
0.88	0.028	0.044	0.052	0.052	0.041	0.020
0.90	0.029	0.044	0.052	0.051	0.040	0.020
0.92	0.031	0.046	0.053	0.052	0.040	0.020
0.94	0.034	0.048	0.055	0.053	0.041	0.020
0.96	0.041	0.054	0.060	0.057	0.044	0.022
0.98	0.063	0.073	0.076	0.070	0.054	0.027

Table 3.3.2-1d (p₁ = 0.05 atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at P₁ = 0.05 atm
AC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.230	1.186	1.119	1.000	0.796	0.453
0.02	1.232	1.189	1.122	1.007	0.800	0.458
0.04	1.234	1.192	1.125	1.011	0.804	0.462
0.06	1.237	1.195	1.128	1.017	0.809	0.467
0.08	1.240	1.199	1.132	1.022	0.814	0.472
0.10	1.243	1.202	1.136	1.028	0.819	0.477
0.12	1.246	1.207	1.142	1.033	0.826	0.482
0.14	1.249	1.212	1.148	1.040	0.832	0.487
0.16	1.251	1.216	1.152	1.047	0.838	0.492
0.18	1.254	1.220	1.159	1.052	0.843	0.496
0.20	1.256	1.224	1.165	1.059	0.852	0.500
0.22	1.258	1.227	1.172	1.066	0.858	0.505
0.24	1.260	1.230	1.178	1.075	0.866	0.510
0.26	1.261	1.234	1.185	1.083	0.872	0.514
0.28	1.261	1.236	1.192	1.092	0.880	0.518
0.30	1.258	1.239	1.201	1.100	0.890	0.523
0.32	0.334	1.250	1.204	1.107	0.899	0.528
0.34	0.279	1.248	1.213	1.112	0.905	0.532
0.36	0.237	1.246	1.216	1.119	0.910	0.538
0.38	0.204	1.244	1.218	1.123	0.918	0.543
0.40	0.176	1.239	1.219	1.129	0.927	0.546
0.42	0.152	1.227	1.220	1.132	0.931	0.549
0.44	0.132	1.211	1.218	1.135	0.934	0.552
0.46	0.115	0.593	1.215	1.135	0.937	0.554
0.48	0.100	0.482	1.208	1.135	0.939	0.557
0.50	0.088	0.385	1.194	1.132	0.940	0.558
0.52	0.077	0.309	1.190	1.127	0.939	0.559
0.54	0.068	0.251	1.173	1.116	0.937	0.559
0.56	0.061	0.206	0.688	1.115	0.931	0.558
0.58	0.054	0.170	0.524	1.104	0.929	0.557
0.60	0.049	0.142	0.391	1.083	0.923	0.554
0.62	0.044	0.119	0.297	0.743	0.912	0.551
0.64	0.040	0.101	0.229	0.541	0.892	0.545
0.66	0.036	0.087	0.180	0.375	0.839	0.535
0.68	0.034	0.076	0.144	0.268	0.494	0.516
0.70	0.031	0.067	0.117	0.197	0.316	0.381
0.72	0.029	0.060	0.097	0.148	0.210	0.236
0.74	0.028	0.054	0.082	0.114	0.145	0.141
0.76	0.026	0.050	0.071	0.091	0.104	0.089
0.78	0.025	0.046	0.064	0.075	0.078	0.058
0.80	0.024	0.044	0.058	0.065	0.061	0.040
0.82	0.024	0.042	0.054	0.058	0.050	0.030
0.84	0.023	0.040	0.051	0.053	0.044	0.024
0.86	0.023	0.039	0.049	0.050	0.040	0.021
0.88	0.022	0.038	0.047	0.048	0.038	0.019
0.90	0.022	0.038	0.046	0.046	0.036	0.018
0.92	0.022	0.037	0.046	0.045	0.036	0.017
0.94	0.023	0.038	0.046	0.045	0.035	0.017
0.96	0.023	0.038	0.046	0.045	0.035	0.017
0.98	0.026	0.040	0.048	0.047	0.036	0.018

Table 3.3.2-2a ($p_1 = 3 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
AC Motor Case

Inlet void fraction	Homologous Flow Paramete					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.01	0.01	0.00	0.00	0.00	0.00
0.04	0.03	0.02	0.02	0.02	0.02	0.02
0.06	0.04	0.03	0.03	0.03	0.02	0.02
0.08	0.06	0.04	0.04	0.03	0.03	0.03
0.10	0.07	0.05	0.05	0.04	0.04	0.04
0.12	0.09	0.07	0.06	0.05	0.05	0.05
0.14	0.10	0.08	0.07	0.06	0.06	0.06
0.16	0.12	0.09	0.08	0.08	0.07	0.07
0.18	0.14	0.11	0.09	0.09	0.08	0.08
0.20	0.16	0.12	0.11	0.10	0.09	0.09
0.22	0.17	0.14	0.12	0.11	0.10	0.10
0.24	0.19	0.15	0.13	0.12	0.12	0.11
0.26	0.84	0.17	0.15	0.14	0.13	0.13
0.28	0.86	0.57	0.16	0.15	0.14	0.14
0.30	0.87	0.62	0.37	0.17	0.16	0.15
0.32	0.87	0.67	0.41	0.19	0.17	0.17
0.34	0.88	0.71	0.46	0.21	0.19	0.18
0.36	0.89	0.75	0.51	0.38	0.21	0.20
0.38	0.90	0.77	0.56	0.42	0.25	0.22
0.40	0.90	0.80	0.62	0.46	0.38	0.24
0.42	0.91	0.82	0.66	0.51	0.42	0.37
0.44	0.91	0.83	0.70	0.56	0.46	0.41
0.46	0.92	0.85	0.74	0.61	0.51	0.44
0.48	0.92	0.86	0.77	0.65	0.56	0.49
0.50	0.93	0.87	0.79	0.70	0.60	0.53
0.52	0.93	0.88	0.81	0.73	0.65	0.58
0.54	0.94	0.89	0.83	0.76	0.69	0.63
0.56	0.94	0.90	0.85	0.79	0.73	0.67
0.58	0.94	0.90	0.86	0.81	0.76	0.71
0.60	0.94	0.91	0.87	0.83	0.79	0.75
0.62	0.95	0.92	0.88	0.85	0.81	0.77
0.64	0.95	0.92	0.89	0.86	0.83	0.80
0.66	0.95	0.93	0.90	0.87	0.85	0.82
0.68	0.96	0.94	0.91	0.88	0.86	0.84
0.70	0.96	0.94	0.92	0.90	0.88	0.86
0.72	0.96	0.94	0.93	0.90	0.89	0.87
0.74	0.97	0.95	0.93	0.91	0.90	0.88
0.76	0.97	0.95	0.94	0.92	0.91	0.89
0.78	0.97	0.96	0.94	0.93	0.92	0.90
0.80	0.98	0.96	0.95	0.94	0.93	0.92
0.82	0.98	0.97	0.95	0.94	0.93	0.93
0.84	0.98	0.97	0.96	0.95	0.94	0.93
0.86	0.98	0.97	0.96	0.96	0.95	0.94
0.88	0.99	0.98	0.97	0.96	0.96	0.95
0.90	0.99	0.98	0.98	0.97	0.96	0.96
0.92	0.99	0.99	0.98	0.98	0.97	0.97
0.94	0.99	0.99	0.99	0.98	0.98	0.98
0.96	1.00	0.99	0.99	0.99	0.99	0.98
0.98	1.00	1.00	1.00	0.99	0.99	0.99

Table 3.3.2-2b ($p_1 = 2 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
AC Motor Case

Inlet void fraction	Homologous Flow Paramete					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.01	0.00	0.00	0.00	0.00	0.00
0.04	0.02	0.02	0.01	0.01	0.01	0.01
0.06	0.03	0.03	0.02	0.02	0.02	0.02
0.08	0.05	0.03	0.03	0.03	0.03	0.03
0.10	0.06	0.04	0.04	0.04	0.03	0.03
0.12	0.07	0.05	0.05	0.04	0.04	0.04
0.14	0.09	0.06	0.06	0.05	0.05	0.05
0.16	0.10	0.08	0.07	0.06	0.06	0.05
0.18	0.12	0.09	0.08	0.07	0.07	0.06
0.20	0.13	0.10	0.09	0.08	0.08	0.07
0.22	0.15	0.11	0.10	0.09	0.08	0.08
0.24	0.16	0.13	0.11	0.10	0.09	0.09
0.26	0.84	0.14	0.12	0.11	0.10	0.10
0.28	0.85	0.52	0.14	0.12	0.12	0.11
0.30	0.86	0.59	0.15	0.14	0.13	0.12
0.32	0.87	0.64	0.35	0.15	0.14	0.13
0.34	0.88	0.69	0.40	0.17	0.16	0.15
0.36	0.89	0.73	0.45	0.19	0.17	0.16
0.38	0.90	0.76	0.51	0.36	0.19	0.18
0.40	0.90	0.79	0.57	0.40	0.21	0.19
0.42	0.91	0.81	0.62	0.45	0.36	0.21
0.44	0.91	0.83	0.68	0.50	0.40	0.23
0.46	0.92	0.85	0.72	0.56	0.44	0.38
0.48	0.92	0.86	0.75	0.61	0.49	0.42
0.50	0.93	0.87	0.78	0.66	0.55	0.46
0.52	0.93	0.88	0.81	0.71	0.60	0.51
0.54	0.94	0.89	0.83	0.75	0.66	0.57
0.56	0.94	0.90	0.85	0.78	0.70	0.63
0.58	0.94	0.90	0.86	0.81	0.74	0.68
0.60	0.94	0.91	0.87	0.83	0.78	0.72
0.62	0.95	0.92	0.88	0.84	0.80	0.76
0.64	0.95	0.92	0.89	0.86	0.82	0.79
0.66	0.95	0.93	0.90	0.87	0.84	0.81
0.68	0.96	0.93	0.91	0.88	0.86	0.83
0.70	0.96	0.94	0.92	0.89	0.87	0.85
0.72	0.96	0.94	0.92	0.90	0.89	0.87
0.74	0.97	0.95	0.93	0.91	0.90	0.88
0.76	0.97	0.95	0.94	0.92	0.91	0.89
0.78	0.97	0.96	0.94	0.93	0.92	0.90
0.80	0.98	0.96	0.95	0.94	0.93	0.92
0.82	0.98	0.97	0.95	0.94	0.93	0.93
0.84	0.98	0.97	0.96	0.95	0.94	0.93
0.86	0.98	0.97	0.96	0.96	0.95	0.94
0.88	0.99	0.98	0.97	0.96	0.96	0.95
0.90	0.99	0.98	0.98	0.97	0.96	0.96
0.92	0.99	0.99	0.98	0.98	0.97	0.97
0.94	0.99	0.99	0.99	0.98	0.98	0.98
0.96	1.00	0.99	0.99	0.99	0.99	0.98
0.98	1.00	1.00	1.00	0.99	0.99	0.99

Table 3.3.2-2c ($p_1 = 1 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
AC Motor Case

Inlet Void	Homologous Flow Paramete					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.02	0.01	0.00	0.00	0.00	0.00
0.06	0.02	0.02	0.01	0.01	0.01	0.01
0.08	0.03	0.02	0.02	0.02	0.02	0.02
0.10	0.04	0.03	0.03	0.02	0.02	0.02
0.12	0.05	0.04	0.03	0.03	0.03	0.03
0.14	0.06	0.04	0.04	0.03	0.03	0.03
0.16	0.07	0.05	0.04	0.04	0.04	0.04
0.18	0.08	0.06	0.05	0.05	0.04	0.04
0.20	0.10	0.07	0.06	0.05	0.05	0.05
0.22	0.11	0.08	0.07	0.06	0.06	0.05
0.24	0.12	0.09	0.07	0.07	0.06	0.06
0.26	0.83	0.10	0.08	0.08	0.07	0.07
0.28	0.85	0.11	0.09	0.08	0.08	0.07
0.30	0.86	0.49	0.10	0.09	0.09	0.08
0.32	0.87	0.56	0.11	0.10	0.09	0.09
0.34	0.88	0.63	0.13	0.11	0.10	0.10
0.36	0.89	0.68	0.14	0.13	0.12	0.11
0.38	0.89	0.73	0.39	0.14	0.13	0.12
0.40	0.90	0.77	0.45	0.15	0.14	0.13
0.42	0.91	0.80	0.52	0.17	0.15	0.14
0.44	0.91	0.82	0.59	0.37	0.17	0.16
0.46	0.92	0.84	0.65	0.43	0.19	0.17
0.48	0.92	0.85	0.71	0.49	0.36	0.19
0.50	0.93	0.87	0.75	0.56	0.41	0.21
0.52	0.93	0.88	0.79	0.63	0.47	0.37
0.54	0.93	0.89	0.81	0.69	0.54	0.42
0.56	0.94	0.90	0.84	0.75	0.61	0.49
0.58	0.94	0.90	0.85	0.78	0.68	0.56
0.60	0.94	0.91	0.87	0.81	0.74	0.64
0.62	0.95	0.92	0.88	0.83	0.78	0.71
0.64	0.95	0.92	0.89	0.85	0.81	0.76
0.66	0.95	0.93	0.90	0.87	0.83	0.80
0.68	0.96	0.93	0.91	0.88	0.85	0.82
0.70	0.96	0.94	0.92	0.89	0.87	0.85
0.72	0.96	0.94	0.92	0.90	0.88	0.86
0.74	0.97	0.95	0.93	0.91	0.90	0.88
0.76	0.97	0.95	0.94	0.92	0.91	0.89
0.78	0.97	0.96	0.94	0.93	0.92	0.90
0.80	0.98	0.96	0.95	0.94	0.93	0.91
0.82	0.98	0.97	0.95	0.94	0.93	0.92
0.84	0.98	0.97	0.96	0.95	0.94	0.93
0.86	0.98	0.97	0.96	0.96	0.95	0.94
0.88	0.99	0.98	0.97	0.96	0.96	0.95
0.90	0.99	0.98	0.98	0.97	0.96	0.96
0.92	0.99	0.99	0.98	0.98	0.97	0.97
0.94	0.99	0.99	0.99	0.98	0.98	0.98
0.96	1.00	0.99	0.99	0.99	0.99	0.98
0.98	1.00	1.00	1.00	0.99	0.99	0.99

Table 3.3.2-2d ($p_1 = 0.05 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05 \text{ atm}$
AC Motor Case

Inlet Void	Homologous Flow Paramete					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.00	0.00	0.00	0.00	0.00	0.00
0.06	0.00	0.00	0.00	0.00	0.00	0.00
0.08	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.00	0.00	0.00	0.00	0.00	0.00
0.12	0.00	0.00	0.00	0.00	0.00	0.00
0.14	0.00	0.00	0.00	0.00	0.00	0.00
0.16	0.00	0.00	0.00	0.00	0.00	0.00
0.18	0.00	0.00	0.00	0.00	0.00	0.00
0.20	0.00	0.00	0.00	0.00	0.00	0.00
0.22	0.00	0.00	0.00	0.00	0.00	0.00
0.24	0.00	0.00	0.00	0.00	0.00	0.00
0.26	0.00	0.00	0.00	0.00	0.00	0.00
0.28	0.00	0.00	0.00	0.00	0.00	0.00
0.30	0.00	0.00	0.00	0.00	0.00	0.00
0.32	0.85	0.00	0.00	0.00	0.00	0.00
0.34	0.86	0.00	0.00	0.00	0.00	0.00
0.36	0.87	0.00	0.00	0.00	0.00	0.00
0.38	0.88	0.00	0.00	0.00	0.00	0.00
0.40	0.89	0.00	0.00	0.00	0.00	0.00
0.42	0.90	0.00	0.00	0.00	0.00	0.00
0.44	0.91	0.05	0.00	0.00	0.00	0.00
0.46	0.91	0.74	0.00	0.00	0.00	0.00
0.48	0.92	0.78	0.00	0.00	0.00	0.00
0.50	0.92	0.82	0.00	0.00	0.00	0.00
0.52	0.93	0.84	0.06	0.00	0.00	0.00
0.54	0.93	0.86	0.06	0.00	0.00	0.00
0.56	0.94	0.88	0.66	0.05	0.00	0.00
0.58	0.94	0.89	0.74	0.06	0.05	0.00
0.60	0.94	0.90	0.80	0.07	0.06	0.05
0.62	0.95	0.91	0.84	0.55	0.07	0.06
0.64	0.95	0.92	0.86	0.69	0.08	0.06
0.66	0.95	0.93	0.88	0.78	0.09	0.07
0.68	0.96	0.93	0.89	0.83	0.64	0.09
0.70	0.96	0.94	0.91	0.86	0.77	0.44
0.72	0.96	0.94	0.92	0.88	0.83	0.70
0.74	0.97	0.95	0.93	0.90	0.87	0.81
0.76	0.97	0.95	0.94	0.91	0.89	0.85
0.78	0.97	0.96	0.94	0.93	0.90	0.88
0.80	0.98	0.96	0.95	0.93	0.92	0.90
0.82	0.98	0.97	0.95	0.94	0.93	0.92
0.84	0.98	0.97	0.96	0.95	0.94	0.93
0.86	0.98	0.97	0.96	0.96	0.95	0.94
0.88	0.99	0.98	0.97	0.96	0.96	0.95
0.90	0.99	0.98	0.98	0.97	0.96	0.96
0.92	0.99	0.99	0.98	0.98	0.97	0.97
0.94	0.99	0.99	0.99	0.98	0.98	0.98
0.96	1.00	0.99	0.99	0.99	0.99	0.98
0.98	1.00	1.00	1.00	0.99	0.99	0.99

Table 3.3.2-3a ($p_1 = 3 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
AC Motor Case

Inlet void fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	173.9	174.9	175.9	177.9	179.9	181.9
0.02	170.9	172.9	173.9	175.9	177.9	180.9
0.04	167.9	169.9	171.9	173.9	176.9	178.9
0.06	164.9	167.9	169.9	171.9	174.9	177.9
0.08	161.9	164.9	167.9	169.9	172.9	175.9
0.10	158.9	162.9	164.9	167.9	170.9	174.9
0.12	155.9	159.9	162.9	165.9	168.9	172.9
0.14	151.9	156.9	160.9	163.9	166.9	170.9
0.16	148.9	154.9	157.9	160.9	164.9	168.9
0.18	145.9	151.9	154.9	158.9	162.9	166.9
0.20	142.9	148.9	152.9	156.9	160.9	164.9
0.22	138.9	145.9	149.9	153.9	157.9	162.9
0.24	135.9	142.9	146.9	150.9	155.9	159.9
0.26	34.7	138.9	143.9	147.9	152.9	157.9
0.28	30.1	84.9	140.9	144.9	149.9	154.9
0.30	26.2	74.9	108.9	141.9	146.9	151.9
0.32	22.9	65.9	100.9	130.9	140.9	146.9
0.34	20.1	57.9	92.9	117.9	134.9	141.9
0.36	17.7	50.0	84.9	103.9	125.9	136.9
0.38	15.5	43.4	75.9	96.9	113.9	129.9
0.40	13.6	37.6	67.9	89.9	102.9	119.9
0.42	12.0	32.5	59.9	81.9	95.9	106.9
0.44	10.5	28.1	52.0	73.9	88.9	99.9
0.46	9.2	24.2	45.0	65.9	80.9	92.9
0.48	8.0	20.8	38.6	56.9	72.9	84.9
0.50	7.0	17.9	33.0	49.7	64.9	76.9
0.52	6.1	15.3	28.2	42.6	56.9	68.9
0.54	5.3	13.1	23.9	36.2	48.6	59.9
0.56	4.6	11.2	20.2	30.6	41.3	51.7
0.58	4.0	9.5	17.0	25.7	34.8	43.8
0.60	3.4	8.1	14.3	21.5	29.0	36.7
0.62	3.0	6.8	11.9	17.8	24.0	30.4
0.64	2.5	5.7	9.9	14.7	19.8	24.9
0.66	2.2	4.8	8.2	12.1	16.1	20.3
0.68	1.9	4.0	6.7	9.8	13.1	16.3
0.70	1.6	3.3	5.5	8.0	10.5	13.1
0.72	1.3	2.7	4.4	6.4	8.4	10.3
0.74	1.2	2.2	3.6	5.1	6.6	8.1
0.76	1.0	1.8	2.8	4.0	5.2	6.3
0.78	0.8	1.5	2.2	3.1	4.0	4.8
0.80	0.7	1.2	1.8	2.4	3.0	3.6
0.82	0.6	1.0	1.4	1.8	2.3	2.7
0.84	0.6	0.8	1.1	1.4	1.7	2.0
0.86	0.5	0.7	0.9	1.1	1.3	1.5
0.88	0.5	0.6	0.7	0.8	0.9	1.1
0.90	0.5	0.5	0.6	0.7	0.7	0.8
0.92	0.4	0.5	0.5	0.5	0.6	0.6
0.94	0.4	0.4	0.5	0.5	0.5	0.5
0.96	0.4	0.4	0.4	0.4	0.4	0.5
0.98	0.4	0.4	0.4	0.4	0.4	0.4

Table 3.3.2-3b ($P_1 = 2 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Vold Fraction
for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
AC Motor Case

Inlet vold fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	174.6	175.6	176.6	177.6	179.6	181.6
0.02	171.6	173.6	174.6	176.6	178.6	180.6
0.04	169.6	171.6	172.6	174.6	177.6	179.6
0.06	166.6	168.6	171.6	173.6	175.6	178.6
0.08	163.6	166.6	169.6	171.6	174.6	177.6
0.10	160.6	164.6	167.6	169.6	173.6	176.6
0.12	157.6	162.6	165.6	168.6	171.6	175.6
0.14	155.6	159.6	163.6	166.6	169.6	173.6
0.16	152.6	157.6	160.6	164.6	168.6	172.6
0.18	149.6	154.6	158.6	162.6	166.6	170.6
0.20	146.6	152.6	156.6	160.6	164.6	168.6
0.22	142.6	149.6	153.6	157.6	162.6	167.6
0.24	139.6	146.6	151.6	155.6	160.6	165.6
0.26	35.9	143.6	148.6	153.6	157.6	163.6
0.28	30.9	92.6	145.6	150.6	155.6	160.6
0.30	26.8	81.6	135.6	147.6	152.6	158.6
0.32	23.4	71.6	109.6	140.6	147.6	155.6
0.34	20.4	62.2	101.6	134.6	143.6	150.6
0.36	17.9	53.8	93.6	124.6	138.6	146.6
0.38	15.7	46.3	84.6	106.6	122.6	135.6
0.40	13.7	39.8	75.6	98.6	106.6	127.6
0.42	12.0	34.1	66.1	90.6	99.6	116.6
0.44	10.5	29.3	57.3	82.6	91.6	104.6
0.46	9.2	25.1	49.1	73.6	82.6	96.6
0.48	8.0	21.5	41.8	64.5	72.6	88.6
0.50	7.0	18.4	35.4	55.6	64.5	79.6
0.52	6.0	15.7	29.9	47.2	55.2	69.7
0.54	5.2	13.3	25.1	39.7	46.5	59.9
0.56	4.5	11.3	21.1	33.2	38.7	50.4
0.58	3.9	9.6	17.7	27.6	31.9	41.6
0.60	3.3	8.1	14.7	22.8	26.0	34.0
0.62	2.9	6.8	12.2	18.7	21.2	27.5
0.64	2.4	5.7	10.1	15.3	17.1	22.0
0.66	2.1	4.7	8.3	12.5	13.7	17.5
0.68	1.8	3.9	6.7	10.1	10.9	13.8
0.70	1.5	3.2	5.5	8.1	8.6	10.8
0.72	1.2	2.6	4.4	6.4	6.7	8.3
0.74	1.0	2.1	3.5	5.0	5.2	6.4
0.76	0.9	1.7	2.8	3.9	3.9	4.8
0.78	0.7	1.4	2.1	3.0	3.0	3.6
0.80	0.6	1.1	1.7	2.3	2.2	2.6
0.82	0.5	0.9	1.3	1.7	1.6	1.9
0.84	0.5	0.7	1.0	1.3	1.2	1.4
0.86	0.4	0.6	0.8	1.0	0.8	1.0
0.88	0.4	0.5	0.6	0.7	0.6	0.7
0.90	0.3	0.4	0.5	0.5	0.5	0.5
0.92	0.3	0.4	0.4	0.4	0.4	0.4
0.94	0.3	0.3	0.3	0.3	0.3	0.3
0.96	0.3	0.3	0.3	0.3	0.3	0.3
0.98	0.3	0.3	0.3	0.3	0.3	0.3

Table 3.3.2-3c ($p_1 = 1 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
AC Motor Case

Inlet void fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	174.3	175.3	176.3	178.3	179.3	181.3
0.02	172.3	174.3	175.3	177.3	179.3	181.3
0.04	170.3	172.3	173.3	176.3	178.3	181.3
0.06	168.3	171.3	173.3	175.3	177.3	181.3
0.08	166.3	169.3	171.3	174.3	177.3	180.3
0.10	164.3	167.3	170.3	173.3	176.3	180.3
0.12	162.3	166.3	169.3	172.3	175.3	179.3
0.14	160.3	164.3	167.3	170.3	174.3	178.3
0.16	157.3	162.3	165.3	169.3	173.3	177.3
0.18	155.3	160.3	164.3	168.3	172.3	176.3
0.20	152.3	158.3	162.3	166.3	170.3	175.3
0.22	150.3	156.3	160.3	164.3	169.3	174.3
0.24	147.3	154.3	158.3	163.3	168.3	173.3
0.26	39.3	151.3	156.3	161.3	166.3	172.3
0.28	33.3	149.3	154.3	159.3	164.3	170.3
0.30	28.6	97.3	151.3	157.3	162.3	169.3
0.32	24.7	86.3	145.3	153.3	160.3	167.3
0.34	21.4	74.9	139.3	149.3	156.3	163.3
0.36	18.6	64.2	128.3	145.3	152.3	160.3
0.38	16.2	54.5	103.3	140.3	149.3	156.3
0.40	14.1	46.0	93.3	133.3	144.3	153.3
0.42	12.3	38.8	83.0	122.3	139.3	149.3
0.44	10.7	32.8	71.9	102.3	132.3	144.3
0.46	9.3	27.7	61.0	93.3	122.3	137.3
0.48	8.1	23.4	50.9	83.2	104.3	129.3
0.50	7.0	19.8	42.2	72.1	95.3	118.3
0.52	6.1	16.7	34.9	60.8	85.2	102.3
0.54	5.2	14.1	28.8	50.2	73.9	93.3
0.56	4.5	11.9	23.8	40.9	62.1	82.0
0.58	3.8	9.9	19.5	33.1	50.6	69.8
0.60	3.3	8.3	16.0	26.7	40.6	57.1
0.62	2.8	6.9	13.1	21.5	32.2	45.4
0.64	2.3	5.7	10.7	17.2	25.4	35.5
0.66	2.0	4.7	8.7	13.7	20.0	27.5
0.68	1.6	3.9	7.0	10.9	15.6	21.2
0.70	1.4	3.1	5.6	8.6	12.1	16.2
0.72	1.1	2.5	4.4	6.7	9.3	12.3
0.74	0.9	2.0	3.5	5.2	7.1	9.2
0.76	0.8	1.6	2.7	4.0	5.4	6.9
0.78	0.6	1.2	2.1	3.0	4.0	5.0
0.80	0.5	1.0	1.6	2.2	2.9	3.7
0.82	0.4	0.7	1.2	1.6	2.1	2.6
0.84	0.4	0.6	0.9	1.2	1.5	1.8
0.86	0.3	0.4	0.6	0.8	1.0	1.2
0.88	0.3	0.3	0.5	0.6	0.7	0.8
0.90	0.2	0.3	0.3	0.4	0.5	0.6
0.92	0.2	0.2	0.3	0.3	0.3	0.4
0.94	0.2	0.2	0.2	0.2	0.3	0.3
0.96	0.2	0.2	0.2	0.2	0.2	0.2
0.98	0.2	0.2	0.2	0.2	0.2	0.2

Table 3.3.2-3d ($p_1 = 0.05 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = .05 \text{ atm}$
AC Motor Case

Inlet void fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	174.3	175.3	176.3	178.3	179.3	181.3
0.02	174.3	175.3	176.3	178.3	179.3	181.3
0.04	174.3	175.3	176.3	178.3	179.3	181.3
0.06	174.3	175.3	176.3	178.3	179.3	181.3
0.08	174.3	175.3	176.3	178.3	179.3	181.3
0.10	174.3	175.3	176.3	178.3	179.3	181.3
0.12	174.3	175.3	176.3	178.3	179.3	181.3
0.14	174.3	175.3	176.3	178.3	179.3	181.3
0.16	173.3	175.3	176.3	178.3	179.3	181.3
0.18	173.3	175.3	176.3	178.3	179.3	181.3
0.20	173.3	175.3	176.3	178.3	180.3	182.3
0.22	173.3	175.3	176.3	179.3	181.3	184.3
0.24	173.3	175.3	176.3	180.3	182.3	186.3
0.26	172.3	175.3	176.3	180.3	183.3	188.3
0.28	171.3	175.3	176.3	180.3	184.3	190.3
0.30	170.3	174.3	176.3	180.3	185.3	192.3
0.32	44.5	173.3	176.3	180.3	185.3	193.3
0.34	35.6	172.3	177.3	180.3	185.3	193.3
0.36	29.6	170.3	176.3	180.3	185.3	193.3
0.38	24.8	169.3	175.3	180.3	185.3	193.3
0.40	21.0	167.3	174.3	179.3	185.3	193.3
0.42	17.8	164.3	173.3	179.3	185.3	192.3
0.44	15.1	157.3	171.3	177.3	184.3	191.3
0.46	12.9	74.0	168.3	176.3	183.3	190.3
0.48	10.9	57.3	165.3	174.3	181.3	189.3
0.50	9.3	43.7	160.3	171.3	180.3	187.3
0.52	7.8	33.9	156.3	168.3	177.3	185.3
0.54	6.6	26.7	150.3	163.3	174.3	183.3
0.56	5.6	21.3	81.4	160.3	170.3	180.3
0.58	4.7	17.1	57.9	154.3	165.3	175.3
0.60	3.9	13.7	41.3	147.3	161.3	170.3
0.62	3.2	10.9	30.4	91.4	155.3	166.3
0.64	2.5	8.7	22.9	61.2	146.3	160.3
0.66	2.1	6.9	17.3	40.9	127.3	152.3
0.68	1.7	5.4	13.1	28.7	66.0	139.3
0.70	1.4	4.2	9.9	20.6	41.6	90.0
0.72	1.1	3.2	7.4	14.8	27.9	52.8
0.74	0.8	2.4	5.4	10.6	19.1	33.1
0.76	0.6	1.8	3.9	7.5	13.1	21.6
0.78	0.5	1.3	2.8	5.1	8.8	14.1
0.80	0.4	0.9	1.9	3.5	5.7	9.0
0.82	0.3	0.7	1.3	2.3	3.6	5.6
0.84	0.2	0.4	0.8	1.4	2.2	3.3
0.86	0.1	0.3	0.5	0.9	1.3	1.8
0.88	0.1	0.2	0.3	0.5	0.7	1.0
0.90	0.1	0.1	0.2	0.3	0.4	0.5
0.92	0.0	0.1	0.1	0.1	0.2	0.2
0.94	0.0	0.0	0.1	0.1	0.1	0.1
0.96	0.0	0.0	0.0	0.0	0.0	0.0
0.98	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.3.2-4a ($p_1 = 3 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.10	0.16	0.21	0.26	0.31	0.37
0.02	0.10	0.15	0.20	0.26	0.31	0.36
0.04	0.10	0.15	0.20	0.26	0.31	0.36
0.06	0.10	0.15	0.20	0.25	0.30	0.35
0.08	0.10	0.15	0.20	0.25	0.30	0.35
0.10	0.10	0.15	0.20	0.24	0.29	0.34
0.12	0.10	0.15	0.19	0.24	0.29	0.34
0.14	0.10	0.15	0.19	0.24	0.29	0.33
0.16	0.10	0.14	0.19	0.24	0.28	0.33
0.18	0.10	0.14	0.19	0.23	0.28	0.32
0.20	0.10	0.14	0.19	0.23	0.27	0.32
0.22	0.10	0.14	0.19	0.23	0.27	0.32
0.24	0.10	0.14	0.18	0.23	0.27	0.31
0.26	0.49	0.14	0.18	0.22	0.26	0.31
0.28	0.52	0.26	0.18	0.22	0.26	0.30
0.30	0.54	0.29	0.23	0.22	0.26	0.30
0.32	0.56	0.32	0.24	0.22	0.26	0.30
0.34	0.58	0.36	0.26	0.22	0.25	0.29
0.36	0.60	0.39	0.27	0.27	0.25	0.29
0.38	0.62	0.43	0.30	0.28	0.26	0.29
0.40	0.64	0.46	0.32	0.29	0.30	0.29
0.42	0.66	0.49	0.36	0.31	0.31	0.34
0.44	0.67	0.53	0.39	0.33	0.33	0.35
0.46	0.69	0.56	0.43	0.36	0.34	0.35
0.48	0.70	0.58	0.47	0.39	0.37	0.37
0.50	0.71	0.61	0.51	0.43	0.39	0.39
0.52	0.72	0.63	0.54	0.47	0.43	0.42
0.54	0.74	0.65	0.57	0.51	0.47	0.45
0.56	0.75	0.68	0.60	0.55	0.51	0.49
0.58	0.75	0.69	0.63	0.58	0.55	0.53
0.60	0.76	0.71	0.66	0.62	0.59	0.58
0.62	0.77	0.72	0.68	0.65	0.63	0.61
0.64	0.78	0.74	0.70	0.68	0.66	0.66
0.66	0.78	0.75	0.72	0.70	0.70	0.69
0.68	0.79	0.77	0.74	0.73	0.72	0.72
0.70	0.80	0.78	0.76	0.75	0.75	0.76
0.72	0.81	0.79	0.77	0.77	0.77	0.78
0.74	0.81	0.79	0.79	0.78	0.79	0.80
0.76	0.81	0.81	0.80	0.80	0.81	0.82
0.78	0.82	0.81	0.81	0.81	0.83	0.84
0.80	0.82	0.82	0.82	0.83	0.84	0.86
0.82	0.83	0.83	0.83	0.84	0.85	0.87
0.84	0.83	0.83	0.84	0.85	0.86	0.89
0.86	0.83	0.83	0.84	0.85	0.87	0.89
0.88	0.83	0.84	0.85	0.86	0.88	0.90
0.90	0.83	0.84	0.85	0.86	0.89	0.91
0.92	0.84	0.84	0.85	0.87	0.89	0.91
0.94	0.84	0.84	0.86	0.87	0.90	0.92
0.96	0.84	0.85	0.86	0.87	0.90	0.92
0.98	0.84	0.85	0.86	0.88	0.90	0.93

Table 3.3.2-4b ($p_1 = 2 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.10	0.16	0.21	0.26	0.31	0.37
0.02	0.10	0.15	0.20	0.26	0.31	0.36
0.04	0.10	0.15	0.20	0.25	0.30	0.35
0.06	0.10	0.15	0.20	0.25	0.30	0.35
0.08	0.10	0.15	0.20	0.25	0.30	0.35
0.10	0.10	0.15	0.19	0.24	0.29	0.34
0.12	0.10	0.15	0.19	0.24	0.29	0.33
0.14	0.10	0.14	0.19	0.23	0.28	0.33
0.16	0.10	0.14	0.19	0.23	0.28	0.32
0.18	0.10	0.14	0.19	0.23	0.27	0.32
0.20	0.10	0.14	0.18	0.23	0.27	0.31
0.22	0.10	0.14	0.18	0.22	0.27	0.31
0.24	0.10	0.14	0.18	0.22	0.26	0.30
0.26	0.48	0.13	0.18	0.22	0.26	0.30
0.28	0.51	0.24	0.17	0.21	0.25	0.30
0.30	0.54	0.26	0.17	0.21	0.25	0.29
0.32	0.56	0.30	0.22	0.21	0.25	0.29
0.34	0.58	0.33	0.23	0.21	0.24	0.28
0.36	0.60	0.37	0.24	0.21	0.24	0.28
0.38	0.62	0.41	0.26	0.25	0.24	0.28
0.40	0.64	0.44	0.29	0.26	0.24	0.27
0.42	0.65	0.48	0.32	0.27	0.28	0.27
0.44	0.67	0.51	0.36	0.29	0.29	0.27
0.46	0.69	0.54	0.40	0.32	0.30	0.32
0.48	0.70	0.57	0.44	0.35	0.32	0.32
0.50	0.71	0.60	0.48	0.39	0.34	0.34
0.52	0.72	0.62	0.52	0.43	0.38	0.36
0.54	0.74	0.65	0.56	0.48	0.42	0.39
0.56	0.75	0.67	0.59	0.52	0.47	0.43
0.58	0.75	0.69	0.62	0.56	0.52	0.48
0.60	0.76	0.71	0.65	0.60	0.56	0.53
0.62	0.77	0.72	0.67	0.64	0.60	0.58
0.64	0.78	0.74	0.70	0.67	0.64	0.63
0.66	0.78	0.75	0.72	0.70	0.68	0.67
0.68	0.79	0.76	0.74	0.72	0.71	0.71
0.70	0.80	0.78	0.76	0.75	0.74	0.74
0.72	0.81	0.78	0.77	0.77	0.77	0.77
0.74	0.81	0.79	0.79	0.78	0.79	0.80
0.76	0.82	0.81	0.80	0.80	0.81	0.82
0.78	0.82	0.81	0.81	0.81	0.83	0.84
0.80	0.82	0.82	0.82	0.83	0.84	0.86
0.82	0.83	0.83	0.83	0.84	0.85	0.87
0.84	0.83	0.83	0.84	0.85	0.86	0.88
0.86	0.83	0.83	0.84	0.85	0.87	0.89
0.88	0.83	0.84	0.85	0.86	0.88	0.90
0.90	0.83	0.84	0.85	0.87	0.89	0.91
0.92	0.84	0.84	0.85	0.87	0.89	0.91
0.94	0.84	0.85	0.86	0.87	0.90	0.92
0.96	0.84	0.85	0.86	0.87	0.90	0.93
0.98	0.84	0.85	0.86	0.88	0.90	0.93

Table 3.3.2-4c ($p_1 = 1 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.10	0.16	0.21	0.26	0.31	0.37
0.02	0.10	0.15	0.20	0.26	0.31	0.36
0.04	0.10	0.15	0.20	0.25	0.30	0.35
0.06	0.10	0.15	0.20	0.25	0.30	0.35
0.08	0.10	0.15	0.19	0.24	0.29	0.34
0.10	0.10	0.14	0.19	0.24	0.29	0.34
0.12	0.10	0.14	0.19	0.23	0.28	0.33
0.14	0.10	0.14	0.19	0.23	0.28	0.32
0.16	0.10	0.14	0.18	0.23	0.27	0.32
0.18	0.09	0.14	0.18	0.22	0.27	0.31
0.20	0.09	0.13	0.18	0.22	0.26	0.30
0.22	0.09	0.13	0.17	0.22	0.26	0.30
0.24	0.09	0.13	0.17	0.21	0.25	0.30
0.26	0.47	0.13	0.17	0.21	0.25	0.29
0.28	0.50	0.13	0.16	0.20	0.24	0.28
0.30	0.52	0.22	0.16	0.20	0.24	0.28
0.32	0.54	0.24	0.16	0.20	0.24	0.27
0.34	0.57	0.28	0.16	0.19	0.23	0.27
0.36	0.59	0.32	0.16	0.19	0.23	0.26
0.38	0.61	0.36	0.21	0.19	0.22	0.26
0.40	0.63	0.40	0.23	0.18	0.22	0.25
0.42	0.65	0.44	0.25	0.18	0.21	0.25
0.44	0.66	0.48	0.28	0.23	0.21	0.24
0.46	0.68	0.52	0.32	0.24	0.21	0.24
0.48	0.70	0.55	0.37	0.26	0.25	0.23
0.50	0.71	0.58	0.42	0.30	0.26	0.23
0.52	0.72	0.61	0.47	0.34	0.28	0.28
0.54	0.73	0.64	0.52	0.39	0.31	0.29
0.56	0.74	0.66	0.56	0.45	0.35	0.31
0.58	0.75	0.68	0.60	0.50	0.41	0.35
0.60	0.76	0.70	0.63	0.55	0.48	0.41
0.62	0.77	0.72	0.66	0.60	0.54	0.48
0.64	0.78	0.73	0.69	0.64	0.59	0.54
0.66	0.78	0.75	0.71	0.67	0.64	0.61
0.68	0.79	0.76	0.73	0.70	0.69	0.66
0.70	0.80	0.77	0.75	0.73	0.72	0.71
0.72	0.81	0.78	0.77	0.75	0.75	0.75
0.74	0.81	0.79	0.78	0.78	0.78	0.78
0.76	0.82	0.81	0.80	0.80	0.80	0.81
0.78	0.82	0.81	0.81	0.81	0.82	0.83
0.80	0.82	0.82	0.82	0.83	0.84	0.85
0.82	0.83	0.83	0.83	0.84	0.85	0.87
0.84	0.83	0.83	0.84	0.85	0.86	0.88
0.86	0.83	0.83	0.84	0.85	0.87	0.89
0.88	0.83	0.84	0.85	0.86	0.88	0.90
0.90	0.83	0.84	0.85	0.87	0.89	0.91
0.92	0.84	0.84	0.85	0.87	0.89	0.91
0.94	0.84	0.85	0.86	0.87	0.90	0.92
0.96	0.84	0.85	0.86	0.87	0.90	0.93
0.98	0.84	0.85	0.86	0.88	0.90	0.93

Table 3.3.2-4d ($p_1 = 0.05 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 0.05 \text{ atm}$
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.10	0.16	0.21	0.26	0.31	0.37
0.02	0.10	0.15	0.21	0.26	0.31	0.36
0.04	0.10	0.15	0.20	0.25	0.30	0.35
0.06	0.10	0.15	0.20	0.25	0.30	0.35
0.08	0.10	0.14	0.19	0.24	0.29	0.34
0.10	0.09	0.14	0.19	0.23	0.28	0.33
0.12	0.09	0.14	0.18	0.23	0.27	0.32
0.14	0.09	0.13	0.18	0.22	0.27	0.31
0.16	0.09	0.13	0.18	0.22	0.26	0.31
0.18	0.09	0.13	0.17	0.21	0.26	0.30
0.20	0.08	0.13	0.17	0.21	0.25	0.29
0.22	0.08	0.12	0.16	0.20	0.24	0.28
0.24	0.08	0.12	0.16	0.20	0.24	0.28
0.26	0.08	0.12	0.16	0.19	0.23	0.27
0.28	0.08	0.11	0.15	0.19	0.23	0.26
0.30	0.07	0.11	0.15	0.18	0.22	0.26
0.32	0.47	0.11	0.14	0.18	0.21	0.25
0.34	0.50	0.10	0.14	0.17	0.21	0.24
0.36	0.53	0.10	0.13	0.17	0.20	0.23
0.38	0.56	0.10	0.13	0.16	0.19	0.23
0.40	0.58	0.09	0.13	0.16	0.19	0.22
0.42	0.60	0.09	0.12	0.15	0.18	0.21
0.44	0.62	0.09	0.12	0.14	0.17	0.20
0.46	0.64	0.33	0.11	0.14	0.17	0.19
0.48	0.66	0.38	0.11	0.14	0.16	0.19
0.50	0.68	0.43	0.10	0.13	0.16	0.18
0.52	0.69	0.48	0.10	0.12	0.15	0.17
0.54	0.71	0.52	0.10	0.12	0.14	0.17
0.56	0.72	0.56	0.27	0.12	0.14	0.16
0.58	0.74	0.59	0.34	0.12	0.14	0.15
0.60	0.75	0.62	0.42	0.11	0.13	0.15
0.62	0.76	0.66	0.48	0.22	0.13	0.15
0.64	0.77	0.69	0.54	0.31	0.12	0.14
0.66	0.78	0.71	0.59	0.41	0.11	0.13
0.68	0.78	0.73	0.64	0.50	0.27	0.13
0.70	0.79	0.74	0.67	0.57	0.41	0.19
0.72	0.80	0.76	0.71	0.63	0.52	0.34
0.74	0.81	0.78	0.74	0.68	0.60	0.49
0.76	0.81	0.79	0.77	0.72	0.67	0.59
0.78	0.82	0.81	0.78	0.76	0.73	0.68
0.80	0.82	0.82	0.81	0.79	0.77	0.74
0.82	0.83	0.82	0.81	0.81	0.81	0.80
0.84	0.83	0.83	0.83	0.83	0.84	0.84
0.86	0.83	0.83	0.84	0.85	0.86	0.87
0.88	0.83	0.84	0.85	0.86	0.88	0.89
0.90	0.83	0.84	0.85	0.86	0.89	0.90
0.92	0.84	0.84	0.85	0.87	0.89	0.91
0.94	0.84	0.85	0.86	0.87	0.90	0.92
0.96	0.84	0.85	0.86	0.87	0.90	0.93
0.98	0.84	0.85	0.86	0.88	0.90	0.93

Table 3.3.2-5a ($p_1 = 3 \text{ atm}$)

Normalized Rerative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.05	0.10	0.00	0.00	0.00	0.00
0.04	0.05	0.10	0.15	0.20	0.25	0.30
0.06	0.05	0.10	0.14	0.19	0.24	0.29
0.08	0.05	0.09	0.14	0.19	0.24	0.29
0.10	0.05	0.09	0.14	0.19	0.24	0.28
0.12	0.05	0.09	0.14	0.19	0.23	0.28
0.14	0.05	0.09	0.14	0.18	0.23	0.28
0.16	0.05	0.09	0.14	0.18	0.23	0.27
0.18	0.05	0.09	0.13	0.18	0.22	0.27
0.20	0.05	0.09	0.13	0.18	0.22	0.26
0.22	0.05	0.09	0.13	0.17	0.22	0.26
0.24	0.05	0.09	0.13	0.17	0.22	0.26
0.26	0.02	0.09	0.13	0.17	0.21	0.26
0.28	0.02	0.03	0.13	0.17	0.21	0.25
0.30	0.03	0.04	0.07	0.17	0.21	0.25
0.32	0.03	0.04	0.07	0.17	0.21	0.24
0.34	0.03	0.04	0.07	0.17	0.20	0.24
0.36	0.03	0.04	0.07	0.10	0.20	0.24
0.38	0.04	0.05	0.07	0.10	0.19	0.24
0.40	0.04	0.05	0.07	0.10	0.14	0.24
0.42	0.04	0.05	0.07	0.10	0.14	0.17
0.44	0.04	0.06	0.07	0.10	0.13	0.17
0.46	0.05	0.06	0.08	0.10	0.13	0.17
0.48	0.05	0.07	0.08	0.10	0.13	0.17
0.50	0.05	0.07	0.09	0.11	0.14	0.17
0.52	0.05	0.07	0.09	0.11	0.14	0.17
0.54	0.06	0.08	0.10	0.12	0.14	0.17
0.56	0.06	0.08	0.10	0.12	0.15	0.17
0.58	0.06	0.09	0.11	0.13	0.16	0.18
0.60	0.06	0.09	0.12	0.14	0.16	0.19
0.62	0.06	0.10	0.12	0.15	0.17	0.20
0.64	0.07	0.10	0.13	0.16	0.18	0.21
0.66	0.07	0.10	0.13	0.17	0.19	0.22
0.68	0.07	0.11	0.14	0.17	0.21	0.24
0.70	0.07	0.11	0.15	0.18	0.22	0.25
0.72	0.08	0.11	0.15	0.19	0.22	0.26
0.74	0.08	0.12	0.16	0.19	0.23	0.27
0.76	0.08	0.12	0.16	0.20	0.24	0.28
0.78	0.08	0.13	0.17	0.21	0.25	0.29
0.80	0.08	0.13	0.17	0.21	0.26	0.30
0.82	0.09	0.13	0.17	0.22	0.26	0.31
0.84	0.09	0.13	0.18	0.23	0.27	0.32
0.86	0.09	0.14	0.18	0.23	0.28	0.32
0.88	0.09	0.14	0.19	0.23	0.28	0.33
0.90	0.09	0.14	0.19	0.24	0.29	0.34
0.92	0.10	0.14	0.19	0.24	0.29	0.34
0.94	0.10	0.15	0.20	0.25	0.30	0.35
0.96	0.10	0.15	0.20	0.25	0.30	0.35
0.98	0.10	0.15	0.20	0.26	0.31	0.36

Table 3.3.2-5b ($p_1 = 2 \text{ atm}$)

Normalized Relative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.05	0.00	0.00	0.00	0.00	0.00
0.04	0.05	0.10	0.14	0.19	0.24	0.30
0.06	0.05	0.09	0.14	0.19	0.24	0.29
0.08	0.05	0.09	0.14	0.19	0.24	0.28
0.10	0.05	0.09	0.14	0.19	0.23	0.28
0.12	0.05	0.09	0.13	0.18	0.23	0.28
0.14	0.04	0.09	0.13	0.18	0.23	0.27
0.16	0.04	0.09	0.13	0.18	0.22	0.27
0.18	0.04	0.09	0.13	0.17	0.22	0.26
0.20	0.04	0.08	0.13	0.17	0.21	0.26
0.22	0.04	0.08	0.13	0.17	0.21	0.25
0.24	0.04	0.08	0.12	0.17	0.21	0.25
0.26	0.02	0.08	0.12	0.16	0.20	0.24
0.28	0.02	0.03	0.12	0.16	0.20	0.24
0.30	0.02	0.03	0.12	0.16	0.20	0.24
0.32	0.03	0.03	0.06	0.16	0.19	0.23
0.34	0.03	0.03	0.06	0.15	0.19	0.23
0.36	0.03	0.04	0.06	0.15	0.19	0.22
0.38	0.03	0.04	0.06	0.09	0.19	0.22
0.40	0.03	0.04	0.06	0.09	0.18	0.22
0.42	0.04	0.05	0.06	0.09	0.12	0.22
0.44	0.04	0.05	0.06	0.09	0.12	0.22
0.46	0.04	0.05	0.06	0.09	0.12	0.15
0.48	0.05	0.06	0.07	0.09	0.11	0.15
0.50	0.05	0.06	0.07	0.09	0.11	0.15
0.52	0.05	0.07	0.08	0.10	0.12	0.14
0.54	0.05	0.07	0.09	0.10	0.12	0.14
0.56	0.06	0.08	0.09	0.11	0.13	0.15
0.58	0.06	0.08	0.10	0.12	0.13	0.15
0.60	0.06	0.09	0.11	0.12	0.14	0.16
0.62	0.06	0.09	0.11	0.13	0.15	0.17
0.64	0.07	0.10	0.12	0.14	0.16	0.18
0.66	0.07	0.10	0.13	0.15	0.18	0.20
0.68	0.07	0.10	0.13	0.16	0.19	0.21
0.70	0.07	0.11	0.14	0.17	0.20	0.23
0.72	0.08	0.11	0.15	0.18	0.21	0.24
0.74	0.08	0.12	0.15	0.19	0.22	0.26
0.76	0.08	0.12	0.16	0.20	0.23	0.27
0.78	0.08	0.12	0.16	0.20	0.24	0.28
0.80	0.08	0.13	0.17	0.21	0.25	0.29
0.82	0.09	0.13	0.17	0.22	0.26	0.30
0.84	0.09	0.13	0.18	0.22	0.27	0.31
0.86	0.09	0.14	0.18	0.23	0.27	0.32
0.88	0.09	0.14	0.19	0.23	0.28	0.33
0.90	0.09	0.14	0.19	0.24	0.29	0.34
0.92	0.10	0.14	0.19	0.24	0.29	0.34
0.94	0.10	0.15	0.20	0.25	0.30	0.35
0.96	0.10	0.15	0.20	0.25	0.30	0.35
0.98	0.10	0.15	0.20	0.26	0.31	0.36

Table 3.3.2-5c (p₁ = 1 atm)

Normalized Relative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at P₁ = 1 atm
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.04	0.09	0.00	0.00	0.00	0.00
0.06	0.04	0.09	0.14	0.19	0.24	0.28
0.08	0.04	0.09	0.13	0.18	0.23	0.28
0.10	0.04	0.09	0.13	0.18	0.23	0.27
0.12	0.04	0.08	0.13	0.17	0.22	0.27
0.14	0.04	0.08	0.13	0.17	0.22	0.26
0.16	0.04	0.08	0.13	0.17	0.21	0.26
0.18	0.04	0.08	0.12	0.17	0.21	0.25
0.20	0.04	0.08	0.12	0.16	0.21	0.25
0.22	0.04	0.07	0.12	0.16	0.20	0.24
0.24	0.04	0.07	0.11	0.15	0.19	0.24
0.26	0.01	0.07	0.11	0.15	0.19	0.23
0.28	0.02	0.07	0.11	0.15	0.18	0.22
0.30	0.02	0.02	0.11	0.14	0.18	0.22
0.32	0.02	0.02	0.10	0.14	0.18	0.22
0.34	0.02	0.02	0.10	0.14	0.17	0.21
0.36	0.02	0.02	0.10	0.14	0.17	0.20
0.38	0.03	0.03	0.05	0.13	0.17	0.20
0.40	0.03	0.03	0.04	0.13	0.16	0.19
0.42	0.03	0.03	0.04	0.13	0.16	0.19
0.44	0.03	0.04	0.04	0.07	0.16	0.19
0.46	0.04	0.04	0.04	0.07	0.15	0.18
0.48	0.04	0.04	0.05	0.06	0.09	0.18
0.50	0.04	0.05	0.05	0.06	0.09	0.18
0.52	0.05	0.05	0.06	0.07	0.09	0.11
0.54	0.05	0.06	0.06	0.07	0.09	0.11
0.56	0.05	0.06	0.07	0.08	0.09	0.11
0.58	0.05	0.07	0.08	0.08	0.09	0.11
0.60	0.06	0.07	0.09	0.09	0.10	0.11
0.62	0.06	0.08	0.09	0.10	0.11	0.12
0.64	0.06	0.09	0.10	0.11	0.12	0.13
0.66	0.07	0.09	0.11	0.12	0.13	0.14
0.68	0.07	0.10	0.12	0.13	0.15	0.16
0.70	0.07	0.10	0.13	0.15	0.16	0.18
0.72	0.07	0.11	0.13	0.16	0.18	0.19
0.74	0.08	0.11	0.14	0.17	0.19	0.22
0.76	0.08	0.12	0.15	0.18	0.21	0.24
0.78	0.08	0.12	0.16	0.19	0.22	0.26
0.80	0.08	0.12	0.16	0.20	0.24	0.27
0.82	0.09	0.13	0.17	0.21	0.25	0.29
0.84	0.09	0.13	0.17	0.22	0.26	0.30
0.86	0.09	0.14	0.18	0.23	0.27	0.31
0.88	0.09	0.14	0.19	0.23	0.28	0.32
0.90	0.09	0.14	0.19	0.24	0.29	0.33
0.92	0.10	0.14	0.19	0.24	0.29	0.34
0.94	0.10	0.15	0.20	0.25	0.30	0.35
0.96	0.10	0.15	0.20	0.25	0.30	0.35
0.98	0.10	0.15	0.20	0.26	0.31	0.36

Table 3.3.2-5d ($p_1 = 0.05 \text{ atm}$)

Normalized Relative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 0.05 \text{ atm}$
AC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.00	0.00	0.00	0.00	0.00	0.00
0.06	0.00	0.00	0.00	0.00	0.00	0.00
0.08	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.00	0.00	0.00	0.00	0.00	0.00
0.12	0.00	0.00	0.00	0.00	0.00	0.00
0.14	0.00	0.00	0.00	0.00	0.00	0.00
0.16	0.00	0.00	0.00	0.00	0.00	0.00
0.18	0.00	0.00	0.00	0.00	0.00	0.00
0.20	0.00	0.00	0.00	0.00	0.00	0.00
0.22	0.00	0.00	0.00	0.00	0.00	0.00
0.24	0.00	0.00	0.00	0.00	0.00	0.00
0.26	0.00	0.00	0.00	0.00	0.00	0.00
0.28	0.00	0.00	0.00	0.00	0.00	0.00
0.30	0.00	0.00	0.00	0.00	0.00	0.00
0.32	0.00	0.00	0.00	0.00	0.00	0.00
0.34	0.00	0.00	0.00	0.00	0.00	0.00
0.36	0.00	0.00	0.00	0.00	0.00	0.00
0.38	0.00	0.00	0.00	0.00	0.00	0.00
0.40	0.00	0.00	0.00	0.00	0.00	0.00
0.42	0.00	0.00	0.00	0.00	0.00	0.00
0.44	0.01	0.03	0.00	0.00	0.00	0.00
0.46	0.01	0.00	0.00	0.00	0.00	0.00
0.48	0.01	0.00	0.00	0.00	0.00	0.00
0.50	0.01	0.01	0.00	0.00	0.00	0.00
0.52	0.01	0.01	0.04	0.00	0.00	0.00
0.54	0.01	0.01	0.04	0.00	0.00	0.00
0.56	0.01	0.01	0.01	0.06	0.00	0.00
0.58	0.02	0.01	0.01	0.05	0.07	0.00
0.60	0.02	0.01	0.01	0.05	0.07	0.09
0.62	0.02	0.01	0.01	0.01	0.06	0.08
0.64	0.02	0.02	0.01	0.01	0.06	0.07
0.66	0.03	0.02	0.02	0.01	0.05	0.07
0.68	0.03	0.02	0.02	0.01	0.01	0.06
0.70	0.04	0.03	0.02	0.02	0.01	0.02
0.72	0.04	0.03	0.03	0.02	0.02	0.02
0.74	0.05	0.04	0.04	0.03	0.02	0.02
0.76	0.05	0.05	0.04	0.04	0.03	0.03
0.78	0.06	0.06	0.06	0.05	0.04	0.04
0.80	0.06	0.07	0.07	0.06	0.06	0.05
0.82	0.07	0.08	0.09	0.08	0.08	0.07
0.84	0.08	0.10	0.10	0.11	0.10	0.10
0.86	0.08	0.11	0.13	0.13	0.14	0.13
0.88	0.09	0.12	0.15	0.17	0.18	0.18
0.90	0.09	0.13	0.16	0.19	0.22	0.24
0.92	0.09	0.14	0.18	0.21	0.25	0.28
0.94	0.10	0.14	0.19	0.23	0.28	0.32
0.96	0.10	0.15	0.19	0.24	0.29	0.34
0.98	0.10	0.15	0.20	0.25	0.30	0.35

Table 3.3.2-1a Homologous Torque at $p_1 = 3$ atm (AC Motor)

Inlet Vold	Homologous Flow Parameter ν/α_N					
	0.400	0.600	0.800	1.000	1.200	1.400
0.000	0.687	0.799	0.908	1.000	1.037	0.950
0.020	0.687	0.802	0.915	1.009	1.046	0.960
0.040	0.684	0.801	0.913	1.010	1.047	0.961
0.060	0.684	0.802	0.915	1.013	1.058	0.972
0.080	0.681	0.804	0.919	1.023	1.063	0.978
0.100	0.682	0.805	0.921	1.027	1.069	0.984
0.120	0.679	0.803	0.923	1.031	1.075	0.990
0.140	0.680	0.804	0.926	1.035	1.080	0.997
0.160	0.676	0.806	0.929	1.033	1.086	1.002
0.180	0.674	0.802	0.931	1.038	1.091	1.009
0.200	0.670	0.804	0.928	1.041	1.097	1.016
0.220	0.671	0.801	0.931	1.045	1.103	1.023
0.240	0.668	0.803	0.933	1.050	1.102	1.030
0.260	0.217	0.799	0.931	1.047	1.108	1.030
0.280	0.206	0.444	0.932	1.051	1.114	1.037
0.300	0.198	0.401	0.692	1.047	1.112	1.044
0.320	0.193	0.359	0.653	1.014	1.104	1.039
0.340	0.187	0.322	0.606	0.972	1.089	1.041
0.360	0.182	0.289	0.557	0.780	1.067	1.033
0.380	0.177	0.264	0.505	0.737	1.005	1.022
0.400	0.174	0.239	0.447	0.691	0.852	1.003
0.420	0.170	0.220	0.398	0.634	0.808	0.864
0.440	0.169	0.205	0.351	0.574	0.761	0.831
0.460	0.165	0.190	0.308	0.511	0.703	0.802
0.480	0.164	0.179	0.272	0.454	0.640	0.756
0.500	0.160	0.170	0.244	0.393	0.581	0.713
0.520	0.160	0.161	0.219	0.346	0.513	0.659
0.540	0.156	0.154	0.197	0.302	0.453	0.602
0.560	0.156	0.147	0.178	0.265	0.398	0.551
0.580	0.156	0.144	0.165	0.236	0.353	0.502
0.600	0.156	0.139	0.154	0.210	0.313	0.457
0.620	0.153	0.134	0.144	0.189	0.284	0.429
0.640	0.153	0.133	0.135	0.174	0.259	0.397
0.660	0.154	0.129	0.128	0.162	0.236	0.376
0.680	0.151	0.125	0.122	0.151	0.223	0.357
0.700	0.151	0.125	0.116	0.140	0.207	0.339
0.720	0.152	0.125	0.111	0.136	0.197	0.331
0.740	0.149	0.121	0.110	0.130	0.189	0.324
0.760	0.150	0.122	0.106	0.124	0.182	0.318
0.780	0.151	0.119	0.107	0.120	0.176	0.314
0.800	0.146	0.120	0.104	0.116	0.171	0.299
0.820	0.148	0.117	0.105	0.117	0.174	0.294
0.840	0.150	0.119	0.102	0.114	0.170	0.303
0.860	0.152	0.121	0.105	0.111	0.167	0.299
0.880	0.145	0.117	0.102	0.114	0.163	0.296
0.900	0.147	0.121	0.098	0.112	0.171	0.293
0.920	0.151	0.114	0.103	0.108	0.169	0.287
0.940	0.158	0.120	0.098	0.117	0.165	0.279
0.960	0.139	0.131	0.109	0.115	0.158	0.313
0.980	0.146	0.117	0.100	0.150	0.199	0.315

Table 3.3.2-1b Homologous Torque at $p_1 = 2$ atm (AC Motor)

Inlet Void	Homologous Flow Parameter ν/α_N					
	0.400	0.600	0.800	1.000	1.200	1.400
0.000	0.687	0.799	0.908	1.000	1.037	0.950
0.020	0.688	0.804	0.917	1.011	1.047	0.961
0.040	0.689	0.803	0.920	1.017	1.055	0.969
0.060	0.690	0.805	0.924	1.023	1.062	0.975
0.080	0.688	0.812	0.928	1.029	1.070	0.982
0.100	0.689	0.815	0.932	1.034	1.083	0.995
0.120	0.690	0.817	0.936	1.046	1.090	1.002
0.140	0.688	0.819	0.939	1.052	1.097	1.010
0.160	0.689	0.817	0.944	1.057	1.104	1.024
0.180	0.687	0.820	0.947	1.064	1.112	1.032
0.200	0.688	0.823	0.952	1.070	1.121	1.041
0.220	0.686	0.825	0.956	1.075	1.135	1.049
0.240	0.687	0.823	0.960	1.082	1.143	1.058
0.260	0.219	0.826	0.964	1.088	1.150	1.067
0.280	0.210	0.490	0.962	1.094	1.151	1.075
0.300	0.201	0.435	0.944	1.092	1.160	1.084
0.320	0.194	0.389	0.723	1.083	1.159	1.092
0.340	0.188	0.346	0.678	1.068	1.153	1.087
0.360	0.182	0.308	0.629	1.041	1.151	1.093
0.380	0.177	0.278	0.570	0.827	1.137	1.090
0.400	0.175	0.250	0.509	0.784	1.111	1.091
0.420	0.170	0.229	0.450	0.728	0.911	1.081
0.440	0.169	0.210	0.388	0.666	0.867	1.060
0.460	0.164	0.193	0.338	0.594	0.817	0.896
0.480	0.164	0.181	0.296	0.524	0.754	0.859
0.500	0.160	0.171	0.259	0.452	0.677	0.818
0.520	0.159	0.162	0.227	0.385	0.601	0.763
0.540	0.156	0.154	0.203	0.329	0.518	0.695
0.560	0.156	0.148	0.182	0.284	0.450	0.621
0.580	0.156	0.144	0.167	0.247	0.389	0.556
0.600	0.156	0.139	0.155	0.218	0.336	0.501
0.620	0.153	0.134	0.145	0.198	0.300	0.452
0.640	0.153	0.132	0.136	0.178	0.271	0.415
0.660	0.154	0.128	0.128	0.164	0.246	0.389
0.680	0.151	0.128	0.122	0.153	0.225	0.368
0.700	0.151	0.124	0.116	0.143	0.212	0.348
0.720	0.152	0.124	0.114	0.136	0.197	0.332
0.740	0.148	0.121	0.110	0.129	0.189	0.325
0.760	0.149	0.122	0.106	0.124	0.182	0.319
0.780	0.151	0.119	0.106	0.119	0.176	0.313
0.800	0.146	0.120	0.103	0.115	0.171	0.299
0.820	0.147	0.116	0.104	0.116	0.172	0.295
0.840	0.149	0.118	0.101	0.113	0.169	0.303
0.860	0.152	0.120	0.103	0.109	0.165	0.299
0.880	0.144	0.116	0.101	0.113	0.162	0.296
0.900	0.146	0.119	0.097	0.110	0.170	0.292
0.920	0.150	0.113	0.101	0.106	0.167	0.287
0.940	0.157	0.118	0.096	0.115	0.163	0.279
0.960	0.137	0.129	0.106	0.111	0.156	0.313
0.980	0.142	0.112	0.094	0.144	0.195	0.315

Table 3.3.2-1c Homologous Torque at $p_1 = 1$ atm (AC Motor)

Inlet Void	Homologous Flow Parameter ν/α_N					
	0.400	0.600	0.800	1.000	1.200	1.400
0.000	0.687	0.799	0.908	1.000	1.037	0.950
0.020	0.692	0.806	0.918	1.014	1.050	0.962
0.040	0.691	0.810	0.928	1.027	1.065	0.975
0.060	0.697	0.814	0.934	1.035	1.074	0.985
0.080	0.699	0.822	0.940	1.043	1.084	0.995
0.100	0.701	0.825	0.946	1.056	1.100	1.009
0.120	0.704	0.830	0.957	1.065	1.110	1.018
0.140	0.706	0.839	0.963	1.079	1.126	1.034
0.160	0.709	0.843	0.975	1.088	1.137	1.044
0.180	0.711	0.847	0.981	1.097	1.154	1.061
0.200	0.710	0.851	0.988	1.112	1.164	1.070
0.220	0.713	0.856	0.995	1.121	1.176	1.088
0.240	0.716	0.861	1.008	1.131	1.194	1.100
0.260	0.227	0.866	1.015	1.140	1.206	1.111
0.280	0.214	0.870	1.022	1.157	1.219	1.130
0.300	0.204	0.527	1.029	1.167	1.230	1.142
0.320	0.197	0.469	1.022	1.169	1.250	1.154
0.340	0.190	0.410	1.012	1.174	1.255	1.162
0.360	0.183	0.361	0.992	1.171	1.256	1.174
0.380	0.180	0.315	0.722	1.171	1.263	1.186
0.400	0.175	0.277	0.660	1.166	1.270	1.196
0.420	0.171	0.247	0.586	1.133	1.273	1.206
0.440	0.169	0.224	0.507	0.871	1.260	1.207
0.460	0.165	0.204	0.432	0.801	1.235	1.212
0.480	0.164	0.191	0.361	0.722	0.988	1.205
0.500	0.160	0.176	0.306	0.626	0.924	1.187
0.520	0.159	0.165	0.260	0.523	0.841	0.985
0.540	0.159	0.157	0.228	0.430	0.739	0.931
0.560	0.156	0.149	0.198	0.349	0.625	0.850
0.580	0.156	0.145	0.179	0.294	0.511	0.756
0.600	0.156	0.139	0.161	0.249	0.417	0.644
0.620	0.153	0.134	0.148	0.216	0.350	0.544
0.640	0.153	0.132	0.138	0.191	0.300	0.472
0.660	0.154	0.128	0.130	0.170	0.266	0.419
0.680	0.150	0.128	0.122	0.156	0.240	0.389
0.700	0.151	0.124	0.116	0.145	0.218	0.357
0.720	0.152	0.124	0.114	0.137	0.205	0.344
0.740	0.148	0.121	0.110	0.129	0.190	0.327
0.760	0.149	0.121	0.105	0.124	0.182	0.320
0.780	0.150	0.118	0.105	0.119	0.175	0.315
0.800	0.145	0.119	0.102	0.114	0.170	0.310
0.820	0.147	0.115	0.103	0.115	0.172	0.306
0.840	0.149	0.117	0.100	0.112	0.168	0.303
0.860	0.151	0.120	0.102	0.108	0.164	0.299
0.880	0.143	0.115	0.099	0.112	0.161	0.295
0.900	0.146	0.118	0.095	0.108	0.168	0.292
0.920	0.149	0.111	0.099	0.105	0.165	0.286
0.940	0.155	0.116	0.094	0.112	0.160	0.277
0.960	0.135	0.126	0.102	0.107	0.152	0.312
0.980	0.139	0.106	0.088	0.135	0.188	0.314

Table 3.3.2-1d Homologous Torque at $p_1 = 0.05$ atm (AC Motor)

Homologous Flow Parameter ν/α_N						
Inlet Void	0.400	0.600	0.800	1.000	1.200	1.400
0.000	0.687	0.799	0.908	1.000	1.037	0.950
0.020	0.694	0.808	0.919	1.016	1.052	0.966
0.040	0.702	0.819	0.931	1.031	1.067	0.981
0.060	0.711	0.829	0.943	1.047	1.084	0.998
0.080	0.720	0.841	0.957	1.064	1.102	1.016
0.100	0.730	0.852	0.971	1.082	1.120	1.034
0.120	0.739	0.865	0.987	1.099	1.141	1.053
0.140	0.750	0.879	1.004	1.119	1.162	1.073
0.160	0.760	0.892	1.020	1.140	1.184	1.093
0.180	0.771	0.906	1.039	1.160	1.206	1.113
0.200	0.783	0.921	1.058	1.183	1.233	1.134
0.220	0.795	0.936	1.079	1.207	1.258	1.157
0.240	0.807	0.952	1.099	1.234	1.286	1.181
0.260	0.820	0.969	1.122	1.261	1.313	1.205
0.280	0.833	0.985	1.146	1.291	1.344	1.230
0.300	0.846	1.004	1.172	1.321	1.379	1.258
0.320	0.228	1.028	1.195	1.351	1.415	1.287
0.340	0.214	1.045	1.225	1.381	1.448	1.317
0.360	0.204	1.064	1.251	1.415	1.482	1.351
0.380	0.195	1.083	1.277	1.448	1.523	1.386
0.400	0.188	1.102	1.304	1.484	1.566	1.419
0.420	0.181	1.117	1.333	1.520	1.606	1.455
0.440	0.175	1.095	1.362	1.558	1.647	1.493
0.460	0.172	0.362	1.391	1.595	1.690	1.532
0.480	0.167	0.306	1.418	1.635	1.736	1.575
0.500	0.166	0.257	1.441	1.674	1.783	1.619
0.520	0.162	0.225	1.417	1.713	1.831	1.665
0.540	0.161	0.200	1.440	1.748	1.881	1.714
0.560	0.157	0.180	0.539	1.740	1.929	1.766
0.580	0.156	0.167	0.399	1.768	1.920	1.822
0.600	0.156	0.156	0.299	1.785	1.962	1.813
0.620	0.153	0.147	0.236	0.849	1.999	1.860
0.640	0.153	0.139	0.197	0.558	2.024	1.920
0.660	0.153	0.133	0.169	0.373	1.991	1.964
0.680	0.150	0.131	0.150	0.275	0.767	1.976
0.700	0.151	0.126	0.133	0.217	0.471	1.239
0.720	0.151	0.125	0.122	0.180	0.338	0.711
0.740	0.148	0.121	0.114	0.154	0.264	0.492
0.760	0.148	0.121	0.108	0.139	0.225	0.410
0.780	0.150	0.117	0.106	0.124	0.204	0.360
0.800	0.145	0.118	0.102	0.121	0.184	0.332
0.820	0.146	0.114	0.102	0.115	0.174	0.311
0.840	0.148	0.116	0.099	0.111	0.168	0.304
0.860	0.150	0.118	0.101	0.107	0.163	0.299
0.880	0.142	0.113	0.097	0.109	0.159	0.295
0.900	0.144	0.116	0.093	0.106	0.165	0.291
0.920	0.148	0.109	0.096	0.101	0.162	0.285
0.940	0.153	0.113	0.090	0.108	0.157	0.276
0.960	0.131	0.121	0.096	0.101	0.147	0.310
0.980	0.132	0.098	0.078	0.122	0.177	0.311

Table 3.5.2-1a ($p_1 =$ (m)Static Pressure Increase, ($p_2 - p_1$) (psi)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	259.688	250.569	238.569	220.437	192.918	152.761	96.712
0.02	256.988	248.627	237.467	219.959	192.995	153.280	97.385
0.04	254.551	246.580	236.266	219.386	192.984	153.720	98.002
0.06	252.115	244.429	234.969	218.724	192.889	154.086	98.568
0.08	249.418	242.172	233.572	217.966	192.705	154.375	99.078
0.10	246.197	239.805	232.070	217.108	192.427	154.583	99.533
0.12	242.191	237.325	230.459	216.146	192.050	154.705	99.926
0.14	237.138	234.731	228.733	215.072	191.570	154.737	100.257
0.16	230.776	232.017	226.887	213.883	190.981	154.675	100.522
0.18	8.397	229.182	224.916	212.569	190.278	154.513	100.716
0.20	6.511	226.220	222.815	211.121	189.453	154.246	100.836
0.22	5.765	223.120	220.576	209.536	188.501	153.869	100.878
0.24	5.192	219.746	218.182	207.808	187.414	153.373	100.838
0.26	4.682	37.478	215.555	205.892	186.167	152.745	100.705
0.28	4.273	31.861	134.959	203.738	184.719	151.951	100.459
0.30	3.885	27.311	115.485	195.916	182.987	150.953	100.080
0.32	3.547	23.520	97.219	185.979	177.937	148.312	99.001
0.34	3.256	20.334	80.798	149.313	173.429	145.825	97.646
0.36	2.994	17.644	66.754	136.507	167.354	142.881	96.254
0.38	2.756	15.339	55.070	121.755	158.239	139.102	94.515
0.40	2.538	13.351	45.498	105.473	131.016	134.078	92.298
0.42	2.339	11.633	37.725	88.743	120.301	127.102	89.427
0.44	2.157	10.139	31.368	72.976	107.845	106.438	85.632
0.46	1.991	8.840	26.147	59.208	93.737	97.952	79.888
0.48	1.838	7.706	21.840	47.781	78.690	88.022	67.391
0.50	1.698	6.716	18.270	38.585	64.076	76.564	61.330
0.52	1.571	5.850	15.294	31.171	51.152	64.007	54.182
0.54	1.455	5.093	12.802	25.200	40.496	51.551	45.939
0.56	1.350	4.430	10.709	20.385	31.950	40.481	37.186
0.58	1.253	3.850	8.947	16.485	25.128	31.432	29.017
0.60	1.165	3.344	7.460	13.311	19.728	24.154	22.145
0.62	1.086	2.902	6.206	10.720	15.443	18.452	16.613
0.64	1.014	2.518	5.147	8.600	12.035	14.007	12.319
0.66	0.948	2.185	4.256	6.864	9.317	10.540	9.020
0.68	0.889	1.898	3.506	5.444	7.150	7.834	6.492
0.70	0.836	1.649	2.880	4.285	5.423	5.725	4.559
0.72	0.788	1.436	2.358	3.344	4.051	4.087	3.086
0.74	0.744	1.254	1.926	2.585	2.970	2.823	1.974
0.76	0.705	1.101	1.572	1.979	2.126	1.861	1.147
0.78	0.669	0.971	1.286	1.499	1.479	1.140	0.545
0.80	0.637	0.863	1.056	1.129	0.991	0.616	0.123
0.82	0.608	0.773	0.876	0.848	0.636	0.249	-0.155
0.84	0.581	0.699	0.736	0.644	0.390	0.012	-0.321
0.86	0.557	0.640	0.631	0.501	0.232	-0.124	-0.396
0.88	0.535	0.591	0.556	0.408	0.145	-0.179	-0.404
0.90	0.514	0.553	0.505	0.358	0.115	-0.172	-0.359
0.92	0.495	0.521	0.471	0.338	0.127	-0.117	0.250
0.94	0.477	0.496	0.453	0.343	0.172	-0.027	0.227
0.96	0.460	0.475	0.444	0.365	0.238	0.084	0.227
0.98	0.443	0.456	0.442	0.396	0.316	0.207	0.241
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

v_{L2} Liquid Flow Velocity (feet/sec)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	9.078	18.155	27.233	36.311	45.389	54.466	63.544
0.02	8.930	17.850	26.773	35.693	44.624	53.559	62.498
0.04	8.780	17.547	26.315	35.075	43.858	52.648	61.447
0.06	8.630	17.245	25.861	34.456	43.092	51.737	60.394
0.08	8.479	16.945	25.410	33.839	42.326	50.826	59.340
0.10	8.329	16.647	24.962	33.222	41.561	49.915	58.285
0.12	8.180	16.351	24.514	32.607	40.796	49.004	57.229
0.14	8.031	16.056	24.072	31.992	40.033	48.094	56.173
0.16	7.885	15.763	23.631	31.379	39.271	47.184	55.118
0.18	8.612	15.472	23.194	30.779	38.511	46.276	54.062
0.20	8.612	15.184	22.758	30.199	37.752	45.369	53.008
0.22	8.585	14.896	22.327	29.626	36.995	44.464	51.955
0.24	8.558	14.611	21.897	29.067	36.241	43.561	50.904
0.26	8.515	15.644	21.470	28.506	35.490	42.662	49.856
0.28	8.507	15.597	21.293	27.951	34.743	41.766	48.811
0.30	8.475	15.575	21.080	27.432	34.000	40.875	47.771
0.32	8.454	15.568	20.958	26.940	33.298	40.013	46.753
0.34	8.438	15.572	20.929	26.500	32.600	39.156	45.750
0.36	8.418	15.586	20.977	26.112	31.933	38.315	44.753
0.38	8.398	15.607	21.080	25.814	31.330	37.502	43.777
0.40	8.377	15.634	21.208	25.644	31.149	36.731	42.831
0.42	8.357	15.665	21.200	25.632	30.716	36.036	41.927
0.44	8.337	15.699	21.285	25.786	30.410	35.861	41.092
0.46	8.317	15.735	21.456	26.075	30.287	35.383	40.404
0.48	8.297	15.770	21.653	26.437	30.401	35.069	40.281
0.50	8.277	15.805	21.862	26.567	30.769	34.998	39.861
0.52	8.257	15.838	22.076	26.896	31.329	35.254	39.698
0.54	8.238	15.869	22.289	27.345	31.751	35.858	39.914
0.56	8.218	15.897	22.496	27.825	32.217	36.628	40.586
0.58	8.199	15.922	22.692	28.312	32.987	37.115	41.399
0.60	8.180	15.943	22.876	28.789	33.811	38.212	42.257
0.62	8.162	15.960	23.045	29.246	34.643	39.430	43.791
0.64	8.144	15.972	23.198	29.673	35.451	40.679	45.491
0.66	8.126	15.981	23.333	30.064	36.215	41.904	47.237
0.68	8.108	15.984	23.450	30.415	36.918	43.063	48.945
0.70	8.089	15.984	23.549	30.723	37.549	44.127	50.554
0.72	8.070	15.978	23.630	30.987	38.103	45.076	52.018
0.74	8.050	15.969	23.692	31.207	38.573	45.897	53.303
0.76	8.031	15.955	23.737	31.383	38.961	46.581	54.385
0.78	8.011	15.936	23.764	31.517	39.266	47.126	55.251
0.80	7.991	15.914	23.776	31.609	39.490	47.534	55.897
0.82	7.970	15.887	23.772	31.664	39.639	47.811	56.332
0.84	7.949	15.858	23.754	31.683	39.718	47.966	56.569
0.86	7.928	15.825	23.723	31.670	39.734	48.011	56.631
0.88	7.907	15.790	23.682	31.630	39.694	47.962	56.541
0.90	7.886	15.753	23.632	31.565	39.607	47.830	56.328
0.92	7.865	15.715	23.575	31.481	39.480	47.634	109.316
0.94	7.845	15.675	23.512	31.382	39.323	47.386	109.476
0.96	7.825	15.636	23.446	31.273	39.145	47.104	109.586
0.98	7.805	15.597	23.378	31.157	38.955	46.799	109.650
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

v_{g2} Gas Flow Velocity (feet/sec)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	6.984	13.616	22.411	32.926	41.389	50.030	58.947
0.04	6.984	13.246	21.650	32.347	40.660	49.144	57.886
0.06	6.963	12.904	20.946	31.770	39.933	48.260	56.828
0.08	6.919	12.586	20.293	31.193	39.208	47.378	55.775
0.10	6.849	12.317	19.688	30.618	38.484	46.499	54.726
0.12	6.756	12.033	19.196	30.045	37.762	45.622	53.680
0.14	6.639	11.766	18.664	29.473	37.043	44.747	52.639
0.16	6.500	11.512	18.168	28.903	36.325	43.876	51.602
0.18	9.737	11.270	17.704	28.048	35.609	43.008	50.570
0.20	9.792	11.027	17.267	26.841	34.897	42.142	49.542
0.22	9.802	10.805	16.825	25.712	34.187	41.281	48.518
0.24	9.808	10.590	16.438	24.558	33.480	40.423	47.500
0.26	9.791	16.019	16.069	23.637	32.777	39.570	46.488
0.28	9.807	16.311	19.565	22.801	32.078	38.721	45.482
0.30	9.780	16.500	19.433	22.237	31.385	37.879	44.483
0.32	9.757	16.665	19.412	21.798	30.730	37.067	43.509
0.34	9.742	16.817	19.512	24.407	30.079	36.260	42.550
0.36	9.721	16.963	19.724	24.080	29.459	35.469	41.501
0.38	9.700	17.103	20.050	23.855	28.900	34.705	40.673
0.40	9.680	17.239	20.517	23.776	28.809	33.984	39.776
0.42	9.660	17.370	21.493	23.887	28.447	33.336	38.922
0.44	9.641	17.496	22.209	24.214	28.226	33.299	38.134
0.46	9.621	17.615	22.722	24.762	28.213	32.904	37.499
0.48	9.602	17.728	23.205	25.552	28.489	32.691	37.588
0.50	9.581	17.833	23.669	27.056	29.110	32.760	37.276
0.52	9.561	17.931	24.117	28.177	30.115	33.238	37.264
0.54	9.540	18.019	24.547	29.114	31.879	34.244	37.727
0.56	9.518	18.098	24.954	30.019	33.732	35.962	38.887
0.58	9.496	18.168	25.336	30.895	35.186	38.686	41.240
0.60	9.472	18.229	25.689	31.733	36.613	40.717	44.371
0.62	9.448	18.280	26.011	32.523	38.005	42.757	47.031
0.64	9.424	18.322	26.300	33.255	39.336	44.781	49.785
0.66	9.400	18.355	26.555	33.921	40.582	46.735	52.546
0.68	9.375	18.378	26.776	34.516	41.719	48.565	55.210
0.70	9.350	18.394	26.962	35.035	42.732	50.228	57.683
0.72	9.325	18.401	27.116	35.477	43.610	51.689	59.891
0.74	9.300	18.401	27.238	35.844	44.349	52.931	61.782
0.76	9.274	18.393	27.330	36.138	44.950	53.945	63.329
0.78	9.249	18.378	27.393	36.362	45.417	54.734	64.524
0.80	9.223	18.357	27.431	36.522	45.759	55.310	65.379
0.82	9.197	18.330	27.445	36.623	45.985	55.689	65.921
0.84	9.171	18.298	27.437	36.670	46.108	55.891	66.185
0.86	9.145	18.261	27.410	36.670	46.140	55.939	66.209
0.88	9.119	18.221	27.366	36.628	46.092	55.856	66.034
0.90	9.092	18.176	27.308	36.552	45.979	55.666	65.701
0.92	9.066	18.129	27.238	36.447	45.811	55.390	67.141
0.94	9.040	18.079	27.159	36.320	45.602	55.049	67.722
0.96	9.014	18.029	27.074	36.176	45.364	54.663	68.276
0.98	8.988	17.977	26.984	36.023	45.107	54.249	68.809
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Inlet Void Fraction	α_2 Void Fraction							
	Homologous Parameter							
	α_1	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.004
0.04	0.008	0.007	0.006	0.006	0.006	0.006	0.007	0.007
0.06	0.011	0.010	0.010	0.009	0.010	0.010	0.010	0.011
0.08	0.015	0.014	0.014	0.013	0.013	0.013	0.014	0.015
0.10	0.019	0.018	0.018	0.016	0.017	0.017	0.018	0.019
0.12	0.024	0.023	0.022	0.020	0.021	0.021	0.022	0.023
0.14	0.028	0.027	0.027	0.024	0.025	0.025	0.026	0.027
0.16	0.033	0.032	0.032	0.028	0.029	0.029	0.030	0.032
0.18	0.133	0.038	0.037	0.033	0.033	0.033	0.035	0.036
0.20	0.154	0.043	0.043	0.038	0.038	0.038	0.040	0.041
0.22	0.173	0.049	0.049	0.044	0.043	0.043	0.044	0.046
0.24	0.192	0.055	0.055	0.051	0.048	0.048	0.050	0.051
0.26	0.210	0.141	0.061	0.057	0.054	0.054	0.055	0.057
0.28	0.229	0.162	0.078	0.065	0.059	0.059	0.061	0.063
0.30	0.249	0.184	0.096	0.073	0.065	0.065	0.067	0.069
0.32	0.268	0.207	0.118	0.083	0.073	0.073	0.074	0.076
0.34	0.288	0.230	0.143	0.095	0.081	0.081	0.082	0.083
0.36	0.308	0.254	0.171	0.109	0.090	0.090	0.090	0.091
0.38	0.328	0.279	0.200	0.127	0.102	0.102	0.099	0.100
0.40	0.348	0.303	0.230	0.150	0.125	0.125	0.110	0.110
0.42	0.369	0.328	0.256	0.178	0.142	0.142	0.123	0.121
0.44	0.389	0.352	0.284	0.212	0.164	0.164	0.149	0.134
0.46	0.409	0.377	0.315	0.248	0.190	0.190	0.169	0.151
0.48	0.430	0.401	0.346	0.286	0.223	0.223	0.192	0.180
0.50	0.451	0.426	0.377	0.317	0.262	0.262	0.222	0.203
0.52	0.471	0.450	0.408	0.352	0.305	0.305	0.258	0.231
0.54	0.492	0.474	0.438	0.389	0.342	0.342	0.301	0.267
0.56	0.513	0.497	0.467	0.426	0.380	0.380	0.346	0.311
0.58	0.534	0.521	0.496	0.461	0.422	0.422	0.384	0.355
0.60	0.555	0.544	0.524	0.496	0.463	0.463	0.430	0.398
0.62	0.577	0.568	0.551	0.528	0.502	0.502	0.475	0.449
0.64	0.598	0.591	0.577	0.559	0.539	0.539	0.518	0.497
0.66	0.620	0.614	0.603	0.589	0.574	0.574	0.558	0.543
0.68	0.641	0.636	0.628	0.618	0.607	0.607	0.595	0.584
0.70	0.663	0.659	0.653	0.645	0.637	0.637	0.630	0.623
0.72	0.685	0.682	0.677	0.672	0.666	0.666	0.662	0.658
0.74	0.706	0.704	0.701	0.697	0.694	0.694	0.691	0.690
0.76	0.728	0.727	0.725	0.722	0.720	0.720	0.719	0.720
0.78	0.750	0.749	0.748	0.747	0.746	0.746	0.746	0.747
0.80	0.773	0.772	0.771	0.770	0.770	0.770	0.771	0.773
0.82	0.795	0.794	0.794	0.794	0.794	0.794	0.795	0.797
0.84	0.817	0.817	0.817	0.817	0.817	0.817	0.818	0.820
0.86	0.840	0.839	0.839	0.839	0.840	0.840	0.841	0.843
0.88	0.862	0.862	0.862	0.862	0.863	0.863	0.864	0.865
0.90	0.885	0.885	0.885	0.885	0.885	0.885	0.886	0.887
0.92	0.908	0.908	0.908	0.908	0.908	0.908	0.909	0.949
0.94	0.931	0.931	0.931	0.931	0.931	0.931	0.931	0.962
0.96	0.954	0.954	0.954	0.954	0.954	0.954	0.954	0.975
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.977	0.987
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3.5.2-1b ($p_1 = 2 \text{ atm}$)Static Pressure Increase, ($p_2 - p_1$) (psi)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	259.688	250.569	238.569	220.437	192.918	152.761	96.712
0.02	259.530	249.230	237.995	220.439	193.440	153.676	97.663
0.04	258.213	247.779	237.323	220.368	193.896	154.518	98.562
0.06	255.999	246.231	236.568	220.219	194.281	155.298	99.417
0.08	253.154	244.581	235.727	219.988	194.590	156.012	100.226
0.10	249.942	242.824	234.792	219.672	194.820	156.658	100.987
0.12	246.623	240.956	233.760	219.264	194.965	157.230	101.696
0.14	243.462	238.973	232.624	218.761	195.020	157.726	102.350
0.16	240.724	236.871	231.381	218.155	194.979	158.141	102.948
0.18	238.670	234.644	230.023	217.441	194.839	158.467	103.485
0.20	6.467	232.287	228.543	216.614	194.593	158.702	103.958
0.22	5.704	229.793	226.935	215.664	194.233	158.839	104.361
0.24	5.118	227.080	225.186	214.583	193.755	158.873	104.692
0.26	4.599	39.479	223.241	213.335	193.136	158.791	104.943
0.28	4.183	33.261	220.984	211.886	192.346	158.565	105.094
0.30	3.790	28.323	136.036	207.791	191.332	158.168	105.131
0.32	3.446	24.254	115.000	203.092	188.136	156.612	104.967
0.34	3.152	20.863	94.932	196.735	185.441	155.024	103.826
0.36	2.886	18.022	77.317	184.045	182.149	153.307	103.089
0.38	2.645	15.601	62.676	145.621	177.756	151.140	102.134
0.40	2.424	13.525	50.881	129.359	171.499	148.335	100.883
0.42	2.222	11.737	41.491	110.464	161.521	144.633	99.252
0.44	2.038	10.191	34.036	90.564	131.597	139.572	97.117
0.46	1.870	8.849	28.030	72.140	118.101	132.263	94.277
0.48	1.715	7.681	23.169	56.778	101.730	109.305	90.408
0.50	1.574	6.665	19.202	44.662	83.254	98.734	84.910
0.52	1.445	5.778	15.940	35.318	65.252	85.600	69.998
0.54	1.328	5.003	13.239	28.022	50.076	69.975	62.240
0.56	1.220	4.328	10.993	22.306	38.321	54.040	52.407
0.58	1.124	3.738	9.117	17.786	29.361	40.473	41.007
0.60	1.035	3.224	7.546	14.183	22.530	30.119	30.336
0.62	0.955	2.776	6.228	11.290	17.297	22.326	21.985
0.64	0.881	2.387	5.123	8.957	13.250	16.520	15.757
0.66	0.815	2.050	4.196	7.068	10.098	12.161	11.213
0.68	0.756	1.759	3.421	5.539	7.630	8.863	7.882
0.70	0.701	1.508	2.775	4.302	5.693	6.353	5.419
0.72	0.652	1.294	2.239	3.305	4.177	4.440	3.589
0.74	0.609	1.111	1.798	2.507	2.995	2.988	2.235
0.76	0.568	0.956	1.437	1.873	2.083	1.900	1.243
0.78	0.532	0.825	1.144	1.376	1.390	1.096	0.535
0.80	0.500	0.717	0.911	0.993	0.874	0.521	0.048
0.82	0.471	0.627	0.728	0.706	0.502	0.126	-0.265
0.84	0.443	0.553	0.588	0.497	0.247	-0.125	-0.444
0.86	0.419	0.493	0.484	0.352	0.086	-0.265	-0.519
0.88	0.397	0.445	0.407	0.260	0.000	-0.318	-0.520
0.90	0.376	0.406	0.356	0.209	-0.028	-0.303	-0.466
0.92	0.357	0.375	0.324	0.191	-0.014	-0.242	0.161
0.94	0.338	0.349	0.305	0.197	0.034	-0.147	0.139
0.96	0.321	0.329	0.297	0.220	0.102	-0.031	0.140
0.98	0.304	0.310	0.295	0.252	0.182	0.095	0.153
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Inlet Void Fraction α_1	v_{12} Liquid Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	9.078	18.155	27.233	36.311	45.389	54.466	63.544
0.02	8.913	17.830	26.743	35.661	44.582	53.506	62.433
0.04	8.750	17.504	26.255	35.009	43.772	52.541	61.315
0.06	8.588	17.180	25.769	34.358	42.963	51.575	60.196
0.08	8.428	16.858	25.284	33.706	42.153	50.609	59.075
0.10	8.269	16.538	24.802	33.055	41.343	49.642	57.953
0.12	8.111	16.219	24.324	32.405	40.533	48.675	56.829
0.14	7.953	15.902	23.847	31.755	39.724	47.707	55.704
0.16	7.797	15.586	23.373	31.105	38.915	46.740	54.579
0.18	7.642	15.272	22.898	30.456	38.106	45.772	53.453
0.20	8.514	14.959	22.428	29.808	37.298	44.805	52.327
0.22	8.490	14.648	21.960	29.161	36.491	43.838	51.200
0.24	8.462	14.338	21.493	28.531	35.685	42.872	50.074
0.26	8.420	15.181	21.028	27.915	34.881	41.907	48.949
0.28	8.411	15.073	20.566	27.310	34.078	40.944	47.825
0.30	8.379	15.022	20.334	26.703	33.277	39.983	46.703
0.32	8.358	14.992	20.049	26.112	32.494	39.036	45.585
0.34	8.345	14.980	19.879	25.532	31.711	38.091	44.488
0.36	8.327	14.984	19.813	24.973	30.937	37.152	43.386
0.38	8.309	15.002	19.828	24.578	30.178	36.221	42.292
0.40	8.291	15.033	19.896	24.171	29.447	35.305	41.208
0.42	8.274	15.073	19.982	23.893	28.776	34.410	40.140
0.44	8.257	15.122	19.946	23.795	28.492	33.550	39.094
0.46	8.240	15.178	20.090	23.896	28.022	32.754	38.081
0.48	8.224	15.237	20.285	24.157	27.731	32.433	37.122
0.50	8.208	15.300	20.515	24.501	27.715	31.890	36.261
0.52	8.192	15.364	20.769	24.640	28.024	31.575	35.993
0.54	8.176	15.428	21.039	25.073	28.589	31.641	35.506
0.56	8.160	15.490	21.317	25.600	29.008	32.186	35.407
0.58	8.145	15.549	21.596	26.179	29.684	33.066	35.926
0.60	8.130	15.604	21.871	26.786	30.597	33.728	37.010
0.62	8.115	15.655	22.137	27.402	31.604	35.028	37.969
0.64	8.101	15.700	22.389	28.011	32.656	36.521	39.792
0.66	8.086	15.739	22.624	28.597	33.716	38.114	41.911
0.68	8.070	15.772	22.837	29.150	34.749	39.738	44.192
0.70	8.055	15.799	23.028	29.657	35.728	41.331	46.530
0.72	8.038	15.819	23.193	30.112	36.628	42.838	48.824
0.74	8.022	15.832	23.334	30.508	37.429	44.212	50.979
0.76	8.005	15.839	23.448	30.843	38.117	45.411	52.900
0.78	7.988	15.839	23.536	31.116	38.685	46.408	54.512
0.80	7.969	15.833	23.600	31.326	39.129	47.189	55.767
0.82	7.951	15.821	23.640	31.476	39.453	47.752	56.648
0.84	7.933	15.803	23.658	31.570	39.662	48.109	57.173
0.86	7.914	15.781	23.655	31.613	39.768	48.280	57.382
0.88	7.895	15.755	23.636	31.611	39.783	48.290	57.327
0.90	7.875	15.725	23.601	31.571	39.720	48.166	57.062
0.92	7.857	15.693	23.555	31.498	39.595	47.937	109.353
0.94	7.838	15.659	23.499	31.402	39.422	47.630	109.513
0.96	7.820	15.625	23.438	31.287	39.215	47.270	109.623
0.98	7.802	15.590	23.372	31.163	38.988	46.880	109.686
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

v_g Gas Flow Velocity (feet/sec)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	9.530	14.727	24.267	32.889	41.341	49.969	58.873
0.04	8.923	14.276	23.322	32.279	40.570	49.029	57.743
0.06	8.444	13.846	22.407	31.670	39.802	48.092	56.618
0.08	8.058	13.437	21.688	31.061	39.034	47.156	55.498
0.10	7.737	12.984	20.869	30.453	38.267	46.222	54.381
0.12	7.458	12.619	20.105	29.846	37.502	45.290	53.268
0.14	7.202	12.222	19.392	29.240	36.737	44.361	52.159
0.16	6.951	11.895	18.729	28.635	35.975	43.433	51.054
0.18	6.689	11.545	18.186	28.032	35.214	42.508	49.953
0.20	9.669	11.217	17.599	27.429	34.454	41.585	48.856
0.22	9.684	10.909	17.050	26.828	33.696	40.664	47.762
0.24	9.690	10.618	16.535	25.810	32.941	39.746	46.672
0.26	9.676	15.184	16.051	24.597	32.187	38.831	45.587
0.28	9.694	15.690	15.595	23.353	31.436	37.920	44.506
0.30	9.677	15.870	18.639	22.585	30.688	37.012	43.429
0.32	9.657	16.019	18.445	21.754	29.958	36.118	42.360
0.34	9.642	16.159	18.388	21.082	29.228	35.229	41.314
0.36	9.623	16.296	18.466	20.842	28.507	34.346	40.265
0.38	9.604	16.435	18.668	22.602	27.801	33.473	39.226
0.40	9.586	16.577	18.998	22.267	27.123	32.614	38.200
0.42	9.570	16.720	19.527	22.081	26.501	31.777	37.191
0.44	9.551	16.864	20.602	22.113	26.293	30.974	36.204
0.46	9.538	17.006	21.152	22.400	25.902	30.234	35.252
0.48	9.522	17.145	21.654	22.946	25.715	30.023	34.353
0.50	9.506	17.281	22.150	23.793	25.853	29.569	33.548
0.52	9.490	17.411	22.648	25.424	26.414	29.372	33.446
0.54	9.473	17.535	23.143	26.466	27.435	29.626	33.073
0.56	9.456	17.651	23.633	27.456	29.467	30.525	33.153
0.58	9.437	17.759	24.109	28.450	31.248	32.227	34.030
0.60	9.418	17.857	24.566	29.442	32.841	35.195	36.049
0.62	9.398	17.946	24.999	30.420	34.460	37.474	39.754
0.64	9.378	18.024	25.401	31.366	36.089	39.832	42.818
0.66	9.357	18.092	25.770	32.263	37.693	42.250	46.085
0.68	9.335	18.149	26.100	33.094	39.231	44.661	49.488
0.70	9.314	18.195	26.392	33.849	40.666	46.985	52.903
0.72	9.292	18.230	26.644	34.517	41.966	49.148	56.190
0.74	9.270	18.256	26.855	35.092	43.105	51.082	59.210
0.76	9.247	18.271	27.026	35.572	44.070	52.738	61.839
0.78	9.225	18.277	27.159	35.958	44.851	54.085	63.986
0.80	9.201	18.274	27.256	36.253	45.452	55.112	65.599
0.82	9.178	18.263	27.318	36.463	45.881	55.829	66.679
0.84	9.154	18.244	27.350	36.593	46.150	56.258	67.265
0.86	9.130	18.219	27.354	36.654	46.277	56.436	67.426
0.88	9.107	18.188	27.332	36.651	46.282	56.401	67.243
0.90	9.082	18.151	27.290	36.597	46.186	56.194	66.797
0.92	9.058	18.110	27.231	36.499	46.006	55.852	67.115
0.94	9.034	18.066	27.157	36.368	45.764	55.414	67.710
0.96	9.009	18.020	27.074	36.212	45.478	54.911	68.272
0.98	8.986	17.973	26.984	36.042	45.165	54.373	68.808
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Inlet Void Fraction α_1	α_2 Void Fraction						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.002	0.002	0.002	0.002	0.002	0.002	0.002
0.04	0.004	0.004	0.004	0.004	0.005	0.005	0.005
0.06	0.007	0.007	0.007	0.007	0.007	0.007	0.008
0.08	0.009	0.009	0.009	0.009	0.009	0.010	0.010
0.10	0.012	0.012	0.012	0.011	0.012	0.012	0.013
0.12	0.016	0.015	0.015	0.014	0.015	0.015	0.016
0.14	0.019	0.018	0.018	0.017	0.017	0.018	0.019
0.16	0.022	0.021	0.021	0.019	0.020	0.021	0.022
0.18	0.026	0.025	0.025	0.022	0.023	0.024	0.025
0.20	0.145	0.029	0.029	0.025	0.026	0.027	0.028
0.22	0.164	0.033	0.033	0.029	0.030	0.031	0.032
0.24	0.182	0.038	0.037	0.033	0.033	0.034	0.036
0.26	0.201	0.114	0.042	0.037	0.037	0.038	0.039
0.28	0.221	0.132	0.046	0.043	0.041	0.042	0.043
0.30	0.240	0.153	0.061	0.048	0.045	0.046	0.048
0.32	0.260	0.176	0.078	0.054	0.050	0.051	0.052
0.34	0.280	0.200	0.099	0.061	0.055	0.056	0.057
0.36	0.301	0.224	0.123	0.070	0.061	0.062	0.063
0.38	0.321	0.249	0.151	0.083	0.067	0.068	0.068
0.40	0.342	0.275	0.180	0.097	0.075	0.074	0.075
0.42	0.362	0.301	0.211	0.118	0.085	0.082	0.082
0.44	0.383	0.327	0.236	0.146	0.107	0.091	0.090
0.46	0.404	0.354	0.268	0.180	0.125	0.102	0.099
0.48	0.425	0.380	0.302	0.219	0.148	0.126	0.110
0.50	0.446	0.407	0.337	0.260	0.181	0.146	0.124
0.52	0.467	0.433	0.371	0.293	0.223	0.172	0.152
0.54	0.488	0.459	0.405	0.334	0.270	0.208	0.176
0.56	0.510	0.484	0.438	0.376	0.312	0.255	0.210
0.58	0.531	0.509	0.470	0.418	0.358	0.308	0.257
0.60	0.553	0.534	0.502	0.458	0.407	0.354	0.313
0.62	0.574	0.559	0.533	0.496	0.454	0.409	0.364
0.64	0.596	0.584	0.562	0.533	0.500	0.463	0.425
0.66	0.618	0.608	0.591	0.568	0.542	0.514	0.484
0.68	0.640	0.632	0.618	0.601	0.582	0.561	0.540
0.70	0.661	0.655	0.645	0.633	0.619	0.605	0.590
0.72	0.683	0.679	0.671	0.662	0.653	0.644	0.636
0.74	0.705	0.702	0.697	0.691	0.685	0.680	0.676
0.76	0.727	0.725	0.721	0.717	0.714	0.712	0.712
0.78	0.750	0.748	0.745	0.743	0.742	0.742	0.744
0.80	0.772	0.771	0.769	0.768	0.768	0.769	0.772
0.82	0.794	0.793	0.793	0.792	0.793	0.795	0.798
0.84	0.817	0.816	0.816	0.816	0.817	0.819	0.822
0.86	0.839	0.839	0.839	0.839	0.840	0.842	0.845
0.88	0.862	0.862	0.862	0.862	0.863	0.865	0.867
0.90	0.885	0.885	0.885	0.885	0.886	0.887	0.889
0.92	0.908	0.907	0.908	0.908	0.908	0.909	0.949
0.94	0.930	0.930	0.930	0.931	0.931	0.931	0.962
0.96	0.954	0.954	0.954	0.954	0.954	0.954	0.975
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.987
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3.5.2-1c (p_1 atm)

Inlet Void Fraction α_1	Static Pressure Increase, ($p_2 - p_1$) (psi)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	259.688	250.569	238.569	220.437	192.918	152.761	96.712
0.02	259.208	250.005	238.665	221.071	194.029	154.183	98.018
0.04	258.447	249.353	238.685	221.652	195.093	155.549	99.282
0.06	257.425	248.627	238.646	222.179	196.106	156.868	100.514
0.08	256.158	247.819	238.545	222.647	197.064	158.141	101.711
0.10	254.662	246.925	238.378	223.052	197.965	159.361	102.873
0.12	252.959	245.938	238.141	223.392	198.803	160.530	103.996
0.14	251.063	244.854	237.829	223.662	199.577	161.641	105.079
0.16	248.992	243.663	237.436	223.858	200.282	162.693	106.118
0.18	246.766	242.360	236.957	223.974	200.914	163.681	107.113
0.20	6.447	240.938	236.385	224.005	201.468	164.601	108.059
0.22	5.616	239.388	235.713	223.952	201.939	165.449	108.956
0.24	5.011	237.679	234.934	223.803	202.320	166.221	109.798
0.26	4.485	235.680	234.013	223.542	202.602	166.909	110.581
0.28	4.062	37.097	232.908	223.137	202.762	167.491	111.291
0.30	3.664	31.173	226.411	222.539	202.775	167.949	111.913
0.32	3.318	26.380	157.173	219.588	201.599	168.197	112.403
0.34	3.021	22.465	132.923	217.437	200.436	167.160	112.022
0.36	2.754	19.239	108.273	214.751	199.277	166.771	112.073
0.38	2.511	16.526	85.531	210.965	197.753	166.174	112.024
0.40	2.289	14.224	67.024	204.945	195.714	165.286	111.808
0.42	2.086	12.260	52.675	160.068	192.949	164.033	111.390
0.44	1.900	10.576	41.783	140.162	189.090	162.311	110.729
0.46	1.730	9.125	33.486	114.754	183.332	159.960	109.769
0.48	1.575	7.871	27.044	87.725	173.258	156.705	108.426
0.50	1.433	6.786	21.976	65.118	135.098	152.041	106.564
0.52	1.304	5.844	17.935	48.552	113.604	144.834	103.974
0.54	1.186	5.025	14.675	36.736	86.335	117.027	100.253
0.56	1.078	4.314	12.021	28.146	61.475	100.536	94.547
0.58	0.981	3.696	9.844	21.753	43.678	77.196	75.673
0.60	0.892	3.159	8.049	16.903	31.595	53.173	62.945
0.62	0.811	2.693	6.564	13.160	23.150	36.083	44.679
0.64	0.738	2.289	5.331	10.235	17.095	24.952	29.000
0.66	0.671	1.940	4.309	7.927	12.646	17.460	19.001
0.68	0.611	1.640	3.462	6.098	9.313	12.257	12.615
0.70	0.557	1.382	2.762	4.644	6.785	8.538	8.377
0.72	0.508	1.162	2.185	3.489	4.855	5.822	5.451
0.74	0.464	0.975	1.712	2.577	3.379	3.817	3.368
0.76	0.424	0.817	1.329	1.861	2.260	2.334	1.858
0.78	0.389	0.684	1.021	1.308	1.422	1.254	0.765
0.80	0.356	0.574	0.777	0.887	0.810	0.491	0.002
0.82	0.326	0.482	0.587	0.575	0.379	-0.016	-0.483
0.84	0.300	0.407	0.442	0.352	0.093	-0.322	-0.733
0.86	0.275	0.347	0.335	0.201	-0.081	-0.476	-0.806
0.88	0.253	0.298	0.258	0.106	-0.168	-0.518	-0.766
0.90	0.232	0.260	0.207	0.057	-0.192	-0.485	0.125
0.92	0.213	0.228	0.174	0.040	-0.167	-0.401	0.072
0.94	0.195	0.203	0.156	0.048	-0.112	-0.285	0.051
0.96	0.177	0.182	0.149	0.073	-0.037	-0.154	0.051
0.98	0.160	0.163	0.147	0.107	0.047	-0.019	0.067
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

v_{12} Liquid Flow Velocity (feet/sec)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	9.078	18.155	27.233	36.311	45.389	54.466	63.544
0.02	8.904	17.810	26.717	35.626	44.535	53.446	62.359
0.04	8.731	17.464	26.200	34.938	43.679	52.422	61.169
0.06	8.558	17.118	25.683	34.251	42.822	51.397	59.977
0.08	8.385	16.772	25.166	33.563	41.964	50.371	58.783
0.10	8.212	16.426	24.649	32.875	41.107	49.345	57.589
0.12	8.040	16.080	24.132	32.187	40.249	48.317	56.392
0.14	7.869	15.735	23.615	31.500	39.391	47.289	55.195
0.16	7.697	15.391	23.099	30.812	38.532	46.261	53.997
0.18	7.527	15.046	22.582	30.124	37.674	45.232	52.798
0.20	8.304	14.703	22.069	29.436	36.815	44.203	51.598
0.22	8.264	14.359	21.561	28.749	35.957	43.173	50.397
0.24	8.230	14.017	21.054	28.062	35.098	42.143	49.196
0.26	8.188	13.678	20.551	27.375	34.240	41.113	47.994
0.28	8.173	14.528	20.044	26.688	33.382	40.084	46.793
0.30	8.139	14.132	19.541	26.002	32.524	39.054	45.591
0.32	8.115	14.019	19.198	25.323	31.671	38.026	44.390
0.34	8.101	13.935	18.818	24.650	30.819	37.005	43.198
0.36	8.086	13.878	18.343	23.988	29.967	35.981	42.001
0.38	8.072	13.845	18.311	23.328	29.117	34.958	40.805
0.40	8.060	13.838	18.029	22.678	28.271	33.938	39.612
0.42	8.049	13.854	17.959	22.216	27.430	32.922	38.422
0.44	8.040	13.892	17.930	21.658	26.597	31.910	37.236
0.46	8.031	13.950	17.825	21.220	25.779	30.906	36.055
0.48	8.023	14.025	17.876	21.008	24.996	29.912	34.882
0.50	8.016	14.116	18.004	21.026	24.548	28.937	33.720
0.52	8.009	14.219	18.197	21.189	24.014	27.999	32.575
0.54	8.003	14.331	18.448	21.296	23.798	27.419	31.460
0.56	7.997	14.452	18.752	21.571	23.994	26.766	30.402
0.58	7.991	14.577	19.100	22.033	24.461	26.516	29.805
0.60	7.985	14.704	19.484	22.619	24.826	26.915	29.211
0.62	7.981	14.830	19.895	23.313	25.635	27.711	29.392
0.64	7.975	14.952	20.320	24.096	26.677	28.542	30.438
0.66	7.969	15.068	20.750	24.946	27.914	30.013	31.588
0.68	7.963	15.176	21.173	25.839	29.314	31.836	33.655
0.70	7.956	15.275	21.579	26.744	30.830	33.965	36.291
0.72	7.948	15.363	21.958	27.631	32.407	36.337	39.455
0.74	7.940	15.440	22.303	28.471	33.980	38.862	43.093
0.76	7.930	15.505	22.608	29.238	35.476	41.414	47.091
0.78	7.920	15.557	22.869	29.908	36.825	43.833	51.221
0.80	7.909	15.598	23.083	30.469	37.971	45.945	55.099
0.82	7.898	15.627	23.252	30.913	38.875	47.608	58.220
0.84	7.886	15.646	23.376	31.240	39.524	48.749	60.189
0.86	7.872	15.654	23.458	31.456	39.930	49.379	60.964
0.88	7.859	15.654	23.503	31.573	40.118	49.567	60.819
0.90	7.846	15.647	23.516	31.605	40.126	49.414	109.173
0.92	7.833	15.633	23.503	31.566	39.990	49.017	109.389
0.94	7.819	15.616	23.469	31.474	39.751	48.462	109.550
0.96	7.807	15.595	23.420	31.343	39.444	47.819	109.660
0.98	7.794	15.574	23.363	31.191	39.100	47.142	109.723
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

v_{g2} Gas Flow Velocity (feet/sec)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	10.622	16.282	24.525	32.846	41.285	49.900	58.788
0.04	10.225	15.964	24.045	32.201	40.469	48.901	57.583
0.06	9.870	15.647	23.566	31.557	39.655	47.905	56.384
0.08	9.546	15.329	23.087	30.914	38.841	46.910	55.190
0.10	9.242	15.012	22.609	30.271	38.028	45.918	54.001
0.12	8.949	14.695	22.131	29.629	37.216	44.928	52.816
0.14	8.659	14.378	21.654	28.987	36.405	43.939	51.636
0.16	8.362	14.062	21.177	28.346	35.596	42.953	50.460
0.18	8.054	13.747	20.700	27.705	34.787	41.969	49.288
0.20	9.301	13.432	19.981	27.066	33.979	40.987	48.120
0.22	9.394	13.118	19.098	26.427	33.173	40.007	46.955
0.24	9.397	12.804	18.246	25.789	32.368	39.028	45.794
0.26	9.385	12.332	17.333	25.151	31.564	38.052	44.636
0.28	9.402	14.857	16.691	24.515	30.761	37.077	43.481
0.30	9.393	14.819	16.272	23.879	29.960	36.105	42.330
0.32	9.389	14.910	17.481	23.250	29.163	35.135	41.183
0.34	9.380	14.986	17.201	22.369	28.369	34.174	40.047
0.36	9.362	15.060	16.815	21.326	27.575	33.212	38.909
0.38	9.345	15.145	16.944	20.454	26.785	32.252	37.776
0.40	9.332	15.244	16.834	19.624	25.999	31.297	36.648
0.42	9.320	15.359	17.019	20.336	25.218	30.347	35.524
0.44	9.311	15.490	17.400	19.848	24.445	29.402	34.407
0.46	9.304	15.635	18.414	19.514	23.688	28.465	33.297
0.48	9.298	15.793	18.881	19.460	22.962	27.540	32.197
0.50	9.292	15.961	19.307	19.721	22.557	26.633	31.109
0.52	9.286	16.137	19.753	20.274	22.121	25.762	30.039
0.54	9.280	16.318	20.234	21.625	22.072	25.248	28.998
0.56	9.274	16.501	20.752	22.717	22.575	24.696	28.014
0.58	9.267	16.682	21.304	23.649	23.650	24.619	27.519
0.60	9.259	16.859	21.882	24.645	25.853	25.399	27.056
0.62	9.250	17.032	22.477	25.725	27.414	27.250	27.541
0.64	9.240	17.196	23.077	26.880	29.084	30.171	29.484
0.66	9.229	17.350	23.670	28.089	30.920	32.571	33.345
0.68	9.218	17.492	24.243	29.325	32.908	35.268	36.668
0.70	9.206	17.619	24.784	30.554	35.003	38.274	40.516
0.72	9.194	17.732	25.283	31.740	37.139	41.534	44.946
0.74	9.181	17.830	25.732	32.846	39.234	44.941	49.922
0.76	9.167	17.911	26.124	33.842	41.199	48.336	55.323
0.78	9.152	17.976	26.456	34.703	42.947	51.514	60.875
0.80	9.137	18.026	26.726	35.412	44.406	54.247	66.064
0.82	9.120	18.062	26.935	35.964	45.533	56.346	70.158
0.84	9.104	18.083	27.086	36.360	46.316	57.719	72.563
0.86	9.087	18.091	27.183	36.612	46.775	58.394	73.247
0.88	9.069	18.088	27.231	36.733	46.950	58.483	72.668
0.90	9.051	18.075	27.237	36.745	46.891	58.132	66.327
0.92	9.033	18.054	27.208	36.667	46.652	57.481	67.038
0.94	9.015	18.027	27.151	36.520	46.285	56.646	67.678
0.96	8.997	17.995	27.075	36.324	45.835	55.715	68.263
0.98	8.979	17.960	26.986	36.099	45.342	54.758	68.807
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Inlet Void Fraction α_1	α_2 Void Fraction						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.001	0.001	0.001	0.001	0.001	0.001	0.001
0.04	0.002	0.002	0.002	0.002	0.002	0.003	0.003
0.06	0.003	0.003	0.003	0.003	0.004	0.004	0.004
0.08	0.004	0.004	0.004	0.005	0.005	0.005	0.005
0.10	0.005	0.005	0.006	0.006	0.006	0.007	0.007
0.12	0.006	0.006	0.007	0.007	0.008	0.008	0.008
0.14	0.008	0.008	0.008	0.009	0.009	0.009	0.010
0.16	0.009	0.009	0.010	0.010	0.010	0.011	0.011
0.18	0.011	0.011	0.011	0.012	0.012	0.013	0.013
0.20	0.123	0.012	0.013	0.013	0.014	0.014	0.015
0.22	0.141	0.014	0.015	0.015	0.015	0.016	0.016
0.24	0.159	0.016	0.017	0.017	0.017	0.018	0.018
0.26	0.178	0.018	0.019	0.018	0.019	0.020	0.020
0.28	0.198	0.098	0.022	0.020	0.021	0.022	0.022
0.30	0.217	0.099	0.024	0.022	0.023	0.024	0.024
0.32	0.238	0.118	0.032	0.025	0.025	0.026	0.027
0.34	0.259	0.139	0.047	0.028	0.028	0.029	0.029
0.36	0.280	0.162	0.055	0.031	0.031	0.031	0.032
0.38	0.301	0.186	0.084	0.035	0.033	0.034	0.034
0.40	0.323	0.212	0.098	0.039	0.037	0.037	0.037
0.42	0.344	0.239	0.123	0.049	0.040	0.040	0.041
0.44	0.366	0.268	0.150	0.059	0.044	0.044	0.044
0.46	0.388	0.297	0.176	0.076	0.049	0.048	0.048
0.48	0.410	0.326	0.208	0.103	0.056	0.053	0.053
0.50	0.433	0.357	0.244	0.139	0.074	0.059	0.058
0.52	0.455	0.387	0.282	0.179	0.092	0.066	0.064
0.54	0.477	0.417	0.321	0.217	0.123	0.085	0.071
0.56	0.500	0.447	0.361	0.260	0.169	0.104	0.080
0.58	0.522	0.477	0.401	0.308	0.222	0.137	0.104
0.60	0.544	0.506	0.441	0.358	0.269	0.191	0.129
0.62	0.567	0.535	0.480	0.408	0.327	0.254	0.178
0.64	0.590	0.563	0.518	0.458	0.388	0.313	0.249
0.66	0.612	0.590	0.554	0.505	0.447	0.383	0.316
0.68	0.635	0.617	0.588	0.550	0.505	0.453	0.396
0.70	0.657	0.643	0.621	0.593	0.558	0.519	0.475
0.72	0.680	0.669	0.653	0.632	0.608	0.580	0.549
0.74	0.702	0.694	0.683	0.668	0.653	0.636	0.617
0.76	0.725	0.719	0.711	0.702	0.693	0.684	0.676
0.78	0.748	0.743	0.738	0.733	0.729	0.727	0.727
0.80	0.770	0.767	0.764	0.762	0.761	0.763	0.769
0.82	0.793	0.791	0.789	0.789	0.790	0.794	0.804
0.84	0.816	0.814	0.814	0.814	0.816	0.821	0.831
0.86	0.838	0.838	0.837	0.838	0.841	0.846	0.854
0.88	0.861	0.861	0.861	0.862	0.864	0.868	0.875
0.90	0.884	0.884	0.884	0.885	0.887	0.890	0.936
0.92	0.907	0.907	0.907	0.908	0.909	0.911	0.949
0.94	0.930	0.930	0.930	0.931	0.931	0.933	0.962
0.96	0.953	0.953	0.953	0.954	0.954	0.954	0.975
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.987
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3.5.2-1d ($p_1 =$ atm)

Inlet Void Fraction α_1	Static Pressure Increase, ($p_2 - p_1$) (psi)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	259.688	250.569	238.569	220.437	192.918	152.761	96.712
0.02	259.217	250.607	239.102	221.645	194.422	154.519	98.253
0.04	258.733	250.490	239.590	222.668	195.894	156.234	99.759
0.06	258.203	250.316	240.038	223.652	197.331	157.915	101.240
0.08	257.602	250.043	240.443	224.594	198.727	159.561	102.696
0.10	256.901	249.805	240.803	225.494	200.082	161.170	104.125
0.12	256.072	249.451	241.113	226.347	201.396	162.740	106.015
0.14	255.086	249.027	241.371	227.148	202.660	164.271	107.464
0.16	253.915	248.527	241.571	227.898	203.878	165.757	108.841
0.18	252.530	247.940	241.709	228.597	205.042	167.228	109.815
0.20	6.754	247.261	241.780	229.239	206.150	169.350	110.522
0.22	5.647	246.465	241.778	229.820	207.199	169.888	111.049
0.24	5.015	245.517	241.695	230.330	208.185	170.463	110.940
0.26	4.478	244.488	241.521	230.765	209.110	171.184	112.459
0.28	4.037	42.984	241.223	231.103	209.950	172.068	113.670
0.30	3.632	35.735	240.713	231.316	210.684	174.649	114.808
0.32	3.279	29.791	236.811	230.254	211.240	175.568	116.149
0.34	2.978	25.069	234.112	229.326	210.375	175.308	117.488
0.36	2.708	21.258	229.801	228.447	210.310	175.702	118.000
0.38	2.462	18.104	124.442	227.223	210.078	176.017	118.523
0.40	2.237	15.463	97.312	225.493	209.577	176.154	118.931
0.42	2.031	13.235	73.510	223.007	208.753	176.079	119.210
0.44	1.844	11.343	55.896	219.262	207.500	175.741	119.335
0.46	1.671	9.727	43.116	212.671	205.696	175.089	119.277
0.48	1.514	8.342	33.736	147.068	203.088	174.035	119.005
0.50	1.371	7.152	26.720	112.582	199.228	172.461	118.462
0.52	1.240	6.124	21.353	78.404	192.985	170.174	117.580
0.54	1.121	5.237	17.168	54.760	178.399	166.826	116.257
0.56	1.013	4.470	13.854	39.397	121.057	161.693	114.313
0.58	0.914	3.807	11.198	29.089	81.147	152.630	111.461
0.60	0.825	3.233	9.050	21.829	52.252	112.878	107.050
0.62	0.743	2.736	7.299	16.543	35.183	76.755	99.193
0.64	0.669	2.308	5.868	12.592	24.529	45.828	70.557
0.66	0.602	1.939	4.694	9.584	17.432	28.911	41.765
0.68	0.542	1.623	3.730	7.264	12.487	19.042	23.872
0.70	0.487	1.351	2.938	5.457	8.927	12.788	14.606
0.72	0.438	1.121	2.292	4.043	6.307	8.587	9.200
0.74	0.394	0.925	1.766	2.937	4.349	5.649	5.766
0.76	0.353	0.761	1.342	2.075	2.874	3.526	3.440
0.78	0.318	0.623	1.004	1.411	1.764	1.955	1.755
0.80	0.285	0.509	0.738	0.911	0.944	0.767	0.353
0.82	0.255	0.415	0.533	0.543	0.362	-0.125	-0.814
0.84	0.228	0.339	0.378	0.286	-0.017	-0.728	-2.775
0.86	0.204	0.277	0.264	0.117	-0.232	-0.977	-1.999
0.88	0.181	0.226	0.184	0.016	-0.322	-0.935	-0.900
0.90	0.162	0.187	0.132	-0.033	-0.329	-0.778	0.081
0.92	0.141	0.155	0.099	-0.045	-0.282	-0.592	0.028
0.94	0.123	0.130	0.081	-0.032	-0.205	-0.408	0.007
0.96	0.105	0.108	0.073	-0.003	-0.115	-0.237	0.008
0.98	0.089	0.091	0.072	0.034	-0.022	-0.081	0.022
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

v_{12} Liquid Flow Velocity (feet/sec)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	9.078	18.155	27.233	36.311	45.389	54.466	63.544
0.02	8.900	17.801	26.704	35.607	44.510	53.414	62.319
0.04	8.722	17.446	26.173	34.900	43.628	52.358	61.090
0.06	8.545	17.091	25.643	34.193	42.746	51.301	59.859
0.08	8.367	16.744	25.112	33.487	41.864	50.244	58.627
0.10	8.189	16.379	24.581	32.780	40.981	49.186	57.394
0.12	8.012	16.023	24.050	32.073	40.099	48.128	56.008
0.14	7.835	15.668	23.519	31.366	39.216	47.069	54.649
0.16	7.657	15.313	22.988	30.659	38.332	46.010	53.351
0.18	7.480	14.958	22.458	29.951	37.449	44.944	52.108
0.20	8.029	14.604	21.927	29.244	36.565	44.469	50.063
0.22	7.985	14.250	21.396	28.537	35.681	42.690	49.078
0.24	7.931	13.906	20.865	27.829	34.797	41.772	48.712
0.26	7.872	13.547	20.335	27.122	33.913	40.711	47.352
0.28	7.840	16.913	19.804	26.415	33.029	39.646	46.240
0.30	7.797	13.756	19.274	25.707	32.145	38.586	45.023
0.32	7.765	13.390	18.746	25.002	31.261	37.525	44.751
0.34	7.741	13.104	18.211	24.296	30.379	36.467	42.557
0.36	7.717	12.934	17.652	23.590	29.497	35.407	41.320
0.38	7.700	12.797	17.497	22.886	28.614	34.348	40.083
0.40	7.689	12.692	17.295	22.182	27.733	33.289	38.847
0.42	7.682	12.620	17.100	21.480	26.852	32.230	37.611
0.44	7.679	12.579	16.815	20.779	25.973	31.173	36.375
0.46	7.678	12.571	16.267	20.069	25.095	30.117	35.142
0.48	7.680	12.594	16.038	19.628	24.221	29.063	33.908
0.50	7.684	12.648	15.926	18.818	23.350	28.011	32.678
0.52	7.689	12.731	15.894	18.849	22.489	26.964	31.451
0.54	7.696	12.843	15.942	18.658	21.544	25.922	30.228
0.56	7.704	12.979	16.071	18.626	21.143	24.893	29.011
0.58	7.712	13.138	16.286	18.563	20.769	23.887	27.805
0.60	7.721	13.316	16.585	18.754	20.829	23.212	26.619
0.62	7.731	13.509	16.968	19.114	20.946	22.731	25.482
0.64	7.742	13.713	17.430	19.650	21.276	22.957	24.797
0.66	7.752	13.922	17.960	20.367	21.951	23.303	24.749
0.68	7.761	14.131	18.544	21.263	22.943	24.158	25.406
0.70	7.769	14.334	19.164	22.326	24.273	25.522	26.469
0.72	7.777	14.528	19.800	23.528	25.952	27.449	28.402
0.74	7.783	14.708	20.429	24.829	27.964	30.014	31.245
0.76	7.788	14.873	21.030	26.171	30.263	33.281	35.258
0.78	7.791	15.019	21.583	27.484	32.745	37.297	40.920
0.80	7.793	15.146	22.072	28.696	35.246	42.056	49.863
0.82	7.794	15.252	22.485	29.741	37.534	47.367	61.620
0.84	7.794	15.339	22.818	30.573	39.368	52.395	108.071
0.86	7.793	15.407	23.070	31.173	40.591	55.257	108.533
0.88	7.791	15.458	23.246	31.549	41.195	55.327	108.851
0.90	7.789	15.494	23.355	31.728	41.291	54.046	109.186
0.92	7.787	15.518	23.407	31.747	41.033	52.392	109.406
0.94	7.785	15.533	23.415	31.649	40.557	50.719	109.568
0.96	7.783	15.541	23.391	31.473	39.969	49.145	109.678
0.98	7.782	15.546	23.349	31.256	39.346	47.722	109.741
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

v_{g2} Gas Flow Velocity (feet/sec)

Inlet Void Fraction α_1	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	11.298	16.257	24.505	32.825	41.260	49.868	58.749
0.04	10.879	15.930	24.012	32.162	40.419	48.837	57.502
0.06	10.544	15.605	23.520	31.499	39.579	47.808	56.261
0.08	10.269	15.300	23.028	30.837	38.740	46.782	55.028
0.10	10.038	14.948	22.537	30.175	37.903	45.759	53.801
0.12	9.834	14.621	22.046	29.513	37.067	44.738	52.433
0.14	9.645	14.295	21.555	28.853	36.232	43.720	50.831
0.16	9.456	13.970	21.064	28.192	35.397	42.703	49.632
0.18	9.255	13.646	20.574	27.533	34.564	41.683	47.951
0.20	8.769	13.322	20.084	26.875	33.732	41.243	46.621
0.22	8.841	13.001	19.594	26.217	32.901	39.533	45.661
0.24	8.907	12.690	19.104	25.560	32.071	38.661	45.309
0.26	8.971	12.358	18.614	24.903	31.243	37.652	43.999
0.28	8.979	16.517	18.125	24.247	30.416	36.646	42.931
0.30	8.964	14.179	17.637	23.591	29.589	35.645	41.766
0.32	8.960	14.085	17.150	22.937	28.764	34.645	40.533
0.34	8.960	13.972	16.658	22.284	27.942	33.648	39.415
0.36	8.954	13.959	16.143	21.631	27.120	32.653	38.241
0.38	8.938	13.964	16.024	20.979	26.299	31.659	37.069
0.40	8.923	13.980	15.960	20.329	25.479	30.668	35.900
0.42	8.913	13.994	15.914	19.680	24.662	29.678	34.734
0.44	8.908	14.030	15.811	19.034	23.846	28.691	33.572
0.46	8.908	14.093	15.647	18.378	23.032	27.706	32.413
0.48	8.911	14.184	16.516	17.890	22.222	26.724	31.257
0.50	8.917	14.307	16.846	17.171	21.417	25.746	30.105
0.52	8.924	14.458	17.101	17.451	20.621	24.773	28.958
0.54	8.934	14.636	17.382	17.578	19.747	23.807	27.817
0.56	8.944	14.839	17.719	18.179	19.362	22.853	26.684
0.58	8.954	15.063	18.127	19.482	19.206	21.921	25.563
0.60	8.964	15.303	18.612	20.152	19.687	21.285	24.462
0.62	8.973	15.554	19.175	20.893	21.196	21.001	23.407
0.64	8.981	15.811	19.810	21.776	22.628	21.746	22.804
0.66	8.987	16.070	20.513	22.832	23.911	24.137	23.129
0.68	8.994	16.326	21.269	24.069	25.455	26.025	25.413
0.70	8.999	16.573	22.060	25.481	27.338	28.206	28.466
0.72	9.004	16.808	22.861	27.044	29.600	30.955	31.526
0.74	9.007	17.025	23.647	28.711	32.242	34.420	35.545
0.76	9.009	17.221	24.391	30.415	35.223	38.738	40.958
0.78	9.009	17.393	25.070	32.070	38.431	44.048	48.580
0.80	9.009	17.541	25.663	33.584	41.658	50.466	61.447
0.82	9.007	17.664	26.159	34.872	44.596	57.882	75.016
0.84	9.004	17.762	26.550	35.875	46.899	65.096	62.218
0.86	8.999	17.836	26.838	36.570	48.347	68.846	63.733
0.88	8.994	17.889	27.029	36.971	48.941	68.084	64.851
0.90	8.988	17.923	27.133	37.118	48.859	65.486	66.022
0.92	8.983	17.941	27.166	37.062	48.328	62.648	66.886
0.94	8.977	17.947	27.142	36.861	47.543	60.009	67.615
0.96	8.971	17.943	27.078	36.564	46.641	57.656	68.244
0.98	8.966	17.935	26.990	36.219	45.718	55.598	68.805
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Inlet Void Fraction α_1	α_2 Void Fraction						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.000	0.000	0.001	0.001	0.001	0.001	0.001
0.04	0.001	0.001	0.001	0.001	0.001	0.001	0.001
0.06	0.001	0.001	0.002	0.002	0.002	0.002	0.002
0.08	0.002	0.002	0.002	0.002	0.002	0.003	0.003
0.10	0.002	0.002	0.003	0.003	0.003	0.003	0.004
0.12	0.003	0.003	0.003	0.004	0.004	0.004	0.004
0.14	0.003	0.003	0.004	0.004	0.005	0.005	0.005
0.16	0.004	0.004	0.005	0.005	0.005	0.006	0.006
0.18	0.005	0.005	0.006	0.006	0.006	0.006	0.006
0.20	0.093	0.006	0.006	0.007	0.007	0.007	0.007
0.22	0.111	0.007	0.007	0.007	0.008	0.008	0.007
0.24	0.128	0.008	0.008	0.008	0.009	0.009	0.009
0.26	0.145	0.008	0.009	0.009	0.010	0.010	0.010
0.28	0.163	0.342	0.010	0.010	0.011	0.011	0.011
0.30	0.183	0.092	0.011	0.011	0.012	0.012	0.012
0.32	0.203	0.077	0.012	0.012	0.013	0.013	0.000
0.34	0.224	0.083	0.013	0.014	0.014	0.014	0.014
0.36	0.245	0.099	0.015	0.015	0.015	0.015	0.016
0.38	0.267	0.118	0.057	0.016	0.017	0.017	0.017
0.40	0.290	0.140	0.060	0.018	0.018	0.018	0.019
0.42	0.313	0.164	0.073	0.020	0.020	0.020	0.020
0.44	0.336	0.190	0.095	0.021	0.021	0.021	0.022
0.46	0.360	0.219	0.106	0.024	0.023	0.023	0.023
0.48	0.384	0.249	0.117	0.035	0.025	0.025	0.025
0.50	0.408	0.281	0.145	0.042	0.028	0.028	0.028
0.52	0.432	0.315	0.177	0.082	0.031	0.030	0.030
0.54	0.456	0.349	0.214	0.108	0.035	0.033	0.033
0.56	0.480	0.384	0.254	0.143	0.054	0.037	0.036
0.58	0.505	0.419	0.297	0.179	0.085	0.042	0.040
0.60	0.529	0.454	0.343	0.226	0.131	0.059	0.045
0.62	0.553	0.489	0.390	0.278	0.178	0.090	0.052
0.64	0.577	0.523	0.437	0.335	0.233	0.148	0.076
0.66	0.601	0.556	0.484	0.394	0.297	0.206	0.128
0.68	0.625	0.589	0.530	0.454	0.367	0.279	0.201
0.70	0.649	0.620	0.574	0.512	0.439	0.360	0.280
0.72	0.673	0.650	0.615	0.568	0.510	0.445	0.374
0.74	0.696	0.679	0.653	0.620	0.578	0.528	0.471
0.76	0.720	0.707	0.689	0.667	0.640	0.607	0.567
0.78	0.743	0.734	0.722	0.709	0.695	0.679	0.658
0.80	0.767	0.760	0.753	0.747	0.742	0.741	0.745
0.82	0.790	0.786	0.782	0.780	0.782	0.793	0.820
0.84	0.813	0.811	0.809	0.810	0.816	0.834	0.897
0.86	0.837	0.835	0.835	0.837	0.843	0.862	0.910
0.88	0.860	0.859	0.859	0.862	0.868	0.882	0.923
0.90	0.883	0.883	0.883	0.886	0.890	0.899	0.936
0.92	0.907	0.906	0.907	0.909	0.912	0.917	0.949
0.94	0.930	0.930	0.930	0.931	0.933	0.936	0.962
0.96	0.953	0.953	0.953	0.954	0.955	0.956	0.975
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.987
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000

4. Air/Water Two-Phase Flow Performance of SRPR (Savannah River Plant Reactor) Pump Under DC Motor Operation (Task 7, Task 9 and Task 16)

4.1 Objectives

Under the hypothetical loss of coolant accident (LOCA) conditions, there is a possibility that the water level of the coolant tank becomes so low that air may be ingested into the water line. The coolant pump then experiences the air/water flow going through the blades. As has been demonstrated by experiments conducted by Babcock & Wilcox (1977) and Creare (1982) as well as the theory of Furuya (1985), the head of the pump operating under the air/water two-phase flow condition severely degrades as the inlet void fraction reaches about 20% or higher (although this threshold point for the degradation varies depending on the type of pump and operational conditions). It is crucial from the reactor safety viewpoints to determine the extent of the pump head degradation either theoretically or experimentally. However, this type of experiments is too costly and time consuming.

During the normal cooling operation, the SRPR pump is driven by the AC motor at 1,000 rpm as the rated speed, while under the emergency condition, it is operated by the DC motor at 300 rpm as its rated speed. The objective of Task 3, Task 9 and Task 15 was therefore to theoretically determine the head and torque degradation of the SRPR pump operating under the air/water two-phase flow conditions for various physical, hydrodynamic and mechanical conditions at the AC motor operation mode. The parameters which represented such conditions included the inlet void fraction, static pressure at upstream, flow rate and pump rotational speed.

In Tasks 7, 9 and 16, the pump characteristics under the DC motor operation were investigated. Two types of pump flow configuration were used for the present work as before. One is that normally used for the single phase pump design and analysis where the pump blade flow passage is used with the diffuser effect being ignored or treated empirically in terms of the head loss. (Task 7 and Task 9) The other is that with the diffuser section incorporated. (Task 16) It should be also noted that the H-Q curve used for the former (Task 7 and Task 9) is different from that of the latter. The reason is that the results of curve fitting for the single phase pump performance based on the experimental data changed from time to time. When the two-phase flow pump performance without diffuser was calculated some time ago, only the H-Q curve available was the one obtained at an earlier stage of the experiments which was thus used then. On the other hand, the calculation with the diffuser

section incorporated was made with the H-Q curve obtained from more recent experiments.

4.2 Theoretical Basis---Without Diffuser (Task 7 and Task 9)

The theoretical basis, the definition of pump head under the two-phase flow condition and numerical solution method for calculating the performance of the SRPR pump without the diffuser section remain the same as those for the AC motor operations. The reader is therefore advised to refer to Section 3.2 of this report.

Nomenclature

A:	cross sectional area normal to the direction of s
C_d :	drag coefficient
C_{vm} :	virtual (or added) mass coefficient
ds:	infinitesimal increment in the s-coordinate
g:	gravitational acceleration
h:	normalized head ($= H/H_R$)
H:	head in feet
m:	mass flow rate
N:	pump rotational speed (rpm)
p:	static pressure
Q:	volumetric flow rate
r:	radial distance measured from the center of pump rotation
r_g :	radius of gas bubble
s:	streamline coordinate
v:	absolute velocity
w:	flow velocity relative to the rotating blade in the s-direction
x:	gas mass flow rate ratio ($= m_g/m$)
α :	void fraction
α_N :	normalized rotational speed ($= N/N_R$)
α_Q :	normalized flow rate ($= Q/Q_R$)
ρ :	density
ω :	angular velocity of pump rotor ($= 2\pi N/60$)

Subscripts:

g,l :	denotes the quantities related to the gas and liquid phases, respectively
1,2:	denotes the quantities related to the inlet and exit of the pump, respectively
R:	denotes the quantities at the pump rated condition
2 ϕ :	two-phase flow quantities
1 ϕ :	single-phase flow quantities

4.3 Numerical Calculations---Without Diffuser (Task 7)

4.3.1 Parametric Range

1) Pump

The SRPR pump is a double suction, double-volute centrifugal pump manufactured by Bingham Corp. having the rated flow rate of 25,000 gpm (12,500 gpm/volute) with the total head of 420 feet at the rated rotational speed of 1,000 rpm under the AC motor operation. On the other hand, when this pump is operated by the DC motor at the rotation speed of 300 rpm, the flow rate is 6,200 gpm (3,100 gpm/volute).

The head vs. flow rate curve driven by the AC motor at 1,000 rpm and by the DC motor at 300 rpm are given in Figures 4.3.1-1 and 4.3.1-2, respectively. In these figures both the total pump dynamic head and that of fluid flowing are given for the AC motor pump performance while only the latter is given for the DC motor case. The correction is thus to be made for the DC motor head curve as follows:

$$H_{1\phi \text{ DC}} = 47.7 - 0.4289 \times (Q / 1000)^{0.943} + \Delta H \quad (4.3.1-1)$$

$$\Delta H = 4.236 \times (Q / 10,000)^2 \quad (4.3.1-2)$$

where the formula for Equations (4.3.1-1) and (4.3.1-2) were given by the report No. DPS-83-282 and the Los Alamos National Laboratory. Therefore, the rated head at the DC motor operation will be readily calculated

$$H_{1\phi \text{ DC at 300rpm}} = 46.93 \text{ feet.}$$

It should be noted that the homologous flow parameters and head data presented hereafter for the DC motor operation are all normalized by using $N_{R300} = 300 \text{ rpm}$, $Q_{R300} = 6200 \text{ gpm}$ and $H_{R300} = 46.93 \text{ feet}$.

The pump performance curves nondimensionalized by using the unified rated parameters (i.e., N_R , Q_R and H_R at 1,000 rpm) show a clear difference between the AC and DC motor operations (see Figure 4.3.1-3)).

2) Line Static Pressure (p_1)

The following line static pressures were used for the present calculations:

0.05 atm

1.00 atm

2.00 atm

3.00 atm

3) Flow Rate (Q) and Pump Rotational Speed (N)

Since the pump performance only depends on the ratio between the flow rate and the rotational speed, the range of these parameters is expressed in terms of the homologous flow parameter defined by ν / α_N where

$$\nu = Q / Q_R$$

$$\alpha_N = N / N_R .$$

The range of the homologous head parameter used for the calculations is

$$\nu / \alpha_N = 0.4$$

0.6

0.8

1.0

1.2

1.4

With these homologous parameters, the range of the actual flow rate will be 2,480 gpm to 8,680 gpm assuming the constant rotational speed (i.e., 300 rpm). It is to be noted however that the present two-phase flow pump performance is calculated on the basis of the H-Q curve with the DC motor rated condition used as described above.

4) Inlet Void Fraction (α_1)

$$\alpha_1 = 0.00 \text{ to } 0.98$$

4.3.2 Results

Figures 4.3.2-1a to 1d show the homologous head as the function of the inlet void fraction with the homologous flow parameter ν / α_N ranging from 0.4 to 1.4 at the static pressure $p_1 = 3 \text{ atm}$, 2 atm , 1 atm and 0.05 atm , respectively.

Tables 4.3.2-1a to 1d simply provide the homologous head data used for the figures above in terms of the numbers.

Tables 4.3.2-2 to 5 are the detailed pump hydraulic data as discussed in Section 3.2.4 of the report mentioned above (OF-88-003). Tables 4.3.2-2a to 2d provide the void fraction at the exit of the pump blade for the same inlet static pressure range while Tables 4.3.2-3a to 3d present the static pressure at the pump blade exit.

Tables 4.3.2-4a to 4d and 4.3.2-5a to 5d provide the relative flow velocities of water and air at the blade exit of the pump, respectively. These relative flow velocities in these tables were normalized by the pump blade tip speed u_2 at the rated pump rotational speed of 300 rpm:

$$\begin{aligned} u_2 \text{ at } 300\text{rpm} &= 2 \pi N_{R2} / 60 \\ &= 2 \pi \times 300 \times 21" / 12 / 60 \\ &= 54.98 \text{ ft/sec} \end{aligned}$$

The absolute velocities of water and air at the exit of the pump blade will be readily calculated from the velocity triangle with the blade angle at the exit $\beta = 15.071^\circ$ known (see the table at page 2-2 of the interim report for Task 2).

The homologous torques for these cases were also calculated based on the formula given in Section 3.2.5 and are shown in Tables 4.3.2-1a to 1d.

4.4 Theoretical Basis---With Diffuser (Task 16)

The same argument as that for the AC motor operation (see Section 3.4) is applied to the present case of the DC motor operation with the diffuser section incorporated.

4.5 Numerical Calculations---With Diffuser (Task 16)

4.5.1 Parametric Range

1) Pump

Rated Flow Rate Q_R :	6,200 gpm (3,100 gpm/volute)
Rated Head H_R :	45.3 feet (Experimental; from Equation (4.5.1) below)
Rotational Speed (DC Motor):	300 rpm

where the H-Q curve for the Savannah River Plant reactor pump is obtained from

$$\Delta H = C_0 + C_1 Q + C_2 Q^2 + C_3 Q^3 \quad (4.5.1)$$

where

ΔH = pump head (ft of D_2O)

Q = flow rate (kgpm)

$C_0 = 562.16$

$C_1 = -4.4957$

$C_2 = 0.15145$

$C_3 = -0.0090580.$

2) Line Static Pressure (p_1)

The following line static pressures were used for the present calculations:

0.5 atm

1.00 atm

2.00 atm

3.00 atm

3) Flow Rate (Q) and Pump Rotational Speed (N)

Since the pump performance depends on the ratio between the flow rate and the rotational speed, the range of these parameters is expressed in terms of the homologous flow parameter defined by ν / α_N where

$$\nu = Q / Q_R$$

$$\alpha_N = N / N_R .$$

The range of the homologous head parameter used for the calculations is

$$\nu / \alpha_N = 0.2$$

0.4

0.6

0.8

1.0

1.2

1.4

With these homologous parameters, the range of the actual flow rate will be 1,240 gpm to 8,680 gpm assuming the constant rotational speed (i.e., 300 rpm).

4) Inlet Void Fraction (α_1)

$$\alpha_1 = 0.00 \text{ to } 0.98$$

4.5.2 Results

Tables 4.5.2-1a to 1d show the homologous head as the function of the inlet void fraction with the homologous flow parameter ν / α_N ranging from 0.2 to 1.4 at the static pressure $p_1 = 3 \text{ atm}$, 2 atm , 1 atm and 0.5 atm , respectively.

4.6 References

OF Technologies, Inc., 1988, *Air/water two-phase flow performance of SRPR pump under AC motor operation*, Report No. OF-88-003, September.

Figure 4.3.1-1

Figure 4.3.1-2

Figure 4.3.1-3

Single-phase Performance of SRPRP AC and DC Mototr Performances

Figure 4.3.2-1a ($p_1 = 3 \text{ atm}$)

Head Degradation of SRPRP

Air-Water Case, DC Motor, $P_1 = 3 \text{ atm}$

ν/α_H — 0.4 0.6 - - - 0.8 — 1.0 - - - 1.2 - - - 1.4

Figure 4.3.2-1b ($p_1 = 2 \text{ atm}$)

Figure 4.3.2-1c ($p_1 = 1 \text{ atm}$)

Head Degradation of SRPRP

Air-Water Case, DC Motor, $P_1 = 1 \text{ atm}$

ν/α_H — 0.4 0.6 - - - 0.8 — 1.0 - - - 1.2 1.4

Figure 4.3.2-1d ($p_1 = 0.05 \text{ atm}$)

Head Degradation of SRPRP

Air-Water Case, DC Motor, $P_1 = .05 \text{ atm}$

Table 4.3.2-1a ($p_1 = 3 \text{ atm}$)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
DC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.032	1.022	1.012	1.000	0.992	0.983
0.02	1.012	1.008	1.000	0.991	0.982	0.972
0.04	0.996	0.994	0.988	0.980	0.971	0.962
0.06	0.980	0.982	0.976	0.969	0.960	0.951
0.08	0.965	0.969	0.965	0.958	0.950	0.941
0.10	0.951	0.957	0.953	0.947	0.939	0.931
0.12	0.938	0.945	0.942	0.936	0.929	0.920
0.14	0.925	0.934	0.931	0.926	0.918	0.910
0.16	0.913	0.922	0.921	0.915	0.908	0.899
0.18	0.618	0.911	0.910	0.905	0.897	0.889
0.20	0.267	0.901	0.900	0.894	0.887	0.879
0.22	0.172	0.881	0.889	0.884	0.877	0.868
0.24	0.144	0.456	0.872	0.872	0.866	0.858
0.26	0.128	0.384	0.620	0.853	0.850	0.844
0.28	0.115	0.342	0.555	0.656	0.825	0.824
0.30	0.103	0.306	0.511	0.616	0.661	0.680
0.32	0.092	0.273	0.468	0.579	0.629	0.650
0.34	0.083	0.243	0.426	0.541	0.596	0.621
0.36	0.075	0.216	0.386	0.503	0.563	0.591
0.38	0.068	0.193	0.348	0.464	0.528	0.559
0.40	0.062	0.172	0.312	0.425	0.492	0.526
0.42	0.056	0.153	0.279	0.387	0.455	0.492
0.44	0.051	0.137	0.248	0.350	0.418	0.457
0.46	0.047	0.122	0.221	0.314	0.382	0.422
0.48	0.043	0.110	0.196	0.281	0.346	0.386
0.50	0.039	0.098	0.174	0.251	0.311	0.351
0.52	0.036	0.089	0.155	0.223	0.278	0.317
0.54	0.034	0.080	0.138	0.197	0.248	0.283
0.56	0.031	0.072	0.123	0.175	0.219	0.252
0.58	0.029	0.066	0.110	0.155	0.194	0.223
0.60	0.028	0.060	0.099	0.137	0.171	0.197
0.62	0.026	0.056	0.089	0.122	0.151	0.173
0.64	0.025	0.051	0.081	0.109	0.134	0.153
0.66	0.024	0.048	0.073	0.098	0.119	0.134
0.68	0.023	0.045	0.067	0.089	0.106	0.118
0.70	0.022	0.042	0.062	0.080	0.095	0.105
0.72	0.022	0.040	0.058	0.074	0.086	0.094
0.74	0.021	0.038	0.055	0.068	0.078	0.084
0.76	0.021	0.038	0.052	0.064	0.072	0.076
0.78	0.022	0.037	0.050	0.060	0.067	0.070
0.80	0.021	0.036	0.048	0.058	0.064	0.065
0.82	0.022	0.036	0.047	0.056	0.061	0.062
0.84	0.024	0.036	0.047	0.055	0.059	0.059
0.86	0.025	0.038	0.047	0.054	0.058	0.058
0.88	0.027	0.038	0.049	0.054	0.058	0.057
0.90	0.031	0.041	0.050	0.057	0.059	0.057
0.92	0.038	0.047	0.056	0.059	0.062	0.062
0.94	0.051	0.057	0.060	0.065	0.066	0.065
0.96	0.066	0.060	0.076	0.083	0.080	0.077
0.98	0.161	0.134	0.145	0.110	0.134	0.133

Table 4.3.2-1b ($p_1 = 2 \text{ atm}$)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
DC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.032	1.022	1.012	1.000	0.992	0.983
0.02	1.013	1.009	1.001	0.992	0.983	0.974
0.04	0.997	0.996	0.990	0.982	0.973	0.964
0.06	0.982	0.984	0.979	0.972	0.964	0.955
0.08	0.968	0.972	0.968	0.962	0.954	0.946
0.10	0.954	0.960	0.957	0.951	0.944	0.936
0.12	0.941	0.949	0.947	0.941	0.935	0.927
0.14	0.929	0.938	0.937	0.932	0.925	0.917
0.16	0.917	0.927	0.926	0.922	0.915	0.908
0.18	0.904	0.916	0.916	0.912	0.905	0.898
0.20	0.891	0.906	0.906	0.902	0.896	0.888
0.22	0.879	0.893	0.896	0.892	0.886	0.878
0.24	0.867	0.880	0.883	0.881	0.876	0.869
0.26	0.855	0.867	0.866	0.866	0.863	0.857
0.28	0.844	0.855	0.856	0.856	0.853	0.847
0.30	0.832	0.843	0.843	0.843	0.840	0.834
0.32	0.821	0.831	0.831	0.831	0.828	0.822
0.34	0.810	0.820	0.820	0.820	0.817	0.811
0.36	0.799	0.809	0.809	0.809	0.806	0.800
0.38	0.788	0.798	0.798	0.798	0.795	0.789
0.40	0.777	0.787	0.787	0.787	0.784	0.778
0.42	0.766	0.776	0.776	0.776	0.773	0.767
0.44	0.755	0.765	0.765	0.765	0.762	0.756
0.46	0.744	0.754	0.754	0.754	0.751	0.745
0.48	0.733	0.743	0.743	0.743	0.740	0.734
0.50	0.722	0.732	0.732	0.732	0.729	0.723
0.52	0.711	0.721	0.721	0.721	0.718	0.712
0.54	0.700	0.710	0.710	0.710	0.707	0.701
0.56	0.689	0.699	0.699	0.699	0.696	0.690
0.58	0.678	0.688	0.688	0.688	0.685	0.679
0.60	0.667	0.677	0.677	0.677	0.674	0.668
0.62	0.656	0.666	0.666	0.666	0.663	0.657
0.64	0.645	0.655	0.655	0.655	0.652	0.646
0.66	0.634	0.644	0.644	0.644	0.641	0.635
0.68	0.623	0.633	0.633	0.633	0.630	0.624
0.70	0.612	0.622	0.622	0.622	0.619	0.613
0.72	0.601	0.611	0.611	0.611	0.608	0.602
0.74	0.590	0.600	0.600	0.600	0.597	0.591
0.76	0.579	0.589	0.589	0.589	0.586	0.580
0.78	0.568	0.578	0.578	0.578	0.575	0.569
0.80	0.557	0.567	0.567	0.567	0.564	0.558
0.82	0.546	0.556	0.556	0.556	0.553	0.547
0.84	0.535	0.545	0.545	0.545	0.542	0.536
0.86	0.524	0.534	0.534	0.534	0.531	0.525
0.88	0.513	0.523	0.523	0.523	0.520	0.514
0.90	0.502	0.512	0.512	0.512	0.509	0.503
0.92	0.491	0.501	0.501	0.501	0.498	0.492
0.94	0.480	0.490	0.490	0.490	0.487	0.481
0.96	0.469	0.479	0.479	0.479	0.476	0.470
0.98	0.458	0.468	0.468	0.468	0.465	0.459

Table 4.3.2-1c ($p_1 = 1 \text{ atm}$)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
DC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.032	1.022	1.012	1.000	0.992	0.983
0.02	1.016	1.011	1.003	0.994	0.985	0.976
0.04	1.002	1.000	0.994	0.986	0.978	0.970
0.06	0.988	0.990	0.985	0.978	0.971	0.963
0.08	0.975	0.979	0.976	0.970	0.963	0.956
0.10	0.962	0.969	0.967	0.962	0.956	0.949
0.12	0.950	0.959	0.958	0.953	0.948	0.942
0.14	0.938	0.949	0.949	0.945	0.940	0.934
0.16	0.927	0.939	0.940	0.937	0.932	0.927
0.18	0.916	0.929	0.930	0.928	0.924	0.919
0.20	0.902	0.919	0.921	0.919	0.916	0.911
0.22	0.179	0.909	0.912	0.911	0.907	0.903
0.24	0.144	0.895	0.902	0.902	0.899	0.894
0.26	0.128	0.398	0.890	0.891	0.889	0.885
0.28	0.114	0.353	0.592	0.877	0.878	0.875
0.30	0.102	0.314	0.544	0.662	0.712	0.738
0.32	0.091	0.279	0.496	0.623	0.680	0.707
0.34	0.082	0.247	0.450	0.583	0.647	0.678
0.36	0.074	0.219	0.405	0.541	0.611	0.647
0.38	0.067	0.195	0.363	0.498	0.574	0.614
0.40	0.061	0.173	0.324	0.454	0.534	0.578
0.42	0.055	0.154	0.288	0.411	0.493	0.541
0.44	0.050	0.137	0.255	0.369	0.451	0.502
0.46	0.045	0.122	0.225	0.329	0.409	0.461
0.48	0.041	0.109	0.199	0.292	0.368	0.420
0.50	0.038	0.097	0.176	0.258	0.328	0.379
0.52	0.035	0.087	0.156	0.228	0.291	0.339
0.54	0.032	0.078	0.138	0.201	0.257	0.300
0.56	0.029	0.071	0.122	0.177	0.226	0.265
0.58	0.027	0.064	0.109	0.156	0.198	0.232
0.60	0.025	0.058	0.097	0.137	0.174	0.203
0.62	0.024	0.053	0.087	0.121	0.152	0.177
0.64	0.022	0.049	0.079	0.108	0.134	0.154
0.66	0.021	0.045	0.071	0.096	0.118	0.134
0.68	0.020	0.042	0.065	0.086	0.104	0.118
0.70	0.019	0.040	0.060	0.078	0.093	0.103
0.72	0.018	0.037	0.055	0.071	0.084	0.092
0.74	0.018	0.035	0.052	0.065	0.076	0.082
0.76	0.017	0.034	0.049	0.061	0.069	0.074
0.78	0.017	0.033	0.046	0.057	0.064	0.067
0.80	0.017	0.032	0.044	0.054	0.060	0.062
0.82	0.017	0.031	0.043	0.051	0.056	0.058
0.84	0.017	0.031	0.042	0.050	0.054	0.055
0.86	0.018	0.031	0.041	0.049	0.052	0.052
0.88	0.019	0.031	0.041	0.048	0.051	0.051
0.90	0.020	0.032	0.042	0.048	0.051	0.051
0.92	0.022	0.034	0.044	0.049	0.052	0.052
0.94	0.025	0.037	0.046	0.052	0.054	0.053
0.96	0.034	0.044	0.051	0.058	0.060	0.056
0.98	0.070	0.072	0.090	0.081	0.081	0.083

Table 4.3.2-1c ($p_1 = 1 \text{ atm}$)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
DC Motor Case

Inlet void	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.032	1.022	1.012	1.000	0.992	0.983
0.02	1.016	1.011	1.003	0.994	0.985	0.976
0.04	1.002	1.000	0.994	0.986	0.978	0.970
0.06	0.988	0.990	0.985	0.978	0.971	0.963
0.08	0.975	0.979	0.976	0.970	0.963	0.956
0.10	0.962	0.969	0.967	0.962	0.956	0.949
0.12	0.950	0.959	0.958	0.953	0.948	0.942
0.14	0.938	0.949	0.949	0.945	0.940	0.934
0.16	0.927	0.939	0.940	0.937	0.932	0.927
0.18	0.916	0.929	0.930	0.928	0.924	0.919
0.20	0.902	0.919	0.921	0.919	0.916	0.911
0.22	0.179	0.909	0.912	0.911	0.907	0.903
0.24	0.144	0.895	0.902	0.902	0.899	0.894
0.26	0.128	0.398	0.890	0.891	0.889	0.885
0.28	0.114	0.353	0.592	0.877	0.878	0.875
0.30	0.102	0.314	0.544	0.662	0.712	0.738
0.32	0.091	0.279	0.496	0.623	0.680	0.707
0.34	0.082	0.247	0.450	0.583	0.647	0.678
0.36	0.074	0.219	0.405	0.541	0.611	0.647
0.38	0.067	0.195	0.363	0.498	0.574	0.614
0.40	0.061	0.173	0.324	0.454	0.534	0.578
0.42	0.055	0.154	0.288	0.411	0.493	0.541
0.44	0.050	0.137	0.255	0.369	0.451	0.502
0.46	0.045	0.122	0.225	0.329	0.409	0.461
0.48	0.041	0.109	0.199	0.292	0.368	0.420
0.50	0.038	0.097	0.176	0.258	0.328	0.379
0.52	0.035	0.087	0.156	0.228	0.291	0.339
0.54	0.032	0.078	0.138	0.201	0.257	0.300
0.56	0.029	0.071	0.122	0.177	0.226	0.265
0.58	0.027	0.064	0.109	0.156	0.198	0.232
0.60	0.025	0.058	0.097	0.137	0.174	0.203
0.62	0.024	0.053	0.087	0.121	0.152	0.177
0.64	0.022	0.049	0.079	0.108	0.134	0.154
0.66	0.021	0.045	0.071	0.096	0.118	0.134
0.68	0.020	0.042	0.065	0.086	0.104	0.118
0.70	0.019	0.040	0.060	0.078	0.093	0.103
0.72	0.018	0.037	0.055	0.071	0.084	0.092
0.74	0.018	0.035	0.052	0.065	0.076	0.082
0.76	0.017	0.034	0.049	0.061	0.069	0.074
0.78	0.017	0.033	0.046	0.057	0.064	0.067
0.80	0.017	0.032	0.044	0.054	0.060	0.062
0.82	0.017	0.031	0.043	0.051	0.056	0.058
0.84	0.017	0.031	0.042	0.050	0.054	0.055
0.86	0.018	0.031	0.041	0.049	0.052	0.052
0.88	0.019	0.031	0.041	0.048	0.051	0.051
0.90	0.020	0.032	0.042	0.048	0.051	0.051
0.92	0.022	0.034	0.044	0.049	0.052	0.052
0.94	0.025	0.037	0.046	0.052	0.054	0.053
0.96	0.034	0.044	0.051	0.058	0.060	0.056
0.98	0.070	0.072	0.090	0.081	0.081	0.083

Table 4.3.2-2a ($p_1 = 3 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
DC Motor Case

Inlet Void	Homologous Flow Paramete					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.03	0.03	0.02	0.02	0.02	0.02
0.04	0.07	0.05	0.05	0.04	0.04	0.04
0.06	0.11	0.08	0.07	0.06	0.06	0.06
0.08	0.14	0.10	0.09	0.09	0.08	0.08
0.10	0.16	0.13	0.11	0.11	0.10	0.10
0.12	0.19	0.15	0.14	0.13	0.12	0.12
0.14	0.22	0.18	0.16	0.15	0.14	0.14
0.16	0.24	0.20	0.18	0.17	0.16	0.16
0.18	0.76	0.22	0.20	0.19	0.18	0.18
0.20	0.87	0.24	0.22	0.21	0.20	0.20
0.22	0.88	0.28	0.25	0.23	0.22	0.22
0.24	0.89	0.73	0.27	0.25	0.25	0.24
0.26	0.89	0.76	0.57	0.28	0.27	0.26
0.28	0.90	0.78	0.61	0.49	0.30	0.29
0.30	0.90	0.80	0.64	0.53	0.46	0.42
0.32	0.91	0.82	0.68	0.56	0.49	0.45
0.34	0.91	0.83	0.71	0.60	0.52	0.48
0.36	0.92	0.84	0.74	0.63	0.56	0.51
0.38	0.92	0.85	0.76	0.66	0.59	0.54
0.40	0.93	0.87	0.78	0.69	0.62	0.57
0.42	0.93	0.87	0.80	0.72	0.65	0.60
0.44	0.93	0.88	0.81	0.74	0.68	0.63
0.46	0.94	0.89	0.83	0.76	0.70	0.66
0.48	0.94	0.90	0.84	0.79	0.73	0.69
0.50	0.94	0.90	0.86	0.80	0.75	0.71
0.52	0.94	0.91	0.87	0.82	0.77	0.73
0.54	0.95	0.92	0.88	0.83	0.79	0.76
0.56	0.95	0.92	0.88	0.85	0.81	0.78
0.58	0.95	0.93	0.89	0.86	0.83	0.80
0.60	0.96	0.93	0.90	0.87	0.84	0.81
0.62	0.96	0.93	0.91	0.88	0.85	0.83
0.64	0.96	0.94	0.92	0.89	0.87	0.84
0.66	0.96	0.94	0.92	0.90	0.88	0.86
0.68	0.97	0.95	0.93	0.91	0.89	0.87
0.70	0.97	0.95	0.93	0.92	0.90	0.88
0.72	0.97	0.95	0.94	0.92	0.91	0.89
0.74	0.97	0.96	0.94	0.93	0.92	0.90
0.76	0.98	0.96	0.95	0.94	0.92	0.91
0.78	0.98	0.96	0.95	0.94	0.93	0.92
0.80	0.98	0.97	0.96	0.95	0.94	0.93
0.82	0.98	0.97	0.96	0.95	0.94	0.94
0.84	0.98	0.98	0.97	0.96	0.95	0.94
0.86	0.99	0.98	0.97	0.96	0.96	0.95
0.88	0.99	0.98	0.98	0.97	0.96	0.96
0.90	0.99	0.99	0.98	0.98	0.97	0.97
0.92	0.99	0.99	0.98	0.98	0.98	0.97
0.94	0.99	0.99	0.99	0.99	0.98	0.98
0.96	1.00	0.99	0.99	0.99	0.99	0.99
0.98	1.00	1.00	1.00	1.00	0.99	0.99

Table 4.3.2-2b ($p_1 = 2 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
DC Motor Case

Inlet Void	Homologous Flow Paramete					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.03	0.03	0.02	0.02	0.02	0.02
0.04	0.07	0.05	0.04	0.04	0.04	0.04
0.06	0.10	0.07	0.06	0.06	0.06	0.05
0.08	0.13	0.10	0.09	0.08	0.08	0.07
0.10	0.16	0.12	0.11	0.10	0.09	0.09
0.12	0.18	0.14	0.13	0.12	0.11	0.11
0.14	0.21	0.17	0.15	0.14	0.13	0.13
0.16	0.23	0.19	0.17	0.16	0.15	0.15
0.18	0.26	0.21	0.19	0.18	0.17	0.17
0.20	0.26	0.23	0.21	0.20	0.19	0.19
0.22	0.28	0.26	0.23	0.22	0.21	0.21
0.24	0.29	0.27	0.26	0.24	0.23	0.23
0.26	0.29	0.26	0.29	0.27	0.25	0.25
0.28	0.30	0.28	0.30	0.28	0.28	0.27
0.30	0.30	0.30	0.30	0.30	0.30	0.30
0.32	0.31	0.31	0.31	0.31	0.31	0.31
0.34	0.31	0.31	0.31	0.31	0.31	0.31
0.36	0.32	0.32	0.32	0.32	0.32	0.32
0.38	0.32	0.32	0.32	0.32	0.32	0.32
0.40	0.33	0.33	0.33	0.33	0.33	0.33
0.42	0.33	0.33	0.33	0.33	0.33	0.33
0.44	0.33	0.33	0.33	0.33	0.33	0.33
0.46	0.34	0.34	0.34	0.34	0.34	0.34
0.48	0.34	0.34	0.34	0.34	0.34	0.34
0.50	0.34	0.34	0.34	0.34	0.34	0.34
0.52	0.35	0.35	0.35	0.35	0.35	0.35
0.54	0.35	0.35	0.35	0.35	0.35	0.35
0.56	0.35	0.35	0.35	0.35	0.35	0.35
0.58	0.36	0.36	0.36	0.36	0.36	0.36
0.60	0.36	0.36	0.36	0.36	0.36	0.36
0.62	0.36	0.36	0.36	0.36	0.36	0.36
0.64	0.37	0.37	0.37	0.37	0.37	0.37
0.66	0.37	0.37	0.37	0.37	0.37	0.37
0.68	0.37	0.37	0.37	0.37	0.37	0.37
0.70	0.38	0.38	0.38	0.38	0.38	0.38
0.72	0.38	0.38	0.38	0.38	0.38	0.38
0.74	0.38	0.38	0.38	0.38	0.38	0.38
0.76	0.39	0.39	0.39	0.39	0.39	0.39
0.78	0.39	0.39	0.39	0.39	0.39	0.39
0.80	0.39	0.39	0.39	0.39	0.39	0.39
0.82	0.40	0.40	0.40	0.40	0.40	0.40
0.84	0.40	0.40	0.40	0.40	0.40	0.40
0.86	0.40	0.40	0.40	0.40	0.40	0.40
0.88	0.41	0.41	0.41	0.41	0.41	0.41
0.90	0.41	0.41	0.41	0.41	0.41	0.41
0.92	0.41	0.41	0.41	0.41	0.41	0.41
0.94	0.42	0.42	0.42	0.42	0.42	0.42
0.96	0.42	0.42	0.42	0.42	0.42	0.42
0.98	0.42	0.42	0.42	0.42	0.42	0.42

Table 4.3.2-2c ($p_1 = 1 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
DC Motor Case

Inlet Void	Homologous Flow Paramete					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.03	0.02	0.02	0.02	0.02	0.01
0.04	0.06	0.04	0.04	0.03	0.03	0.03
0.06	0.09	0.06	0.05	0.05	0.05	0.04
0.08	0.11	0.08	0.07	0.07	0.06	0.06
0.10	0.14	0.10	0.09	0.08	0.08	0.08
0.12	0.16	0.12	0.11	0.10	0.10	0.09
0.14	0.18	0.14	0.13	0.12	0.11	0.11
0.16	0.21	0.17	0.15	0.14	0.13	0.13
0.18	0.23	0.19	0.17	0.16	0.15	0.14
0.20	0.25	0.21	0.19	0.17	0.17	0.16
0.22	0.28	0.23	0.20	0.19	0.18	0.18
0.24	0.29	0.25	0.22	0.21	0.20	0.20
0.26	0.29	0.25	0.24	0.23	0.22	0.22
0.28	0.30	0.27	0.25	0.25	0.24	0.23
0.30	0.30	0.28	0.26	0.26	0.25	0.24
0.32	0.31	0.29	0.27	0.27	0.26	0.25
0.34	0.31	0.30	0.28	0.28	0.27	0.26
0.36	0.32	0.31	0.29	0.29	0.28	0.27
0.38	0.32	0.32	0.30	0.30	0.29	0.28
0.40	0.33	0.33	0.31	0.31	0.30	0.29
0.42	0.33	0.34	0.32	0.32	0.31	0.30
0.44	0.34	0.35	0.33	0.33	0.32	0.31
0.46	0.34	0.36	0.34	0.34	0.33	0.32
0.48	0.35	0.37	0.35	0.35	0.34	0.33
0.50	0.35	0.38	0.36	0.36	0.35	0.34
0.52	0.36	0.39	0.37	0.37	0.36	0.35
0.54	0.36	0.40	0.38	0.38	0.37	0.36
0.56	0.37	0.41	0.39	0.39	0.38	0.37
0.58	0.37	0.42	0.40	0.40	0.39	0.38
0.60	0.38	0.43	0.41	0.41	0.40	0.39
0.62	0.38	0.44	0.42	0.42	0.41	0.40
0.64	0.39	0.45	0.43	0.43	0.42	0.41
0.66	0.39	0.46	0.44	0.44	0.43	0.42
0.68	0.40	0.47	0.45	0.45	0.44	0.43
0.70	0.40	0.48	0.46	0.46	0.45	0.44
0.72	0.41	0.49	0.47	0.47	0.46	0.45
0.74	0.41	0.50	0.48	0.48	0.47	0.46
0.76	0.42	0.51	0.49	0.49	0.48	0.47
0.78	0.42	0.52	0.50	0.50	0.49	0.48
0.80	0.43	0.53	0.51	0.51	0.50	0.49
0.82	0.43	0.54	0.52	0.52	0.51	0.50
0.84	0.44	0.55	0.53	0.53	0.52	0.51
0.86	0.44	0.56	0.54	0.54	0.53	0.52
0.88	0.45	0.57	0.55	0.55	0.54	0.53
0.90	0.45	0.58	0.56	0.56	0.55	0.54
0.92	0.46	0.59	0.57	0.57	0.56	0.55
0.94	0.46	0.60	0.58	0.58	0.57	0.56
0.96	0.47	0.61	0.59	0.59	0.58	0.57
0.98	0.47	0.62	0.60	0.60	0.59	0.58

Table 4.3.2-2d ($p_1 = 0.05 \text{ atm}$)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05 \text{ atm}$
DC Motor Case

Inlet Void	Homologous Flow Parameters					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.01	0.00	0.00	0.00	0.00	0.00
0.06	0.02	0.01	0.01	0.00	0.00	0.00
0.08	0.03	0.02	0.02	0.01	0.01	0.01
0.10	0.04	0.02	0.02	0.02	0.02	0.02
0.12	0.05	0.03	0.02	0.02	0.02	0.02
0.14	0.06	0.04	0.03	0.03	0.02	0.02
0.16	0.07	0.04	0.03	0.03	0.03	0.03
0.18	0.08	0.05	0.04	0.04	0.03	0.03
0.20	0.09	0.06	0.05	0.04	0.04	0.03
0.22	0.11	0.06	0.05	0.05	0.04	0.04
0.24	0.12	0.07	0.06	0.05	0.05	0.04
0.26	0.89	0.08	0.07	0.06	0.05	0.05
0.28	0.90	0.09	0.07	0.06	0.06	0.05
0.30	0.90	0.72	0.08	0.07	0.06	0.06
0.32	0.91	0.76	0.09	0.08	0.07	0.07
0.34	0.91	0.79	0.10	0.09	0.08	0.07
0.36	0.92	0.81	0.46	0.10	0.09	0.08
0.38	0.92	0.83	0.54	0.11	0.10	0.09
0.40	0.93	0.85	0.62	0.12	0.11	0.10
0.42	0.93	0.86	0.68	0.36	0.12	0.11
0.44	0.93	0.87	0.73	0.43	0.13	0.12
0.46	0.94	0.88	0.77	0.51	0.14	0.13
0.48	0.94	0.89	0.81	0.60	0.37	0.14
0.50	0.94	0.90	0.83	0.67	0.44	0.16
0.52	0.94	0.91	0.85	0.73	0.52	0.36
0.54	0.95	0.91	0.86	0.78	0.61	0.43
0.56	0.95	0.92	0.88	0.81	0.69	0.51
0.58	0.95	0.92	0.89	0.83	0.75	0.61
0.60	0.96	0.93	0.90	0.85	0.79	0.69
0.62	0.96	0.93	0.90	0.87	0.82	0.76
0.64	0.96	0.94	0.91	0.88	0.85	0.80
0.66	0.96	0.94	0.92	0.89	0.87	0.83
0.68	0.97	0.95	0.93	0.90	0.88	0.85
0.70	0.97	0.95	0.93	0.91	0.89	0.87
0.72	0.97	0.95	0.94	0.92	0.90	0.88
0.74	0.97	0.96	0.94	0.93	0.91	0.90
0.76	0.98	0.96	0.95	0.94	0.92	0.91
0.78	0.98	0.96	0.95	0.94	0.93	0.92
0.80	0.98	0.97	0.96	0.95	0.94	0.93
0.82	0.98	0.97	0.96	0.95	0.94	0.94
0.84	0.98	0.98	0.97	0.96	0.95	0.94
0.86	0.99	0.98	0.97	0.96	0.96	0.95
0.88	0.99	0.98	0.98	0.97	0.96	0.96
0.90	0.99	0.99	0.98	0.98	0.97	0.97
0.92	0.99	0.99	0.98	0.98	0.98	0.97
0.94	0.99	0.99	0.99	0.99	0.98	0.98
0.96	1.00	0.99	0.99	0.99	0.99	0.99
0.98	1.00	1.00	1.00	1.00	0.99	0.99

Table 4.3.2-3a ($p_1 = 3 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
DC Motor Case

Inlet void fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	15.7	15.7	15.8	15.9	16.0	16.1
0.02	15.1	15.3	15.4	15.5	15.7	15.8
0.04	14.6	14.9	15.0	15.2	15.3	15.5
0.06	14.1	14.5	14.7	14.8	15.0	15.1
0.08	13.7	14.1	14.3	14.5	14.6	14.8
0.10	13.2	13.7	13.9	14.1	14.3	14.5
0.12	12.8	13.3	13.6	13.8	13.9	14.1
0.14	12.4	13.0	13.2	13.4	13.6	13.8
0.16	12.1	12.6	12.9	13.1	13.3	13.5
0.18	9.8	12.2	12.5	12.7	12.9	13.1
0.20	4.4	11.9	12.2	12.4	12.6	12.8
0.22	2.5	11.4	11.9	12.1	12.3	12.5
0.24	2.0	6.1	11.4	11.7	11.9	12.1
0.26	1.7	4.8	8.0	11.2	11.5	11.7
0.28	1.5	4.2	6.9	8.4	11.0	11.3
0.30	1.3	3.7	6.2	7.7	8.6	9.2
0.32	1.2	3.3	5.6	7.1	8.0	8.6
0.34	1.1	2.9	5.0	6.6	7.5	8.1
0.36	0.9	2.6	4.5	6.0	7.0	7.6
0.38	0.8	2.2	4.0	5.4	6.4	7.1
0.40	0.7	2.0	3.5	4.9	5.9	6.5
0.42	0.7	1.7	3.1	4.4	5.4	6.0
0.44	0.6	1.5	2.7	3.9	4.8	5.5
0.46	0.5	1.3	2.4	3.5	4.3	5.0
0.48	0.5	1.2	2.1	3.1	3.9	4.5
0.50	0.4	1.0	1.8	2.7	3.4	4.0
0.52	0.4	0.9	1.6	2.3	3.0	3.6
0.54	0.3	0.8	1.4	2.0	2.6	3.1
0.56	0.3	0.6	1.2	1.7	2.3	2.7
0.58	0.2	0.6	1.0	1.5	2.0	2.4
0.60	0.2	0.5	0.8	1.3	1.7	2.0
0.62	0.2	0.4	0.7	1.1	1.4	1.7
0.64	0.2	0.3	0.6	0.9	1.2	1.5
0.66	0.1	0.3	0.5	0.7	1.0	1.2
0.68	0.1	0.2	0.4	0.6	0.8	1.0
0.70	0.1	0.2	0.3	0.5	0.7	0.8
0.72	0.1	0.2	0.3	0.4	0.5	0.7
0.74	0.1	0.1	0.2	0.3	0.4	0.5
0.76	0.1	0.1	0.2	0.3	0.3	0.4
0.78	0.1	0.1	0.2	0.2	0.3	0.3
0.80	0.1	0.1	0.1	0.2	0.2	0.3
0.82	0.1	0.1	0.1	0.1	0.2	0.2
0.84	0.0	0.1	0.1	0.1	0.1	0.1
0.86	0.0	0.1	0.1	0.1	0.1	0.1
0.88	0.0	0.0	0.1	0.1	0.1	0.1
0.90	0.0	0.0	0.0	0.1	0.1	0.1
0.92	0.0	0.0	0.0	0.0	0.0	0.1
0.94	0.0	0.0	0.0	0.0	0.0	0.0
0.96	0.0	0.0	0.0	0.0	0.0	0.0
0.98	0.0	0.0	0.0	0.0	0.0	0.0

Table 4.3.2-3b ($p_1 = 2 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
DC Motor Case

Inlet void fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	15.7	15.7	15.8	15.9	16.0	16.1
0.02	15.1	15.3	15.4	15.5	15.7	15.8
0.04	14.4	14.9	15.1	15.2	15.3	15.5
0.06	14.2	14.5	14.7	14.9	15.0	15.2
0.08	13.7	14.1	14.4	14.5	14.7	14.9
0.10	13.3	13.8	14.0	14.2	14.4	14.6
0.12	12.9	13.4	13.7	13.9	14.0	14.2
0.14	12.5	13.0	13.3	13.5	13.7	13.9
0.16	12.1	12.7	13.0	13.2	13.4	13.6
0.18	11.8	12.3	12.6	12.9	13.1	13.3
0.20	4.9	12.0	12.3	12.5	12.7	12.9
0.22	2.5	11.6	12.0	12.2	12.4	12.6
0.24	2.0	6.6	11.6	11.9	12.1	12.3
0.26	1.7	4.9	10.9	11.4	11.7	11.9
0.28	1.5	4.3	7.0	8.6	11.2	11.5
0.30	1.3	3.8	6.3	7.9	8.8	9.4
0.32	1.2	3.3	5.7	7.3	8.2	8.8
0.34	1.0	2.9	5.1	6.7	7.7	8.3
0.36	0.9	2.6	4.5	6.1	7.1	7.8
0.38	0.8	2.2	4.0	5.5	6.5	7.2
0.40	0.7	2.0	3.6	5.0	6.0	6.7
0.42	0.6	1.7	3.1	4.5	5.5	6.2
0.44	0.6	1.5	2.8	4.0	4.9	5.6
0.46	0.5	1.3	2.4	3.5	4.4	5.1
0.48	0.4	1.1	2.1	3.1	3.9	4.6
0.50	0.4	1.0	1.8	2.7	3.5	4.1
0.52	0.3	0.9	1.6	2.3	3.0	3.6
0.54	0.3	0.7	1.4	2.0	2.6	3.2
0.56	0.3	0.6	1.2	1.7	2.3	2.8
0.58	0.2	0.5	1.0	1.5	2.0	2.4
0.60	0.2	0.5	0.8	1.3	1.7	2.1
0.62	0.2	0.4	0.7	1.1	1.4	1.7
0.64	0.1	0.3	0.6	0.9	1.2	1.5
0.66	0.1	0.3	0.5	0.7	1.0	1.2
0.68	0.1	0.2	0.4	0.6	0.8	1.0
0.70	0.1	0.2	0.3	0.5	0.7	0.8
0.72	0.1	0.2	0.3	0.4	0.5	0.7
0.74	0.1	0.1	0.2	0.3	0.4	0.5
0.76	0.1	0.1	0.2	0.3	0.3	0.4
0.78	0.1	0.1	0.1	0.2	0.3	0.3
0.80	0.0	0.1	0.1	0.2	0.2	0.2
0.82	0.0	0.1	0.1	0.1	0.2	0.2
0.84	0.0	0.1	0.1	0.1	0.1	0.1
0.86	0.0	0.0	0.1	0.1	0.1	0.1
0.88	0.0	0.0	0.0	0.1	0.1	0.1
0.90	0.0	0.0	0.0	0.0	0.0	0.1
0.92	0.0	0.0	0.0	0.0	0.0	0.0
0.94	0.0	0.0	0.0	0.0	0.0	0.0
0.96	0.0	0.0	0.0	0.0	0.0	0.0
0.98	0.0	0.0	0.0	0.0	0.0	0.0

Table 4.3.2-3c ($p_1 = 1 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
DC Motor Case

Inlet void fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	15.7	15.7	15.8	15.9	16.0	16.1
0.02	15.2	15.4	15.5	15.6	15.7	15.9
0.04	14.7	15.0	15.2	15.3	15.4	15.6
0.06	14.3	14.7	14.8	15.0	15.2	15.3
0.08	13.9	14.3	14.5	14.7	14.9	15.1
0.10	13.5	14.0	14.2	14.4	14.6	14.8
0.12	13.1	13.6	13.9	14.1	14.3	14.5
0.14	12.7	13.3	13.6	13.8	14.0	14.2
0.16	12.4	12.9	13.2	13.5	13.7	13.9
0.18	12.0	12.6	12.9	13.2	13.4	13.6
0.20	11.6	12.3	12.6	12.8	13.1	13.3
0.22	2.6	11.9	12.3	12.5	12.8	13.0
0.24	2.0	11.5	11.9	12.2	12.5	12.7
0.26	1.7	5.0	11.5	11.9	12.1	12.4
0.28	1.5	4.4	7.3	11.4	11.8	12.0
0.30	1.3	3.8	6.6	8.3	9.3	9.9
0.32	1.2	3.4	5.9	7.7	8.7	9.3
0.34	1.0	2.9	5.3	7.0	8.1	8.8
0.36	0.9	2.6	4.7	6.4	7.5	8.3
0.38	0.8	2.3	4.2	5.8	6.9	7.7
0.40	0.7	2.0	3.7	5.2	6.3	7.1
0.42	0.6	1.7	3.2	4.6	5.8	6.6
0.44	0.6	1.5	2.8	4.1	5.2	6.0
0.46	0.5	1.3	2.4	3.6	4.6	5.4
0.48	0.4	1.1	2.1	3.2	4.1	4.9
0.50	0.4	1.0	1.8	2.8	3.6	4.3
0.52	0.3	0.9	1.6	2.4	3.1	3.8
0.54	0.3	0.7	1.4	2.0	2.7	3.3
0.56	0.3	0.6	1.2	1.8	2.3	2.9
0.58	0.2	0.5	1.0	1.5	2.0	2.5
0.60	0.2	0.5	0.8	1.3	1.7	2.1
0.62	0.2	0.4	0.7	1.1	1.4	1.8
0.64	0.1	0.3	0.6	0.9	1.2	1.5
0.66	0.1	0.3	0.5	0.7	1.0	1.2
0.68	0.1	0.2	0.4	0.6	0.8	1.0
0.70	0.1	0.2	0.3	0.5	0.7	0.8
0.72	0.1	0.2	0.3	0.4	0.5	0.7
0.74	0.1	0.1	0.2	0.3	0.4	0.5
0.76	0.0	0.1	0.2	0.2	0.3	0.4
0.78	0.0	0.1	0.1	0.2	0.2	0.3
0.80	0.0	0.1	0.1	0.1	0.2	0.2
0.82	0.0	0.1	0.1	0.1	0.1	0.2
0.84	0.0	0.0	0.1	0.1	0.1	0.1
0.86	0.0	0.0	0.0	0.1	0.1	0.1
0.88	0.0	0.0	0.0	0.0	0.1	0.1
0.90	0.0	0.0	0.0	0.0	0.0	0.0
0.92	0.0	0.0	0.0	0.0	0.0	0.0
0.94	0.0	0.0	0.0	0.0	0.0	0.0
0.96	0.0	0.0	0.0	0.0	0.0	0.0
0.98	0.0	0.0	0.0	0.0	0.0	0.0

Table 4.3.2-3d ($p_1 = 0.05 \text{ atm}$)

Static Pressure Rise in psia vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05 \text{ atm}$
DC Motor Case

Inlet void fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	15.7	15.8	15.8	15.9	16.0	16.2
0.02	15.6	15.7	15.8	15.9	16.0	16.1
0.04	15.4	15.5	15.7	15.8	16.0	16.1
0.06	15.2	15.4	15.6	15.7	15.9	16.1
0.08	15.1	15.3	15.5	15.7	15.8	16.1
0.10	14.9	15.2	15.4	15.6	15.8	16.0
0.12	14.7	15.1	15.3	15.5	15.7	16.0
0.14	14.5	14.9	15.2	15.4	15.6	15.9
0.16	14.3	14.8	15.0	15.3	15.6	15.9
0.18	14.1	14.6	14.9	15.2	15.5	15.8
0.20	13.9	14.5	14.8	15.1	15.4	15.7
0.22	13.7	14.3	14.7	15.0	15.3	15.6
0.24	13.4	14.1	14.5	14.8	15.2	15.5
0.26	2.0	13.9	14.3	14.7	15.1	15.4
0.28	1.7	13.7	14.2	14.5	14.9	15.3
0.30	1.5	6.0	14.0	14.4	14.8	15.2
0.32	1.3	5.1	13.3	14.0	14.6	15.1
0.34	1.1	4.3	12.7	13.7	14.3	14.7
0.36	1.0	3.6	9.0	13.4	14.0	14.5
0.38	0.9	3.0	7.9	13.0	13.7	14.3
0.40	0.8	2.6	6.8	12.4	13.4	14.0
0.42	0.7	2.2	5.7	9.6	12.9	13.7
0.44	0.6	1.8	4.7	8.7	12.4	13.3
0.46	0.5	1.6	3.8	7.6	11.5	12.8
0.48	0.4	1.3	3.1	6.4	9.2	12.2
0.50	0.4	1.1	2.6	5.2	8.2	11.2
0.52	0.3	1.0	2.1	4.2	7.0	9.2
0.54	0.3	0.8	1.8	3.4	5.8	8.1
0.56	0.2	0.7	1.5	2.7	4.6	6.9
0.58	0.2	0.6	1.2	2.2	3.6	5.6
0.60	0.2	0.5	1.0	1.7	2.9	4.4
0.62	0.1	0.4	0.8	1.4	2.2	3.4
0.64	0.1	0.3	0.7	1.1	1.8	2.6
0.66	0.1	0.3	0.5	0.9	1.4	2.0
0.68	0.1	0.2	0.4	0.7	1.1	1.5
0.70	0.1	0.2	0.3	0.6	0.8	1.2
0.72	0.1	0.1	0.3	0.4	0.6	0.9
0.74	0.0	0.1	0.2	0.3	0.5	0.6
0.76	0.0	0.1	0.2	0.2	0.4	0.5
0.78	0.0	0.1	0.1	0.2	0.3	0.3
0.80	0.0	0.0	0.1	0.1	0.2	0.2
0.82	0.0	0.0	0.1	0.1	0.1	0.2
0.84	0.0	0.0	0.0	0.1	0.1	0.1
0.86	0.0	0.0	0.0	0.0	0.1	0.1
0.88	0.0	0.0	0.0	0.0	0.0	0.0
0.90	0.0	0.0	0.0	0.0	0.0	0.0
0.92	0.0	0.0	0.0	0.0	0.0	0.0
0.94	0.0	0.0	0.0	0.0	0.0	0.0
0.96	0.0	0.0	0.0	0.0	0.0	0.0
0.98	0.0	0.0	0.0	0.0	0.0	0.0

Table 4.3.2-4a ($p_1 = 3 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 3 \text{ atm}$
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.09	0.13	0.17	0.22	0.26	0.30
0.02	0.09	0.13	0.17	0.22	0.26	0.30
0.04	0.09	0.13	0.17	0.22	0.26	0.30
0.06	0.09	0.13	0.18	0.22	0.26	0.30
0.08	0.09	0.13	0.18	0.22	0.26	0.30
0.10	0.09	0.13	0.18	0.22	0.26	0.30
0.12	0.09	0.13	0.18	0.22	0.26	0.30
0.14	0.09	0.14	0.18	0.22	0.26	0.30
0.16	0.10	0.14	0.18	0.22	0.26	0.30
0.18	0.30	0.14	0.18	0.22	0.26	0.30
0.20	0.52	0.14	0.18	0.22	0.26	0.30
0.22	0.56	0.14	0.18	0.22	0.26	0.30
0.24	0.59	0.37	0.18	0.22	0.26	0.30
0.26	0.60	0.40	0.30	0.22	0.26	0.30
0.28	0.62	0.43	0.32	0.31	0.27	0.31
0.30	0.63	0.45	0.34	0.32	0.34	0.36
0.32	0.65	0.48	0.37	0.34	0.35	0.37
0.34	0.66	0.50	0.39	0.36	0.36	0.38
0.36	0.68	0.53	0.42	0.38	0.38	0.39
0.38	0.69	0.55	0.44	0.40	0.39	0.41
0.40	0.70	0.58	0.47	0.42	0.41	0.43
0.42	0.71	0.60	0.50	0.45	0.43	0.44
0.44	0.72	0.62	0.52	0.47	0.45	0.46
0.46	0.73	0.64	0.55	0.50	0.47	0.48
0.48	0.74	0.65	0.57	0.52	0.50	0.50
0.50	0.75	0.67	0.60	0.55	0.53	0.52
0.52	0.76	0.69	0.62	0.58	0.55	0.55
0.54	0.76	0.70	0.64	0.60	0.58	0.57
0.56	0.77	0.72	0.66	0.63	0.60	0.60
0.58	0.78	0.73	0.68	0.65	0.63	0.62
0.60	0.78	0.74	0.70	0.67	0.65	0.65
0.62	0.79	0.75	0.72	0.69	0.68	0.67
0.64	0.80	0.76	0.73	0.71	0.70	0.70
0.66	0.80	0.77	0.75	0.73	0.72	0.72
0.68	0.81	0.78	0.76	0.75	0.74	0.75
0.70	0.81	0.79	0.77	0.77	0.76	0.76
0.72	0.81	0.80	0.79	0.78	0.78	0.78
0.74	0.82	0.81	0.79	0.80	0.79	0.80
0.76	0.82	0.81	0.81	0.81	0.81	0.82
0.78	0.82	0.82	0.81	0.82	0.82	0.83
0.80	0.83	0.82	0.82	0.83	0.83	0.84
0.82	0.83	0.83	0.83	0.84	0.84	0.86
0.84	0.83	0.83	0.83	0.84	0.85	0.86
0.86	0.83	0.84	0.84	0.85	0.86	0.87
0.88	0.83	0.84	0.84	0.86	0.86	0.88
0.90	0.84	0.84	0.85	0.86	0.87	0.89
0.92	0.84	0.84	0.85	0.86	0.87	0.89
0.94	0.84	0.84	0.85	0.87	0.88	0.89
0.96	0.84	0.84	0.85	0.87	0.88	0.90
0.98	0.84	0.84	0.85	0.87	0.88	0.90

Table 4.3.2-4b ($p_1 = 2 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.09	0.13	0.17	0.22	0.26	0.30
0.02	0.09	0.13	0.17	0.22	0.26	0.30
0.04	0.09	0.13	0.17	0.22	0.26	0.30
0.06	0.09	0.13	0.17	0.22	0.26	0.30
0.08	0.09	0.13	0.17	0.22	0.26	0.30
0.10	0.09	0.13	0.17	0.22	0.26	0.30
0.12	0.09	0.13	0.17	0.22	0.26	0.30
0.14	0.09	0.13	0.18	0.22	0.26	0.30
0.16	0.09	0.13	0.18	0.22	0.26	0.30
0.18	0.10	0.13	0.18	0.22	0.26	0.30
0.20	0.50	0.14	0.18	0.22	0.26	0.30
0.22	0.56	0.14	0.18	0.22	0.26	0.30
0.24	0.59	0.36	0.18	0.22	0.26	0.30
0.26	0.60	0.39	0.18	0.22	0.26	0.30
0.28	0.62	0.42	0.31	0.30	0.26	0.30
0.30	0.63	0.45	0.34	0.31	0.33	0.35
0.32	0.65	0.48	0.36	0.33	0.34	0.36
0.34	0.66	0.50	0.39	0.35	0.35	0.37
0.36	0.68	0.53	0.41	0.37	0.37	0.39
0.38	0.69	0.55	0.44	0.39	0.38	0.40
0.40	0.70	0.58	0.47	0.41	0.40	0.42
0.42	0.71	0.60	0.50	0.44	0.42	0.43
0.44	0.72	0.62	0.52	0.47	0.44	0.45
0.46	0.73	0.64	0.55	0.49	0.47	0.47
0.48	0.74	0.65	0.57	0.52	0.49	0.49
0.50	0.75	0.67	0.60	0.55	0.52	0.52
0.52	0.76	0.69	0.62	0.58	0.55	0.54
0.54	0.76	0.70	0.64	0.60	0.58	0.57
0.56	0.77	0.72	0.66	0.63	0.60	0.59
0.58	0.78	0.73	0.68	0.65	0.63	0.62
0.60	0.78	0.74	0.70	0.67	0.65	0.65
0.62	0.79	0.75	0.72	0.69	0.68	0.67
0.64	0.80	0.76	0.73	0.71	0.70	0.70
0.66	0.80	0.77	0.75	0.73	0.72	0.72
0.68	0.81	0.78	0.76	0.75	0.74	0.75
0.70	0.81	0.79	0.78	0.77	0.76	0.76
0.72	0.81	0.80	0.79	0.78	0.78	0.78
0.74	0.82	0.81	0.79	0.80	0.79	0.80
0.76	0.82	0.81	0.81	0.81	0.81	0.82
0.78	0.82	0.82	0.81	0.82	0.82	0.83
0.80	0.83	0.82	0.82	0.83	0.83	0.84
0.82	0.83	0.83	0.83	0.84	0.84	0.86
0.84	0.83	0.83	0.83	0.84	0.85	0.87
0.86	0.83	0.84	0.84	0.85	0.86	0.87
0.88	0.84	0.84	0.84	0.86	0.86	0.88
0.90	0.84	0.84	0.85	0.86	0.87	0.89
0.92	0.84	0.84	0.85	0.86	0.88	0.89
0.94	0.84	0.84	0.85	0.87	0.88	0.89
0.96	0.84	0.84	0.85	0.87	0.88	0.90
0.98	0.84	0.85	0.85	0.87	0.88	0.90

Table 4.3.2-4c ($p_1 = 1 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 1 \text{ atm}$
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.09	0.13	0.17	0.22	0.26	0.30
0.02	0.09	0.13	0.17	0.21	0.26	0.30
0.04	0.09	0.13	0.17	0.21	0.26	0.30
0.06	0.09	0.13	0.17	0.21	0.26	0.30
0.08	0.09	0.13	0.17	0.21	0.25	0.30
0.10	0.09	0.13	0.17	0.21	0.25	0.30
0.12	0.09	0.13	0.17	0.21	0.25	0.29
0.14	0.09	0.13	0.17	0.21	0.25	0.29
0.16	0.09	0.13	0.17	0.21	0.25	0.29
0.18	0.09	0.13	0.17	0.21	0.25	0.29
0.20	0.09	0.13	0.17	0.21	0.25	0.29
0.22	0.56	0.13	0.17	0.21	0.25	0.29
0.24	0.59	0.13	0.17	0.21	0.25	0.29
0.26	0.60	0.39	0.17	0.21	0.25	0.29
0.28	0.62	0.42	0.29	0.21	0.25	0.28
0.30	0.63	0.44	0.32	0.29	0.31	0.33
0.32	0.65	0.47	0.34	0.31	0.32	0.34
0.34	0.66	0.50	0.37	0.33	0.33	0.35
0.36	0.68	0.52	0.40	0.35	0.34	0.36
0.38	0.69	0.55	0.43	0.37	0.36	0.37
0.40	0.70	0.57	0.46	0.40	0.38	0.39
0.42	0.71	0.59	0.49	0.42	0.40	0.41
0.44	0.72	0.62	0.52	0.45	0.43	0.43
0.46	0.73	0.64	0.54	0.48	0.45	0.45
0.48	0.74	0.65	0.57	0.51	0.48	0.47
0.50	0.75	0.67	0.59	0.54	0.51	0.50
0.52	0.76	0.69	0.62	0.57	0.54	0.53
0.54	0.76	0.70	0.64	0.60	0.56	0.55
0.56	0.77	0.72	0.66	0.62	0.59	0.58
0.58	0.78	0.73	0.68	0.65	0.62	0.61
0.60	0.79	0.74	0.70	0.67	0.65	0.64
0.62	0.79	0.75	0.72	0.69	0.67	0.67
0.64	0.80	0.76	0.73	0.71	0.70	0.69
0.66	0.80	0.77	0.75	0.73	0.72	0.72
0.68	0.81	0.78	0.76	0.75	0.74	0.74
0.70	0.81	0.79	0.78	0.76	0.76	0.76
0.72	0.81	0.80	0.79	0.78	0.78	0.78
0.74	0.82	0.81	0.80	0.80	0.79	0.80
0.76	0.82	0.81	0.81	0.81	0.81	0.82
0.78	0.83	0.82	0.81	0.82	0.82	0.83
0.80	0.83	0.82	0.82	0.83	0.83	0.84
0.82	0.83	0.83	0.83	0.84	0.84	0.86
0.84	0.83	0.83	0.83	0.84	0.85	0.87
0.86	0.83	0.84	0.84	0.85	0.86	0.87
0.88	0.84	0.84	0.84	0.86	0.86	0.88
0.90	0.84	0.84	0.85	0.86	0.87	0.89
0.92	0.84	0.84	0.85	0.86	0.88	0.89
0.94	0.84	0.84	0.85	0.87	0.88	0.90
0.96	0.84	0.84	0.85	0.87	0.88	0.90
0.98	0.84	0.85	0.85	0.87	0.88	0.90

Table 4.3.2-4d ($p_1 = 0.05 \text{ atm}$)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = .05 \text{ atm}$
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.09	0.13	0.17	0.22	0.26	0.30
0.02	0.08	0.13	0.17	0.21	0.25	0.30
0.04	0.08	0.12	0.17	0.21	0.25	0.29
0.06	0.08	0.12	0.16	0.20	0.24	0.28
0.08	0.08	0.12	0.16	0.20	0.24	0.28
0.10	0.08	0.12	0.16	0.20	0.24	0.28
0.12	0.08	0.12	0.16	0.20	0.23	0.27
0.14	0.08	0.12	0.15	0.19	0.23	0.27
0.16	0.08	0.11	0.15	0.19	0.22	0.26
0.18	0.08	0.11	0.15	0.19	0.22	0.26
0.20	0.08	0.11	0.14	0.18	0.21	0.25
0.22	0.08	0.11	0.14	0.18	0.21	0.25
0.24	0.08	0.11	0.14	0.17	0.21	0.24
0.26	0.58	0.10	0.14	0.17	0.20	0.24
0.28	0.60	0.10	0.13	0.17	0.20	0.23
0.30	0.62	0.33	0.13	0.16	0.19	0.23
0.32	0.63	0.36	0.13	0.16	0.19	0.22
0.34	0.65	0.40	0.13	0.16	0.19	0.22
0.36	0.67	0.44	0.21	0.15	0.18	0.21
0.38	0.68	0.48	0.24	0.15	0.18	0.21
0.40	0.69	0.51	0.27	0.15	0.17	0.20
0.42	0.70	0.54	0.31	0.20	0.17	0.20
0.44	0.71	0.57	0.36	0.21	0.17	0.19
0.46	0.72	0.60	0.41	0.24	0.16	0.19
0.48	0.74	0.62	0.46	0.28	0.21	0.19
0.50	0.75	0.64	0.50	0.33	0.23	0.18
0.52	0.75	0.67	0.54	0.39	0.26	0.23
0.54	0.76	0.69	0.58	0.45	0.31	0.24
0.56	0.77	0.70	0.62	0.50	0.37	0.27
0.58	0.78	0.72	0.64	0.55	0.44	0.32
0.60	0.78	0.73	0.67	0.60	0.50	0.40
0.62	0.79	0.75	0.69	0.64	0.56	0.48
0.64	0.80	0.76	0.72	0.67	0.61	0.55
0.66	0.80	0.77	0.73	0.70	0.65	0.60
0.68	0.81	0.78	0.75	0.73	0.69	0.66
0.70	0.81	0.79	0.77	0.75	0.72	0.70
0.72	0.81	0.80	0.78	0.77	0.75	0.74
0.74	0.82	0.81	0.79	0.79	0.78	0.77
0.76	0.82	0.81	0.80	0.80	0.80	0.80
0.78	0.83	0.82	0.81	0.81	0.81	0.82
0.80	0.83	0.82	0.82	0.82	0.83	0.84
0.82	0.83	0.83	0.83	0.83	0.84	0.85
0.84	0.83	0.83	0.83	0.84	0.85	0.86
0.86	0.83	0.84	0.84	0.85	0.86	0.87
0.88	0.84	0.84	0.84	0.86	0.86	0.88
0.90	0.84	0.84	0.85	0.86	0.87	0.89
0.92	0.84	0.84	0.85	0.87	0.88	0.89
0.94	0.84	0.84	0.85	0.87	0.88	0.90
0.96	0.84	0.85	0.85	0.87	0.88	0.90
0.98	0.84	0.85	0.85	0.87	0.88	0.90

Table 4.3.2-5a (p₁ = 3 atm)

Normalized Relative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at P₁ = 3 atm
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.05	0.10	0.00	0.00	0.00	0.00
0.04	0.05	0.10	0.15	0.20	0.25	0.30
0.06	0.05	0.10	0.14	0.19	0.24	0.29
0.08	0.05	0.09	0.14	0.19	0.24	0.29
0.10	0.05	0.09	0.14	0.19	0.24	0.28
0.12	0.05	0.09	0.14	0.19	0.23	0.28
0.14	0.05	0.09	0.14	0.18	0.23	0.28
0.16	0.05	0.09	0.14	0.18	0.23	0.27
0.18	0.05	0.09	0.13	0.18	0.22	0.27
0.20	0.05	0.09	0.13	0.18	0.22	0.26
0.22	0.05	0.09	0.13	0.17	0.22	0.26
0.24	0.05	0.09	0.13	0.17	0.22	0.26
0.26	0.02	0.09	0.13	0.17	0.21	0.26
0.28	0.02	0.03	0.13	0.17	0.21	0.25
0.30	0.03	0.04	0.07	0.17	0.21	0.25
0.32	0.03	0.04	0.07	0.17	0.21	0.24
0.34	0.03	0.04	0.07	0.17	0.20	0.24
0.36	0.03	0.04	0.07	0.10	0.20	0.24
0.38	0.04	0.05	0.07	0.10	0.19	0.24
0.40	0.04	0.05	0.07	0.10	0.14	0.24
0.42	0.04	0.05	0.07	0.10	0.14	0.17
0.44	0.04	0.06	0.07	0.10	0.13	0.17
0.46	0.05	0.06	0.08	0.10	0.13	0.17
0.48	0.05	0.07	0.08	0.10	0.13	0.17
0.50	0.05	0.07	0.09	0.11	0.14	0.17
0.52	0.05	0.07	0.09	0.11	0.14	0.17
0.54	0.06	0.08	0.10	0.12	0.14	0.17
0.56	0.06	0.08	0.10	0.12	0.15	0.17
0.58	0.06	0.09	0.11	0.13	0.16	0.18
0.60	0.06	0.09	0.12	0.14	0.16	0.19
0.62	0.06	0.10	0.12	0.15	0.17	0.20
0.64	0.07	0.10	0.13	0.16	0.18	0.21
0.66	0.07	0.10	0.13	0.17	0.19	0.22
0.68	0.07	0.11	0.14	0.17	0.21	0.24
0.70	0.07	0.11	0.15	0.18	0.22	0.25
0.72	0.08	0.11	0.15	0.19	0.22	0.26
0.74	0.08	0.12	0.16	0.19	0.23	0.27
0.76	0.08	0.12	0.16	0.20	0.24	0.28
0.78	0.08	0.13	0.17	0.21	0.25	0.29
0.80	0.08	0.13	0.17	0.21	0.26	0.30
0.82	0.09	0.13	0.17	0.22	0.26	0.31
0.84	0.09	0.13	0.18	0.23	0.27	0.32
0.86	0.09	0.14	0.18	0.23	0.28	0.32
0.88	0.09	0.14	0.19	0.23	0.28	0.33
0.90	0.09	0.14	0.19	0.24	0.29	0.34
0.92	0.10	0.14	0.19	0.24	0.29	0.34
0.94	0.10	0.15	0.20	0.25	0.30	0.35
0.96	0.10	0.15	0.20	0.25	0.30	0.35
0.98	0.10	0.15	0.20	0.26	0.31	0.36

Table 4.3.2-5b ($p_1 = 2 \text{ atm}$)

Normalized Relative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 2 \text{ atm}$
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.02	0.08	0.12	0.16	0.20	0.25
0.04	0.04	0.08	0.12	0.16	0.20	0.25
0.06	0.04	0.08	0.12	0.16	0.21	0.25
0.08	0.04	0.08	0.12	0.16	0.21	0.25
0.10	0.04	0.08	0.12	0.16	0.21	0.25
0.12	0.04	0.08	0.12	0.16	0.21	0.25
0.14	0.05	0.08	0.12	0.17	0.21	0.25
0.16	0.05	0.09	0.13	0.17	0.21	0.25
0.18	0.05	0.09	0.13	0.17	0.21	0.25
0.20	0.02	0.09	0.13	0.17	0.21	0.25
0.22	0.02	0.09	0.13	0.17	0.21	0.25
0.24	0.02	0.04	0.13	0.17	0.21	0.25
0.26	0.02	0.04	0.12	0.17	0.21	0.25
0.28	0.03	0.04	0.07	0.11	0.20	0.25
0.30	0.03	0.04	0.07	0.11	0.14	0.19
0.32	0.03	0.05	0.07	0.11	0.14	0.19
0.34	0.03	0.05	0.08	0.11	0.14	0.19
0.36	0.03	0.05	0.08	0.11	0.15	0.19
0.38	0.03	0.05	0.08	0.11	0.15	0.19
0.40	0.04	0.06	0.08	0.11	0.15	0.19
0.42	0.04	0.06	0.08	0.12	0.15	0.19
0.44	0.04	0.06	0.09	0.12	0.15	0.19
0.46	0.04	0.07	0.09	0.12	0.15	0.19
0.48	0.04	0.07	0.09	0.12	0.16	0.19
0.50	0.05	0.07	0.10	0.13	0.16	0.20
0.52	0.05	0.07	0.10	0.13	0.16	0.20
0.54	0.05	0.08	0.10	0.13	0.16	0.20
0.56	0.05	0.08	0.11	0.14	0.17	0.21
0.58	0.05	0.08	0.11	0.14	0.17	0.21
0.60	0.05	0.08	0.11	0.14	0.18	0.21
0.62	0.06	0.09	0.12	0.15	0.18	0.22
0.64	0.06	0.09	0.12	0.15	0.19	0.22
0.66	0.06	0.09	0.12	0.16	0.19	0.23
0.68	0.06	0.09	0.13	0.16	0.19	0.23
0.70	0.06	0.10	0.13	0.16	0.20	0.24
0.72	0.06	0.10	0.13	0.17	0.20	0.24
0.74	0.07	0.10	0.13	0.17	0.21	0.25
0.76	0.07	0.10	0.14	0.18	0.21	0.25
0.78	0.07	0.10	0.14	0.18	0.22	0.26
0.80	0.07	0.11	0.14	0.18	0.22	0.26
0.82	0.07	0.11	0.15	0.19	0.22	0.26
0.84	0.07	0.11	0.15	0.19	0.23	0.27
0.86	0.08	0.11	0.15	0.19	0.23	0.27
0.88	0.08	0.12	0.16	0.20	0.24	0.28
0.90	0.08	0.12	0.16	0.20	0.24	0.28
0.92	0.08	0.12	0.16	0.20	0.24	0.29
0.94	0.08	0.12	0.16	0.21	0.25	0.29
0.96	0.08	0.13	0.17	0.21	0.25	0.30
0.98	0.08	0.13	0.17	0.21	0.25	0.30

Table 4.3.2-5c (p₁ = 1 atm)

Normalized Rerative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at P₁ = 1 atm
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.03	0.08	0.12	0.16	0.20	0.25
0.04	0.04	0.08	0.12	0.16	0.20	0.24
0.06	0.04	0.08	0.12	0.16	0.20	0.24
0.08	0.04	0.08	0.12	0.16	0.20	0.24
0.10	0.04	0.08	0.12	0.16	0.20	0.24
0.12	0.04	0.08	0.12	0.16	0.20	0.24
0.14	0.04	0.08	0.12	0.16	0.20	0.24
0.16	0.04	0.08	0.12	0.16	0.20	0.24
0.18	0.04	0.08	0.12	0.16	0.20	0.24
0.20	0.05	0.08	0.12	0.16	0.20	0.24
0.22	0.02	0.08	0.12	0.16	0.20	0.24
0.24	0.02	0.08	0.12	0.16	0.20	0.24
0.26	0.02	0.04	0.12	0.16	0.20	0.24
0.28	0.03	0.04	0.06	0.16	0.20	0.24
0.30	0.03	0.04	0.06	0.10	0.13	0.17
0.32	0.03	0.04	0.07	0.10	0.13	0.17
0.34	0.03	0.05	0.07	0.10	0.13	0.17
0.36	0.03	0.05	0.07	0.10	0.13	0.17
0.38	0.03	0.05	0.07	0.10	0.14	0.17
0.40	0.04	0.05	0.08	0.10	0.14	0.17
0.42	0.04	0.06	0.08	0.11	0.14	0.17
0.44	0.04	0.06	0.08	0.11	0.14	0.18
0.46	0.04	0.06	0.09	0.11	0.14	0.18
0.48	0.04	0.07	0.09	0.12	0.14	0.18
0.50	0.05	0.07	0.09	0.12	0.15	0.18
0.52	0.05	0.07	0.10	0.12	0.15	0.19
0.54	0.05	0.07	0.10	0.13	0.16	0.19
0.56	0.05	0.08	0.10	0.13	0.16	0.19
0.58	0.05	0.08	0.11	0.14	0.17	0.20
0.60	0.05	0.08	0.11	0.14	0.17	0.21
0.62	0.06	0.08	0.11	0.14	0.18	0.21
0.64	0.06	0.09	0.12	0.15	0.18	0.22
0.66	0.06	0.09	0.12	0.15	0.19	0.22
0.68	0.06	0.09	0.13	0.16	0.19	0.23
0.70	0.06	0.09	0.13	0.16	0.20	0.23
0.72	0.06	0.10	0.13	0.17	0.20	0.24
0.74	0.07	0.10	0.13	0.17	0.21	0.24
0.76	0.07	0.10	0.14	0.17	0.21	0.25
0.78	0.07	0.10	0.14	0.18	0.21	0.25
0.80	0.07	0.11	0.14	0.18	0.22	0.26
0.82	0.07	0.11	0.15	0.19	0.22	0.26
0.84	0.07	0.11	0.15	0.19	0.23	0.27
0.86	0.08	0.11	0.15	0.19	0.23	0.27
0.88	0.08	0.12	0.16	0.20	0.24	0.28
0.90	0.08	0.12	0.16	0.20	0.24	0.28
0.92	0.08	0.12	0.16	0.20	0.24	0.29
0.94	0.08	0.12	0.16	0.21	0.25	0.29
0.96	0.08	0.13	0.17	0.21	0.25	0.30
0.98	0.08	0.13	0.17	0.21	0.25	0.30

Table 4.3.2-5d ($p_1 = 0.05 \text{ atm}$)

Normalized Relative Velocity of Air at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 0.05 \text{ atm}$
DC Motor Case

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	NA	NA	NA	NA	NA	NA
0.02	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.03	0.00	0.00	0.00	0.00	0.00
0.06	0.03	0.06	0.10	0.00	0.00	0.00
0.08	0.02	0.06	0.10	0.14	0.18	0.22
0.10	0.02	0.06	0.10	0.13	0.17	0.21
0.12	0.02	0.06	0.09	0.13	0.17	0.21
0.14	0.02	0.06	0.09	0.13	0.16	0.20
0.16	0.02	0.05	0.09	0.13	0.16	0.20
0.18	0.02	0.05	0.09	0.12	0.16	0.19
0.20	0.02	0.05	0.08	0.12	0.15	0.19
0.22	0.02	0.05	0.08	0.12	0.15	0.18
0.24	0.02	0.05	0.08	0.11	0.14	0.18
0.26	0.01	0.05	0.08	0.11	0.14	0.17
0.28	0.01	0.05	0.08	0.11	0.14	0.17
0.30	0.01	0.01	0.07	0.10	0.13	0.17
0.32	0.01	0.01	0.07	0.10	0.13	0.16
0.34	0.02	0.01	0.07	0.10	0.13	0.16
0.36	0.02	0.02	0.02	0.10	0.12	0.15
0.38	0.02	0.02	0.02	0.09	0.12	0.15
0.40	0.02	0.02	0.02	0.09	0.12	0.14
0.42	0.03	0.02	0.02	0.04	0.11	0.14
0.44	0.03	0.03	0.03	0.04	0.11	0.13
0.46	0.03	0.03	0.03	0.03	0.11	0.13
0.48	0.03	0.03	0.03	0.03	0.05	0.13
0.50	0.03	0.04	0.03	0.04	0.05	0.12
0.52	0.04	0.04	0.04	0.04	0.05	0.07
0.54	0.04	0.04	0.04	0.04	0.05	0.06
0.56	0.04	0.05	0.05	0.05	0.05	0.06
0.58	0.04	0.05	0.06	0.06	0.05	0.06
0.60	0.05	0.06	0.06	0.06	0.06	0.06
0.62	0.05	0.06	0.07	0.07	0.07	0.07
0.64	0.05	0.07	0.08	0.08	0.08	0.08
0.66	0.05	0.07	0.08	0.09	0.09	0.09
0.68	0.06	0.08	0.09	0.10	0.10	0.11
0.70	0.06	0.08	0.10	0.11	0.12	0.12
0.72	0.06	0.09	0.11	0.12	0.13	0.14
0.74	0.06	0.09	0.11	0.13	0.15	0.16
0.76	0.07	0.10	0.12	0.14	0.16	0.18
0.78	0.07	0.10	0.13	0.15	0.18	0.20
0.80	0.07	0.10	0.13	0.16	0.19	0.21
0.82	0.07	0.11	0.14	0.17	0.20	0.23
0.84	0.07	0.11	0.14	0.18	0.21	0.24
0.86	0.08	0.11	0.15	0.19	0.22	0.26
0.88	0.08	0.12	0.15	0.19	0.23	0.27
0.90	0.08	0.12	0.16	0.20	0.24	0.28
0.92	0.08	0.12	0.16	0.20	0.24	0.28
0.94	0.08	0.12	0.16	0.21	0.25	0.29
0.96	0.08	0.13	0.17	0.21	0.25	0.29
0.98	0.08	0.13	0.17	0.21	0.25	0.30

Table 4.3.2-2a Homologous Torque at $p_1 = 3$ atm (DC Motor)

Inlet Vold	Homologous Flow Parameter ν/α_N					
	0.400	0.600	0.800	1.000	1.200	1.400
0.000	0.627	0.743	0.862	1.000	1.179	1.427
0.020	0.617	0.732	0.854	0.992	1.169	1.414
0.040	0.605	0.725	0.841	0.983	1.158	1.402
0.060	0.592	0.715	0.833	0.973	1.146	1.388
0.080	0.584	0.708	0.825	0.958	1.136	1.376
0.100	0.579	0.697	0.817	0.949	1.124	1.364
0.120	0.570	0.691	0.804	0.939	1.114	1.350
0.140	0.562	0.681	0.797	0.930	1.102	1.338
0.160	0.557	0.674	0.789	0.920	1.092	1.325
0.180	0.512	0.668	0.782	0.912	1.080	1.313
0.200	0.210	0.663	0.775	0.902	1.070	1.300
0.220	0.189	0.644	0.762	0.893	1.059	1.287
0.240	0.182	0.304	0.750	0.883	1.041	1.275
0.260	0.179	0.272	0.466	0.860	1.024	1.258
0.280	0.175	0.254	0.420	0.599	0.991	1.225
0.300	0.174	0.238	0.389	0.557	0.739	0.967
0.320	0.170	0.223	0.356	0.522	0.700	0.924
0.340	0.169	0.212	0.327	0.482	0.662	0.882
0.360	0.165	0.202	0.300	0.448	0.617	0.838
0.380	0.165	0.193	0.278	0.413	0.577	0.793
0.400	0.162	0.182	0.257	0.379	0.537	0.747
0.420	0.161	0.177	0.237	0.346	0.496	0.701
0.440	0.161	0.171	0.222	0.318	0.456	0.653
0.460	0.158	0.165	0.205	0.291	0.422	0.606
0.480	0.158	0.159	0.193	0.263	0.384	0.559
0.500	0.158	0.157	0.179	0.244	0.352	0.520
0.520	0.158	0.152	0.169	0.223	0.321	0.481
0.540	0.155	0.148	0.161	0.207	0.294	0.437
0.560	0.155	0.146	0.155	0.190	0.267	0.403
0.580	0.156	0.143	0.148	0.177	0.244	0.370
0.600	0.153	0.142	0.142	0.165	0.226	0.347
0.620	0.153	0.142	0.136	0.156	0.211	0.319
0.640	0.154	0.138	0.131	0.147	0.193	0.301
0.660	0.154	0.138	0.129	0.140	0.182	0.278
0.680	0.151	0.135	0.125	0.133	0.171	0.263
0.700	0.152	0.135	0.124	0.127	0.162	0.251
0.720	0.152	0.136	0.121	0.125	0.155	0.240
0.740	0.153	0.133	0.121	0.120	0.148	0.230
0.760	0.149	0.134	0.118	0.116	0.146	0.222
0.780	0.150	0.135	0.119	0.116	0.141	0.215
0.800	0.151	0.131	0.115	0.113	0.137	0.209
0.820	0.153	0.133	0.117	0.114	0.138	0.204
0.840	0.155	0.129	0.113	0.111	0.135	0.207
0.860	0.148	0.131	0.116	0.114	0.131	0.204
0.880	0.150	0.134	0.112	0.111	0.136	0.199
0.900	0.153	0.127	0.116	0.108	0.133	0.194
0.920	0.158	0.131	0.123	0.113	0.130	0.209
0.940	0.165	0.139	0.116	0.108	0.141	0.204
0.960	0.145	0.149	0.130	0.125	0.140	0.200
0.980	0.162	0.140	0.130	0.113	0.203	0.280

Table 4.3.2-2b Homologous Torque at $p_1 = 2$ atm (DC Motor)

		Homologous Flow Parameter v/α_N						
Inlet								
Void	0.400	0.600	0.800	1.000	1.200	1.400		
0.000	0.627	0.743	0.862	1.000	1.179	1.427		
0.020	0.617	0.733	0.855	0.993	1.170	1.416		
0.040	0.605	0.726	0.847	0.984	1.160	1.404		
0.060	0.596	0.719	0.839	0.976	1.150	1.401		
0.080	0.588	0.709	0.827	0.967	1.140	1.390		
0.100	0.580	0.703	0.820	0.957	1.136	1.378		
0.120	0.575	0.697	0.813	0.949	1.126	1.367		
0.140	0.567	0.687	0.806	0.941	1.116	1.355		
0.160	0.562	0.681	0.798	0.932	1.106	1.344		
0.180	0.554	0.675	0.791	0.923	1.095	1.332		
0.200	0.217	0.670	0.784	0.915	1.086	1.320		
0.220	0.189	0.658	0.777	0.906	1.076	1.308		
0.240	0.182	0.312	0.762	0.896	1.065	1.297		
0.260	0.179	0.273	0.739	0.877	1.052	1.282		
0.280	0.175	0.255	0.429	0.614	1.025	1.263		
0.300	0.173	0.238	0.393	0.575	0.764	1.001		
0.320	0.170	0.226	0.363	0.535	0.719	0.949		
0.340	0.169	0.212	0.334	0.495	0.680	0.906		
0.360	0.165	0.202	0.306	0.459	0.634	0.861		
0.380	0.165	0.193	0.279	0.423	0.593	0.816		
0.400	0.161	0.185	0.258	0.384	0.551	0.770		
0.420	0.161	0.177	0.238	0.354	0.510	0.721		
0.440	0.161	0.171	0.223	0.321	0.468	0.672		
0.460	0.158	0.165	0.206	0.294	0.427	0.623		
0.480	0.158	0.159	0.193	0.269	0.388	0.574		
0.500	0.158	0.157	0.179	0.245	0.355	0.526		
0.520	0.158	0.152	0.169	0.224	0.324	0.486		
0.540	0.155	0.148	0.161	0.207	0.295	0.448		
0.560	0.155	0.146	0.155	0.190	0.269	0.406		
0.580	0.155	0.142	0.148	0.177	0.244	0.372		
0.600	0.153	0.141	0.142	0.165	0.227	0.348		
0.620	0.153	0.141	0.136	0.156	0.211	0.320		
0.640	0.153	0.138	0.131	0.147	0.194	0.300		
0.660	0.154	0.138	0.129	0.139	0.181	0.278		
0.680	0.150	0.135	0.125	0.132	0.171	0.263		
0.700	0.151	0.135	0.124	0.126	0.162	0.250		
0.720	0.152	0.136	0.120	0.125	0.154	0.239		
0.740	0.153	0.132	0.120	0.120	0.147	0.230		
0.760	0.149	0.133	0.117	0.115	0.146	0.221		
0.780	0.150	0.135	0.118	0.116	0.141	0.214		
0.800	0.151	0.131	0.114	0.112	0.136	0.208		
0.820	0.153	0.133	0.113	0.113	0.137	0.202		
0.840	0.155	0.128	0.113	0.110	0.133	0.206		
0.860	0.147	0.130	0.115	0.113	0.130	0.202		
0.880	0.149	0.133	0.111	0.110	0.134	0.198		
0.900	0.152	0.126	0.114	0.106	0.131	0.193		
0.920	0.157	0.130	0.120	0.111	0.127	0.204		
0.940	0.163	0.136	0.114	0.105	0.138	0.200		
0.960	0.144	0.147	0.127	0.118	0.136	0.194		
0.980	0.156	0.129	0.126	0.112	0.197	0.256		

Table 4.3.2-2c Homologous Torque at $p_1 = 1$ atm (DC Motor)

		Homologous Flow Parameter v/c_N					
Inlet		0.400	0.600	0.800	1.000	1.200	1.400
Void							
0.000	0.627	0.743	0.862	1.000	1.179	1.427	
0.020	0.618	0.737	0.856	0.995	1.172	1.426	
0.040	0.610	0.732	0.850	0.993	1.171	1.419	
0.060	0.602	0.726	0.844	0.986	1.164	1.418	
0.080	0.597	0.721	0.842	0.979	1.162	1.410	
0.100	0.589	0.715	0.836	0.978	1.155	1.401	
0.120	0.585	0.710	0.830	0.970	1.146	1.401	
0.140	0.580	0.705	0.823	0.963	1.145	1.391	
0.160	0.573	0.696	0.817	0.956	1.137	1.383	
0.180	0.569	0.690	0.810	0.949	1.129	1.382	
0.200	0.563	0.685	0.804	0.947	1.121	1.373	
0.220	0.561	0.680	0.803	0.940	1.119	1.364	
0.240	0.562	0.672	0.796	0.933	1.111	1.354	
0.260	0.579	0.379	0.788	0.924	1.101	1.343	
0.280	0.575	0.260	0.452	0.912	1.090	1.341	
0.300	0.573	0.240	0.414	0.615	0.818	1.081	
0.320	0.570	0.228	0.378	0.573	0.779	1.027	
0.340	0.568	0.213	0.347	0.531	0.733	0.984	
0.360	0.565	0.203	0.317	0.488	0.684	0.939	
0.380	0.564	0.194	0.289	0.446	0.642	0.884	
0.400	0.561	0.185	0.265	0.407	0.591	0.833	
0.420	0.561	0.178	0.245	0.370	0.545	0.774	
0.440	0.561	0.171	0.225	0.335	0.494	0.722	
0.460	0.558	0.165	0.207	0.301	0.450	0.667	
0.480	0.557	0.159	0.194	0.274	0.407	0.607	
0.500	0.557	0.156	0.180	0.249	0.370	0.561	
0.520	0.556	0.152	0.170	0.226	0.332	0.509	
0.540	0.555	0.147	0.161	0.209	0.301	0.460	
0.560	0.555	0.146	0.155	0.191	0.272	0.421	
0.580	0.552	0.141	0.141	0.178	0.251	0.385	
0.600	0.552	0.141	0.141	0.166	0.228	0.353	
0.620	0.553	0.141	0.136	0.155	0.211	0.323	
0.640	0.553	0.137	0.131	0.147	0.194	0.302	
0.660	0.554	0.137	0.129	0.139	0.181	0.278	
0.680	0.550	0.134	0.124	0.132	0.170	0.263	
0.700	0.551	0.135	0.124	0.126	0.161	0.249	
0.720	0.552	0.135	0.120	0.124	0.154	0.239	
0.740	0.553	0.132	0.120	0.119	0.146	0.229	
0.760	0.554	0.133	0.116	0.115	0.144	0.221	
0.780	0.554	0.134	0.117	0.115	0.139	0.213	
0.800	0.551	0.130	0.114	0.111	0.135	0.207	
0.820	0.552	0.132	0.115	0.112	0.135	0.205	
0.840	0.554	0.127	0.112	0.109	0.122	0.205	
0.860	0.554	0.129	0.114	0.111	0.128	0.199	
0.880	0.551	0.125	0.113	0.108	0.126	0.195	
0.900	0.551	0.125	0.113	0.103	0.126	0.190	
0.920	0.555	0.126	0.116	0.108	0.124	0.202	
0.940	0.561	0.134	0.121	0.102	0.134	0.196	
0.960	0.560	0.140	0.121	0.113	0.139	0.186	
0.980	0.560	0.146	0.124	0.111	0.169	0.245	

Table 4.3.2-2d Homologous Torque at $p_1 = 0.05$ atm (DC Motor)

		Homologous Flow Parameter v/a_N					
Inlet Void	0.400	0.600	0.800	1.000	1.200	1.400	
0.000	0.627	0.743	0.862	1.000	1.179	1.427	
0.020	0.632	0.750	0.872	1.014	1.195	1.447	
0.040	0.634	0.757	0.881	1.026	1.211	1.468	
0.060	0.637	0.761	0.887	1.036	1.227	1.489	
0.080	0.639	0.765	0.893	1.048	1.241	1.508	
0.100	0.641	0.773	0.903	1.056	1.253	1.522	
0.120	0.643	0.778	0.914	1.071	1.271	1.547	
0.140	0.646	0.782	0.921	1.079	1.290	1.572	
0.160	0.648	0.791	0.932	1.094	1.302	1.589	
0.180	0.651	0.795	0.938	1.103	1.322	1.615	
0.200	0.654	0.800	0.946	1.119	1.335	1.642	
0.220	0.652	0.809	0.958	1.128	1.356	1.660	
0.240	0.655	0.814	0.965	1.146	1.370	1.689	
0.260	0.183	0.819	0.972	1.156	1.392	1.709	
0.280	0.178	0.824	0.986	1.174	1.407	1.739	
0.300	0.175	0.822	0.993	1.185	1.431	1.760	
0.320	0.171	0.828	0.987	1.188	1.444	1.780	
0.340	0.169	0.826	0.982	1.195	1.452	1.803	
0.360	0.166	0.828	0.989	1.200	1.464	1.821	
0.380	0.165	0.820	0.982	1.203	1.475	1.841	
0.400	0.162	0.820	0.983	1.199	1.484	1.859	
0.420	0.161	0.819	0.985	0.873	1.491	1.875	
0.440	0.161	0.812	0.986	0.789	1.491	1.888	
0.460	0.158	0.817	0.988	0.688	1.472	1.898	
0.480	0.157	0.816	0.988	0.572	1.084	1.899	
0.500	0.157	0.816	0.988	0.467	0.975	1.862	
0.520	0.157	0.815	0.988	0.379	0.840	1.423	
0.540	0.155	0.815	0.983	0.309	0.680	1.285	
0.560	0.155	0.814	0.983	0.261	0.532	1.109	
0.580	0.155	0.814	0.983	0.226	0.419	0.884	
0.600	0.152	0.814	0.983	0.198	0.340	0.685	
0.620	0.152	0.814	0.983	0.176	0.284	0.528	
0.640	0.153	0.817	0.983	0.161	0.239	0.429	
0.660	0.153	0.817	0.983	0.149	0.209	0.360	
0.680	0.150	0.813	0.983	0.125	0.189	0.314	
0.700	0.151	0.813	0.983	0.123	0.174	0.279	
0.720	0.151	0.813	0.983	0.119	0.162	0.257	
0.740	0.152	0.813	0.983	0.119	0.152	0.235	
0.760	0.148	0.813	0.983	0.115	0.145	0.223	
0.780	0.149	0.813	0.983	0.116	0.139	0.214	
0.800	0.150	0.813	0.983	0.114	0.133	0.206	
0.820	0.152	0.813	0.983	0.114	0.130	0.199	
0.840	0.153	0.813	0.983	0.110	0.125	0.192	
0.860	0.146	0.813	0.983	0.109	0.125	0.192	
0.880	0.146	0.813	0.983	0.105	0.125	0.186	
0.900	0.150	0.813	0.983	0.100	0.125	0.186	
0.920	0.153	0.813	0.983	0.105	0.120	0.190	
0.940	0.159	0.813	0.983	0.107	0.120	0.190	
0.960	0.136	0.813	0.983	0.105	0.120	0.190	
0.980	0.137	0.813	0.993	0.085	0.145	0.215	

Table 4.5.2-1a ($p_1 = 3 \text{ atm}$)

Inlet Void Fraction α_1	Static Pressure Increase, ($p_2 - p_1$) (psi)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	22.589	22.357	22.131	21.911	21.693	21.478	21.264
0.02	0.745	21.740	21.627	21.459	21.262	21.067	20.874
0.04	0.586	21.140	21.128	21.009	20.846	20.681	20.511
0.06	0.612	20.550	20.633	20.559	20.426	20.291	20.143
0.08	0.743	19.979	20.141	20.109	20.004	19.896	19.769
0.10	0.899	19.425	19.653	19.657	19.578	19.495	19.390
0.12	0.998	18.883	19.168	19.205	19.150	19.089	19.005
0.14	0.959	18.353	18.686	18.753	18.719	18.677	18.614
0.16	0.469	17.833	18.205	18.299	18.287	18.262	18.219
0.18	0.398	17.256	17.728	17.846	17.852	17.842	17.819
0.20	0.356	4.249	17.253	17.390	17.414	17.418	17.412
0.22	0.324	2.324	16.704	16.936	16.974	16.992	17.003
0.24	0.296	1.859	7.211	16.406	16.519	16.557	16.587
0.26	0.274	1.618	5.503	11.365	15.950	16.064	16.136
0.28	0.251	1.419	4.730	9.042	11.539	15.441	15.572
0.30	0.231	1.250	4.081	8.006	10.492	11.676	12.298
0.32	0.215	1.104	3.525	7.046	9.557	10.833	11.502
0.34	0.200	0.977	3.046	6.163	8.635	9.993	10.724
0.36	0.186	0.868	2.633	5.361	7.736	9.150	9.939
0.38	0.174	0.770	2.276	4.640	6.870	8.309	9.146
0.40	0.163	0.684	1.967	4.001	6.046	7.477	8.350
0.42	0.152	0.607	1.700	3.443	5.278	6.666	7.557
0.44	0.142	0.539	1.469	2.948	4.574	5.886	6.776
0.46	0.133	0.479	1.268	2.518	3.943	5.151	6.021
0.48	0.125	0.424	1.094	2.144	3.371	4.475	5.304
0.50	0.117	0.378	0.942	1.822	2.864	3.841	4.610
0.52	0.110	0.335	0.811	1.543	2.420	3.266	3.960
0.54	0.104	0.296	0.697	1.303	2.034	2.754	3.364
0.56	0.098	0.263	0.598	1.098	1.700	2.303	2.825
0.58	0.092	0.233	0.512	0.922	1.412	1.910	2.348
0.60	0.087	0.206	0.437	0.770	1.167	1.571	1.929
0.62	0.082	0.183	0.373	0.642	0.959	1.280	1.566
0.64	0.078	0.162	0.317	0.531	0.781	1.033	1.255
0.66	0.074	0.145	0.268	0.438	0.632	0.825	0.991
0.68	0.071	0.128	0.228	0.359	0.507	0.649	0.770
0.70	0.067	0.114	0.193	0.293	0.403	0.505	0.585
0.72	0.064	0.103	0.163	0.238	0.316	0.386	0.435
0.74	0.061	0.092	0.138	0.192	0.245	0.289	0.313
0.76	0.059	0.083	0.117	0.155	0.188	0.210	0.216
0.78	0.056	0.075	0.099	0.123	0.142	0.149	0.139
0.80	0.054	0.068	0.085	0.100	0.107	0.102	0.083
0.82	0.052	0.064	0.075	0.081	0.079	0.067	0.041
0.84	0.050	0.059	0.065	0.067	0.060	0.042	0.012
0.86	0.049	0.055	0.058	0.056	0.045	0.026	-0.005
0.88	0.047	0.051	0.053	0.049	0.037	0.017	-0.013
0.90	0.045	0.048	0.049	0.044	0.032	0.014	-0.013
0.92	0.044	0.046	0.046	0.040	0.031	0.015	-0.008
0.94	0.043	0.044	0.044	0.039	0.032	0.020	0.002
0.96	0.041	0.042	0.042	0.039	0.035	0.026	0.015
0.98	0.040	0.040	0.041	0.040	0.038	0.035	0.030

Table 4.5.2-1a (p₁ = 3 atm)
(continued)

Inlet Void Fraction α_1	v_{12} Liquid Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	2.251	4.503	6.754	9.005	11.256	13.508	15.759
0.02	2.253	4.487	6.738	8.982	11.219	13.429	15.671
0.04	2.252	4.476	6.721	8.957	11.183	13.352	15.584
0.06	2.246	4.466	6.704	8.934	11.148	13.277	15.500
0.08	2.237	4.457	6.689	8.911	11.116	13.206	15.419
0.10	2.221	4.450	6.674	8.889	11.087	13.144	15.341
0.12	2.215	4.445	6.660	8.869	11.058	13.096	15.266
0.14	2.205	4.440	6.648	8.851	11.034	13.055	15.194
0.16	2.200	4.435	6.638	8.835	11.011	13.021	15.126
0.18	2.200	4.431	6.629	8.822	10.992	12.992	15.061
0.20	2.190	4.371	6.623	8.811	10.975	12.969	14.999
0.22	2.180	4.378	6.620	8.803	10.961	12.951	14.941
0.24	2.171	4.371	6.554	8.799	10.951	12.938	14.887
0.26	2.172	4.360	6.590	8.583	10.939	12.910	14.839
0.28	2.163	4.348	6.595	8.647	10.702	12.799	14.800
0.30	2.150	4.336	6.589	8.666	10.716	12.806	14.920
0.32	2.151	4.324	6.538	8.685	10.730	12.811	14.917
0.34	2.146	4.311	6.492	8.704	10.750	12.822	14.919
0.36	2.140	4.298	6.473	8.718	10.773	12.839	14.926
0.38	2.134	4.285	6.456	8.719	10.797	12.860	14.939
0.40	2.128	4.272	6.439	8.683	10.817	12.882	14.954
0.42	2.121	4.259	6.422	8.574	10.824	12.901	14.965
0.44	2.115	4.245	6.404	8.544	10.791	12.904	14.962
0.46	2.109	4.232	6.385	8.521	10.646	12.851	14.895
0.48	2.102	4.218	6.365	8.499	10.605	12.690	14.730
0.50	2.096	4.205	6.344	8.476	10.579	12.650	14.690
0.52	2.089	4.192	6.323	8.451	10.554	12.624	14.666
0.54	2.083	4.179	6.301	8.424	10.527	12.599	14.643
0.56	2.077	4.166	6.279	8.396	10.497	12.570	14.617
0.58	2.071	4.153	6.257	8.366	10.463	12.537	14.586
0.60	2.065	4.140	6.235	8.336	10.428	12.500	14.548
0.62	2.059	4.128	6.213	8.305	10.390	12.458	14.505
0.64	2.054	4.115	6.191	8.274	10.350	12.413	14.457
0.66	2.048	4.103	6.170	8.242	10.310	12.366	14.404
0.68	2.043	4.091	6.149	8.211	10.270	12.318	14.350
0.70	2.037	4.078	6.128	8.181	10.230	12.269	14.295
0.72	2.031	4.066	6.107	8.151	10.191	12.221	14.240
0.74	2.026	4.054	6.087	8.122	10.152	12.175	14.187
0.76	2.020	4.042	6.067	8.093	10.115	12.130	14.136
0.78	2.015	4.030	6.048	8.065	10.079	12.086	14.087
0.80	2.009	4.018	6.029	8.038	10.044	12.044	14.040
0.82	2.003	4.006	6.010	8.012	10.010	12.003	13.994
0.84	1.998	3.995	5.991	7.985	9.976	11.964	13.949
0.86	1.992	3.983	5.973	7.960	9.944	11.925	13.905
0.88	1.986	3.971	5.954	7.935	9.912	11.886	13.862
0.90	1.981	3.960	5.936	7.910	9.880	11.848	13.818
0.92	1.975	3.948	5.919	7.886	9.849	11.811	13.774
0.94	1.970	3.937	5.902	7.862	9.819	11.774	13.731
0.96	1.964	3.926	5.885	7.839	9.789	11.737	13.687
0.98	1.959	3.916	5.868	7.816	9.759	11.701	13.643

Table 4.5.2-1a ($p_1 = 3 \text{ atm}$)
(continued)

Inlet Void Fraction α_1	v_{g2} Gas Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	2.048	3.424	4.724	6.515	8.671	12.462	14.627
0.04	2.144	3.429	4.761	6.550	8.652	12.392	14.546
0.06	2.249	3.433	4.791	6.579	8.650	12.324	14.468
0.08	2.343	3.437	4.815	6.602	8.637	12.258	14.393
0.10	2.420	3.441	4.835	6.622	8.627	12.104	14.321
0.12	2.437	3.445	4.852	6.638	8.626	11.897	14.251
0.14	2.461	3.448	4.866	6.650	8.618	11.710	14.184
0.16	2.493	3.451	4.877	6.661	8.617	11.549	14.120
0.18	2.520	3.453	4.888	6.670	8.611	11.411	14.060
0.20	2.516	4.550	4.897	6.679	8.611	11.293	14.002
0.22	2.512	4.693	4.910	6.686	8.611	11.192	13.948
0.24	2.510	4.726	6.163	6.700	8.612	11.107	13.898
0.26	2.517	4.746	6.254	7.981	8.648	11.106	13.853
0.28	2.510	4.762	6.321	8.072	9.976	11.369	13.821
0.30	2.497	4.775	6.407	8.122	10.011	11.999	14.057
0.32	2.497	4.785	6.584	8.181	10.052	12.029	14.083
0.34	2.490	4.793	6.729	8.251	10.105	12.070	14.119
0.36	2.483	4.799	6.797	8.334	10.171	12.125	14.169
0.38	2.475	4.803	6.850	8.435	10.251	12.195	14.235
0.40	2.468	4.805	6.894	8.587	10.347	12.282	14.321
0.42	2.460	4.806	6.931	8.837	10.466	12.389	14.430
0.44	2.453	4.805	6.962	8.942	10.635	12.527	14.574
0.46	2.446	4.802	6.989	9.022	10.939	12.736	14.806
0.48	2.438	4.799	7.011	9.089	11.080	13.066	15.153
0.50	2.431	4.794	7.028	9.146	11.187	13.225	15.329
0.52	2.424	4.787	7.042	9.195	11.279	13.355	15.478
0.54	2.416	4.780	7.052	9.236	11.358	13.469	15.615
0.56	2.409	4.772	7.059	9.270	11.427	13.571	15.741
0.58	2.401	4.763	7.062	9.297	11.486	13.661	15.856
0.60	2.394	4.754	7.062	9.317	11.534	13.739	15.960
0.62	2.386	4.743	7.059	9.332	11.573	13.805	16.049
0.64	2.378	4.733	7.054	9.340	11.603	13.858	16.124
0.66	2.370	4.721	7.046	9.344	11.623	13.898	16.184
0.68	2.363	4.710	7.036	9.343	11.636	13.927	16.229
0.70	2.355	4.698	7.025	9.337	11.641	13.945	16.259
0.72	2.348	4.685	7.011	9.327	11.638	13.952	16.275
0.74	2.341	4.673	6.997	9.314	11.630	13.949	16.279
0.76	2.333	4.660	6.981	9.299	11.616	13.939	16.271
0.78	2.326	4.647	6.964	9.280	11.598	13.921	16.253
0.80	2.319	4.633	6.947	9.260	11.575	13.897	16.227
0.82	2.312	4.620	6.928	9.237	11.550	13.868	16.194
0.84	2.305	4.607	6.909	9.214	11.521	13.835	16.155
0.86	2.297	4.593	6.890	9.188	11.491	13.798	16.112
0.88	2.290	4.580	6.870	9.162	11.458	13.759	16.065
0.90	2.283	4.566	6.850	9.135	11.425	13.717	16.015
0.92	2.276	4.552	6.829	9.108	11.390	13.674	15.963
0.94	2.269	4.538	6.809	9.080	11.354	13.630	15.909
0.96	2.263	4.525	6.788	9.052	11.318	13.585	15.854
0.98	2.255	4.511	6.767	9.024	11.281	13.539	15.799

Table 4.5.2-1a ($p_1 = 3 \text{ atm}$)
(continued)

Inlet Void Fraction α_1	α_2 Void Fraction						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.022	0.017	0.018	0.017	0.017	0.014	0.014
0.04	0.041	0.035	0.035	0.035	0.034	0.029	0.029
0.06	0.059	0.053	0.053	0.052	0.051	0.044	0.044
0.08	0.089	0.072	0.071	0.070	0.068	0.059	0.060
0.10	0.101	0.090	0.089	0.088	0.086	0.075	0.075
0.12	0.111	0.109	0.108	0.106	0.104	0.092	0.092
0.14	0.119	0.128	0.126	0.125	0.123	0.110	0.108
0.16	0.139	0.147	0.145	0.144	0.141	0.129	0.125
0.18	0.158	0.167	0.165	0.163	0.160	0.147	0.142
0.20	0.176	0.176	0.184	0.182	0.179	0.167	0.159
0.22	0.193	0.197	0.204	0.202	0.199	0.186	0.177
0.24	0.211	0.217	0.218	0.222	0.219	0.207	0.195
0.26	0.230	0.235	0.242	0.223	0.239	0.226	0.214
0.28	0.248	0.254	0.263	0.250	0.242	0.240	0.233
0.30	0.267	0.273	0.283	0.272	0.264	0.262	0.261
0.32	0.287	0.292	0.298	0.295	0.286	0.283	0.282
0.34	0.306	0.310	0.314	0.317	0.309	0.305	0.303
0.36	0.325	0.329	0.333	0.339	0.331	0.326	0.324
0.38	0.344	0.348	0.352	0.360	0.353	0.349	0.346
0.40	0.363	0.367	0.371	0.378	0.375	0.371	0.368
0.42	0.383	0.386	0.390	0.391	0.397	0.393	0.389
0.44	0.402	0.406	0.410	0.410	0.416	0.414	0.410
0.46	0.422	0.425	0.429	0.429	0.429	0.432	0.429
0.48	0.442	0.445	0.448	0.449	0.448	0.446	0.444
0.50	0.462	0.464	0.468	0.469	0.468	0.466	0.464
0.52	0.482	0.484	0.487	0.489	0.488	0.486	0.484
0.54	0.502	0.504	0.507	0.508	0.508	0.507	0.505
0.56	0.522	0.524	0.527	0.528	0.528	0.527	0.526
0.58	0.542	0.544	0.547	0.548	0.548	0.547	0.546
0.60	0.563	0.565	0.567	0.568	0.568	0.568	0.567
0.62	0.584	0.585	0.587	0.588	0.588	0.588	0.587
0.64	0.605	0.606	0.607	0.608	0.608	0.608	0.608
0.66	0.625	0.627	0.628	0.629	0.629	0.629	0.628
0.68	0.647	0.648	0.648	0.649	0.649	0.649	0.649
0.70	0.668	0.669	0.669	0.670	0.670	0.670	0.669
0.72	0.689	0.690	0.690	0.691	0.691	0.690	0.690
0.74	0.711	0.711	0.712	0.712	0.712	0.711	0.711
0.76	0.732	0.733	0.733	0.733	0.733	0.733	0.732
0.78	0.754	0.754	0.754	0.754	0.754	0.754	0.754
0.80	0.776	0.776	0.776	0.776	0.776	0.776	0.775
0.82	0.797	0.798	0.798	0.798	0.798	0.797	0.797
0.84	0.819	0.820	0.820	0.820	0.819	0.819	0.819
0.86	0.842	0.842	0.842	0.842	0.842	0.841	0.841
0.88	0.864	0.864	0.864	0.864	0.864	0.864	0.864
0.90	0.886	0.886	0.886	0.886	0.886	0.886	0.886
0.92	0.909	0.909	0.909	0.909	0.909	0.909	0.908
0.94	0.931	0.931	0.931	0.931	0.931	0.931	0.931
0.96	0.954	0.954	0.954	0.954	0.954	0.954	0.954
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.977

Table 4.5.2-1b ($p_1 = 2$ atm)

Inlet Void Fraction α_1	Static Pressure Increase, ($p_2 - p_1$) (psi)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	22.589	22.357	22.131	21.911	21.693	21.478	21.264
0.02	0.691	21.787	21.679	21.515	21.334	21.152	20.967
0.04	0.656	21.224	21.229	21.115	20.969	20.819	20.660
0.06	0.614	20.678	20.778	20.712	20.598	20.479	20.346
0.08	0.646	20.145	20.327	20.304	20.220	20.130	20.024
0.10	0.868	19.624	19.876	19.892	19.836	19.775	19.692
0.12	1.147	19.112	19.424	19.475	19.446	19.413	19.351
0.14	0.919	18.607	18.972	19.056	19.051	19.042	19.002
0.16	0.456	18.108	18.518	18.631	18.650	18.663	18.645
0.18	0.385	17.615	18.064	18.203	18.244	18.273	18.280
0.20	0.343	5.469	17.608	17.772	17.831	17.878	17.905
0.22	0.311	2.346	17.140	17.338	17.414	17.476	17.523
0.24	0.283	1.849	16.428	16.875	16.986	17.066	17.133
0.26	0.261	1.606	5.595	16.268	16.509	16.623	16.718
0.28	0.238	1.407	4.793	9.377	15.837	16.096	16.250
0.30	0.218	1.238	4.124	8.283	10.960	12.241	12.938
0.32	0.202	1.091	3.553	7.270	9.983	11.373	12.120
0.34	0.187	0.964	3.064	6.337	9.013	10.500	11.319
0.36	0.173	0.854	2.642	5.492	8.061	9.617	10.504
0.38	0.161	0.757	2.279	4.737	7.140	8.728	9.673
0.40	0.150	0.670	1.966	4.070	6.264	7.843	8.829
0.42	0.139	0.594	1.695	3.490	5.447	6.976	7.983
0.44	0.129	0.526	1.462	2.979	4.701	6.140	7.143
0.46	0.120	0.465	1.259	2.537	4.036	5.350	6.323
0.48	0.112	0.411	1.084	2.154	3.438	4.627	5.551
0.50	0.104	0.363	0.932	1.825	2.909	3.956	4.808
0.52	0.097	0.321	0.800	1.542	2.449	3.350	4.111
0.54	0.091	0.283	0.685	1.299	2.050	2.811	3.475
0.56	0.085	0.250	0.585	1.090	1.707	2.341	2.905
0.58	0.079	0.220	0.499	0.912	1.414	1.933	2.401
0.60	0.074	0.193	0.424	0.760	1.164	1.582	1.963
0.62	0.070	0.170	0.360	0.630	0.952	1.284	1.585
0.64	0.065	0.149	0.303	0.519	0.773	1.031	1.263
0.66	0.061	0.131	0.255	0.425	0.621	0.819	0.991
0.68	0.058	0.115	0.215	0.346	0.495	0.641	0.765
0.70	0.054	0.102	0.179	0.279	0.390	0.493	0.577
0.72	0.051	0.090	0.150	0.224	0.302	0.372	0.423
0.74	0.049	0.079	0.124	0.178	0.231	0.275	0.300
0.76	0.046	0.070	0.103	0.141	0.174	0.197	0.201
0.78	0.044	0.063	0.086	0.110	0.128	0.135	0.125
0.80	0.041	0.056	0.073	0.086	0.093	0.087	0.067
0.82	0.039	0.050	0.061	0.067	0.065	0.053	0.025
0.84	0.038	0.046	0.052	0.053	0.045	0.027	-0.003
0.86	0.036	0.042	0.045	0.042	0.031	0.012	-0.020
0.88	0.034	0.038	0.039	0.034	0.023	0.002	-0.029
0.90	0.033	0.035	0.035	0.029	0.018	-0.001	-0.029
0.92	0.031	0.033	0.032	0.027	0.017	0.000	-0.024
0.94	0.030	0.031	0.030	0.026	0.018	0.005	-0.012
0.96	0.028	0.029	0.029	0.026	0.021	0.012	0.000
0.98	0.027	0.027	0.028	0.026	0.024	0.020	0.014

Table 4.5.2-1b ($p_1 = 2 \text{ atm}$)
(continued)

Inlet Void Fraction α_1	v_{12} Liquid Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	2.251	4.503	6.754	9.005	11.256	13.508	15.759
0.02	2.253	4.477	6.718	8.956	11.185	13.401	15.638
0.04	2.252	4.454	6.683	8.908	11.118	13.296	15.519
0.06	2.246	4.432	6.648	8.860	11.055	13.193	15.403
0.08	2.237	4.411	6.614	8.814	10.994	13.092	15.290
0.10	2.223	4.390	6.581	8.769	10.936	12.995	15.179
0.12	2.211	4.371	6.550	8.726	10.880	12.900	15.071
0.14	2.201	4.352	6.520	8.685	10.828	12.808	14.967
0.16	2.198	4.335	6.492	8.647	10.779	12.735	14.866
0.18	2.199	4.320	6.466	8.611	10.733	12.681	14.769
0.20	2.188	4.341	6.443	8.578	10.691	12.633	14.676
0.22	2.178	4.351	6.422	8.548	10.652	12.584	14.587
0.24	2.170	4.347	6.408	8.522	10.617	12.548	14.502
0.26	2.170	4.337	6.485	8.502	10.588	12.513	14.422
0.28	2.161	4.326	6.495	8.435	10.557	12.464	14.350
0.30	2.148	4.315	6.496	8.455	10.412	12.431	14.483
0.32	2.149	4.304	6.460	8.480	10.423	12.425	14.466
0.34	2.145	4.292	6.413	8.508	10.443	12.429	14.457
0.36	2.139	4.281	6.400	8.533	10.472	12.445	14.459
0.38	2.132	4.269	6.388	8.549	10.507	12.471	14.472
0.40	2.126	4.257	6.377	8.536	10.543	12.504	14.494
0.42	2.120	4.244	6.365	8.438	10.571	12.541	14.523
0.44	2.114	4.232	6.352	8.417	10.572	12.572	14.549
0.46	2.107	4.220	6.338	8.406	10.451	12.572	14.550
0.48	2.101	4.207	6.322	8.396	10.419	12.431	14.408
0.50	2.094	4.195	6.306	8.384	10.411	12.400	14.363
0.52	2.088	4.183	6.289	8.369	10.404	12.398	14.365
0.54	2.082	4.170	6.271	8.352	10.394	12.397	14.372
0.56	2.076	4.158	6.252	8.333	10.381	12.393	14.378
0.58	2.070	4.146	6.233	8.311	10.363	12.384	14.378
0.60	2.064	4.134	6.214	8.288	10.342	12.368	14.370
0.62	2.058	4.122	6.195	8.264	10.317	12.347	14.354
0.64	2.053	4.110	6.175	8.239	10.289	12.320	14.331
0.66	2.047	4.098	6.156	8.213	10.259	12.289	14.302
0.68	2.042	4.086	6.137	8.187	10.228	12.255	14.267
0.70	2.036	4.075	6.118	8.160	10.196	12.219	14.230
0.72	2.031	4.063	6.099	8.134	10.163	12.182	14.191
0.74	2.025	4.051	6.080	8.108	10.131	12.145	14.151
0.76	2.019	4.040	6.062	8.082	10.098	12.108	14.110
0.78	2.014	4.028	6.043	8.057	10.067	12.071	14.070
0.80	2.008	4.016	6.025	8.032	10.035	12.034	14.030
0.82	2.003	4.005	6.006	8.007	10.003	11.997	13.990
0.84	1.997	3.993	5.988	7.982	9.972	11.961	13.949
0.86	1.991	3.981	5.970	7.957	9.941	11.924	13.908
0.88	1.986	3.970	5.952	7.932	9.910	11.887	13.866
0.90	1.980	3.959	5.935	7.908	9.879	11.850	13.823
0.92	1.975	3.947	5.917	7.884	9.849	11.812	13.779
0.94	1.969	3.936	5.900	7.861	9.818	11.775	13.734
0.96	1.964	3.925	5.884	7.838	9.788	11.737	13.689
0.98	1.959	3.915	5.867	7.815	9.758	11.700	13.644

Table 4.5.2-1b ($p_1 = 2 \text{ atm}$)
(continued)

Inlet Void Fraction α_1	v_{g2} Gas Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	2.058	3.091	4.725	6.532	8.914	12.433	14.593
0.04	2.144	3.093	4.739	6.534	8.819	12.335	14.481
0.06	2.244	3.098	4.748	6.536	8.719	12.240	14.371
0.08	2.325	3.101	4.754	6.532	8.653	12.147	14.264
0.10	2.416	3.104	4.758	6.527	8.595	12.057	14.160
0.12	2.429	3.106	4.759	6.520	8.545	11.969	14.058
0.14	2.453	3.107	4.759	6.513	8.500	11.884	13.960
0.16	2.489	3.107	4.757	6.504	8.460	11.677	13.865
0.18	2.518	3.107	4.754	6.496	8.424	11.421	13.774
0.20	2.514	4.254	4.751	6.486	8.392	11.201	13.686
0.22	2.511	4.663	4.747	6.476	8.363	11.046	13.602
0.24	2.508	4.701	4.762	6.467	8.336	10.882	13.522
0.26	2.515	4.722	6.145	6.476	8.320	10.770	13.448
0.28	2.509	4.739	6.216	7.860	8.359	10.749	13.381
0.30	2.496	4.753	6.304	7.910	9.709	11.622	13.609
0.32	2.496	4.765	6.469	7.973	9.744	11.639	13.617
0.34	2.489	4.774	6.641	8.049	9.795	11.670	13.638
0.36	2.482	4.781	6.716	8.139	9.862	11.719	13.676
0.38	2.474	4.786	6.776	8.248	9.948	11.788	13.735
0.40	2.466	4.790	6.826	8.399	10.054	11.879	13.817
0.42	2.459	4.791	6.869	8.674	10.183	11.994	13.926
0.44	2.452	4.792	6.907	8.799	10.354	12.139	14.070
0.46	2.444	4.790	6.938	8.894	10.682	12.338	14.270
0.48	2.437	4.788	6.965	8.974	10.863	12.712	14.662
0.50	2.430	4.783	6.988	9.044	10.995	12.925	14.919
0.52	2.423	4.778	7.006	9.105	11.109	13.089	15.113
0.54	2.415	4.772	7.020	9.157	11.209	13.235	15.291
0.56	2.408	4.764	7.030	9.201	11.298	13.368	15.458
0.58	2.400	4.756	7.037	9.237	11.374	13.486	15.613
0.60	2.393	4.747	7.040	9.266	11.439	13.590	15.752
0.62	2.385	4.738	7.041	9.288	11.493	13.680	15.876
0.64	2.377	4.728	7.038	9.304	11.536	13.754	15.982
0.66	2.370	4.717	7.032	9.313	11.569	13.814	16.070
0.68	2.362	4.706	7.025	9.317	11.591	13.860	16.140
0.70	2.355	4.694	7.015	9.316	11.605	13.893	16.191
0.72	2.347	4.682	7.003	9.311	11.611	13.912	16.225
0.74	2.340	4.670	6.990	9.302	11.609	13.921	16.244
0.76	2.333	4.658	6.976	9.289	11.601	13.919	16.249
0.78	2.326	4.645	6.960	9.273	11.587	13.908	16.241
0.80	2.318	4.632	6.943	9.255	11.569	13.890	16.223
0.82	2.311	4.619	6.926	9.234	11.546	13.866	16.196
0.84	2.304	4.606	6.908	9.211	11.520	13.836	16.162
0.86	2.297	4.592	6.888	9.187	11.491	13.802	16.121
0.88	2.290	4.579	6.869	9.162	11.460	13.764	16.075
0.90	2.283	4.565	6.849	9.135	11.426	13.723	16.026
0.92	2.276	4.552	6.829	9.108	11.391	13.679	15.973
0.94	2.269	4.538	6.808	9.080	11.355	13.634	15.917
0.96	2.262	4.525	6.788	9.052	11.319	13.588	15.860
0.98	2.255	4.511	6.767	9.024	11.282	13.541	15.802

Table 4.5.2-1b (p₁ = 2 atm)
(continued)

Inlet Void Fraction α_1	α_2 Void Fraction						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.022	0.015	0.015	0.015	0.014	0.012	0.012
0.04	0.041	0.031	0.030	0.029	0.028	0.025	0.025
0.06	0.059	0.046	0.045	0.045	0.043	0.038	0.038
0.08	0.074	0.061	0.060	0.060	0.058	0.051	0.052
0.10	0.088	0.077	0.076	0.076	0.074	0.064	0.066
0.12	0.101	0.093	0.092	0.092	0.090	0.078	0.080
0.14	0.119	0.110	0.109	0.108	0.106	0.093	0.094
0.16	0.139	0.127	0.126	0.125	0.123	0.109	0.110
0.18	0.158	0.145	0.143	0.142	0.140	0.126	0.125
0.20	0.175	0.170	0.161	0.160	0.158	0.145	0.141
0.22	0.193	0.192	0.180	0.178	0.176	0.163	0.157
0.24	0.211	0.212	0.199	0.197	0.194	0.182	0.174
0.26	0.229	0.231	0.230	0.216	0.213	0.201	0.191
0.28	0.248	0.250	0.252	0.231	0.232	0.220	0.209
0.30	0.266	0.269	0.273	0.254	0.243	0.239	0.238
0.32	0.286	0.288	0.290	0.278	0.265	0.261	0.259
0.34	0.305	0.307	0.305	0.301	0.288	0.283	0.280
0.36	0.324	0.327	0.325	0.325	0.312	0.305	0.302
0.38	0.344	0.346	0.345	0.347	0.336	0.328	0.325
0.40	0.363	0.365	0.365	0.367	0.359	0.352	0.348
0.42	0.382	0.384	0.385	0.381	0.382	0.375	0.371
0.44	0.402	0.404	0.405	0.401	0.404	0.398	0.393
0.46	0.422	0.424	0.425	0.422	0.418	0.420	0.415
0.48	0.441	0.443	0.445	0.442	0.438	0.435	0.431
0.50	0.461	0.463	0.465	0.463	0.459	0.455	0.451
0.52	0.481	0.483	0.485	0.484	0.481	0.477	0.473
0.54	0.501	0.503	0.505	0.504	0.502	0.499	0.496
0.56	0.522	0.523	0.525	0.524	0.523	0.520	0.518
0.58	0.542	0.544	0.545	0.545	0.544	0.542	0.540
0.60	0.563	0.564	0.565	0.565	0.565	0.563	0.561
0.62	0.583	0.585	0.586	0.586	0.585	0.584	0.583
0.64	0.604	0.605	0.606	0.606	0.606	0.605	0.604
0.66	0.625	0.626	0.627	0.627	0.627	0.626	0.625
0.68	0.646	0.647	0.648	0.648	0.648	0.647	0.646
0.70	0.668	0.668	0.669	0.669	0.669	0.668	0.668
0.72	0.689	0.690	0.690	0.690	0.690	0.689	0.689
0.74	0.710	0.711	0.711	0.711	0.711	0.711	0.710
0.76	0.732	0.732	0.733	0.733	0.732	0.732	0.732
0.78	0.754	0.754	0.754	0.754	0.754	0.754	0.754
0.80	0.775	0.776	0.776	0.776	0.776	0.775	0.775
0.82	0.797	0.798	0.798	0.798	0.797	0.797	0.797
0.84	0.819	0.820	0.820	0.819	0.819	0.819	0.819
0.86	0.842	0.842	0.842	0.842	0.841	0.841	0.841
0.88	0.864	0.864	0.864	0.864	0.864	0.864	0.864
0.90	0.886	0.886	0.886	0.886	0.886	0.886	0.886
0.92	0.909	0.909	0.909	0.909	0.909	0.909	0.909
0.94	0.931	0.931	0.931	0.931	0.931	0.931	0.931
0.96	0.954	0.954	0.954	0.954	0.954	0.954	0.954
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.977

Table 4.5.2-1c ($p_1 = 1 \text{ atm}$)

Inlet Void Fraction α_1	Static Pressure Increase, ($p_2 - p_1$) (psi)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	22.589	22.357	22.131	21.911	21.693	21.478	21.264
0.02	0.675	21.902	21.789	21.622	21.445	21.269	21.091
0.04	0.643	21.448	21.441	21.325	21.188	21.048	20.905
0.06	0.601	20.998	21.088	21.019	20.919	20.815	20.708
0.08	0.649	20.550	20.727	20.706	20.642	20.572	20.498
0.10	0.928	20.105	20.360	20.383	20.353	20.317	20.276
0.12	1.285	19.662	19.987	20.052	20.054	20.051	20.041
0.14	1.012	19.218	19.608	19.711	19.745	19.773	19.793
0.16	0.444	18.776	19.221	19.362	19.425	19.484	19.530
0.18	0.372	18.332	18.828	19.003	19.094	19.182	19.257
0.20	0.330	17.883	18.429	18.636	18.752	18.869	18.968
0.22	0.297	2.585	18.022	18.259	18.401	18.542	18.666
0.24	0.270	1.854	17.572	17.869	18.036	18.199	18.350
0.26	0.248	1.604	5.908	17.435	17.645	17.833	18.013
0.28	0.225	1.403	5.016	10.393	17.201	17.431	17.644
0.30	0.205	1.231	4.286	9.143	12.285	13.746	17.208
0.32	0.189	1.084	3.669	7.975	11.229	12.854	13.766
0.34	0.174	0.955	3.146	6.896	10.149	11.936	12.952
0.36	0.160	0.844	2.700	5.925	9.062	10.977	12.098
0.38	0.148	0.746	2.319	5.062	7.989	9.982	11.199
0.40	0.137	0.659	1.993	4.309	6.958	8.965	10.258
0.42	0.126	0.582	1.711	3.661	5.995	7.944	9.285
0.44	0.116	0.514	1.471	3.102	5.119	6.945	8.293
0.46	0.107	0.453	1.262	2.622	4.341	5.994	7.304
0.48	0.099	0.399	1.083	2.212	3.665	5.117	6.342
0.50	0.091	0.352	0.927	1.863	3.072	4.334	5.445
0.52	0.084	0.309	0.793	1.566	2.562	3.628	4.609
0.54	0.078	0.271	0.677	1.313	2.128	3.011	3.847
0.56	0.072	0.237	0.575	1.096	1.759	2.480	3.175
0.58	0.066	0.207	0.488	0.912	1.446	2.028	2.592
0.60	0.061	0.181	0.412	0.756	1.182	1.645	2.093
0.62	0.057	0.157	0.348	0.622	0.960	1.322	1.671
0.64	0.052	0.137	0.291	0.510	0.774	1.052	1.318
0.66	0.048	0.118	0.242	0.415	0.618	0.828	1.024
0.68	0.045	0.103	0.202	0.334	0.487	0.642	0.780
0.70	0.042	0.089	0.166	0.267	0.380	0.489	0.581
0.72	0.038	0.077	0.136	0.212	0.291	0.364	0.420
0.74	0.036	0.066	0.111	0.165	0.219	0.263	0.291
0.76	0.033	0.058	0.090	0.127	0.160	0.183	0.189
0.78	0.031	0.050	0.073	0.096	0.114	0.121	0.110
0.80	0.029	0.043	0.059	0.072	0.078	0.073	0.052
0.82	0.027	0.037	0.048	0.053	0.051	0.037	0.009
0.84	0.025	0.032	0.039	0.038	0.031	0.012	-0.020
0.86	0.023	0.028	0.031	0.028	0.017	-0.004	-0.038
0.88	0.021	0.025	0.026	0.020	0.008	-0.013	-0.045
0.90	0.020	0.022	0.022	0.016	0.003	-0.017	-0.045
0.92	0.018	0.021	0.019	0.013	0.002	-0.015	-0.039
0.94	0.017	0.018	0.017	0.012	0.003	-0.011	-0.029
0.96	0.016	0.017	0.015	0.012	0.006	-0.003	-0.016
0.98	0.014	0.015	0.014	0.013	0.010	0.005	-0.001

Table 4.5.2-1c ($p_1 = 1 \text{ atm}$)
(continued)

Inlet Void Fraction α_1	v_{12} Liquid Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	2.251	4.503	6.754	9.005	11.256	13.508	15.759
0.02	2.249	4.455	6.685	8.912	11.125	13.351	15.580
0.04	2.246	4.409	6.617	8.820	11.000	13.194	15.402
0.06	2.239	4.365	6.549	8.730	10.880	13.040	15.225
0.08	2.228	4.322	6.483	8.641	10.765	12.887	15.051
0.10	2.213	4.279	6.418	8.554	10.652	12.736	14.878
0.12	2.197	4.237	6.354	8.468	10.545	12.587	14.708
0.14	2.189	4.197	6.291	8.385	10.442	12.441	14.540
0.16	2.193	4.157	6.230	8.303	10.342	12.296	14.374
0.18	2.193	4.119	6.171	8.224	10.246	12.155	14.212
0.20	2.182	4.082	6.114	8.146	10.152	12.016	14.053
0.22	2.173	4.267	6.058	8.072	10.061	11.881	13.897
0.24	2.165	4.281	6.006	8.000	9.972	11.782	13.745
0.26	2.165	4.274	6.223	7.933	9.889	11.693	13.598
0.28	2.155	4.265	6.242	7.946	9.812	11.606	13.456
0.30	2.143	4.257	6.255	7.955	9.731	11.605	13.323
0.32	2.144	4.249	6.251	7.979	9.712	11.553	13.447
0.34	2.140	4.240	6.205	8.014	9.712	11.517	13.385
0.36	2.134	4.231	6.202	8.057	9.732	11.502	13.343
0.38	2.128	4.222	6.204	8.100	9.772	11.509	13.322
0.40	2.122	4.213	6.206	8.132	9.829	11.540	13.326
0.42	2.115	4.204	6.207	8.083	9.895	11.595	13.355
0.44	2.109	4.194	6.207	8.072	9.956	11.666	13.410
0.46	2.103	4.185	6.205	8.089	9.971	11.744	13.482
0.48	2.097	4.175	6.202	8.107	9.906	11.790	13.552
0.50	2.091	4.165	6.197	8.123	9.940	11.707	13.495
0.52	2.085	4.155	6.191	8.136	9.980	11.755	13.504
0.54	2.079	4.145	6.183	8.145	10.017	11.818	13.585
0.56	2.073	4.136	6.174	8.151	10.048	11.880	13.674
0.58	2.067	4.126	6.164	8.152	10.074	11.936	13.760
0.60	2.061	4.116	6.153	8.150	10.092	11.982	13.837
0.62	2.056	4.105	6.142	8.145	10.103	12.018	13.902
0.64	2.050	4.095	6.129	8.137	10.109	12.044	13.954
0.66	2.045	4.085	6.116	8.127	10.108	12.061	13.992
0.68	2.039	4.075	6.103	8.115	10.104	12.070	14.019
0.70	2.034	4.064	6.089	8.101	10.095	12.072	14.035
0.72	2.029	4.054	6.075	8.086	10.083	12.068	14.043
0.74	2.023	4.043	6.060	8.069	10.069	12.058	14.043
0.76	2.018	4.033	6.045	8.052	10.051	12.045	14.036
0.78	2.012	4.022	6.030	8.033	10.032	12.027	14.024
0.80	2.007	4.011	6.014	8.014	10.011	12.006	14.005
0.82	2.001	4.000	5.998	7.993	9.987	11.982	13.982
0.84	1.996	3.989	5.981	7.972	9.962	11.955	13.954
0.86	1.990	3.978	5.965	7.950	9.936	11.925	13.921
0.88	1.985	3.967	5.948	7.928	9.908	11.892	13.883
0.90	1.979	3.956	5.932	7.905	9.879	11.857	13.842
0.92	1.974	3.946	5.915	7.883	9.850	11.820	13.797
0.94	1.969	3.935	5.898	7.859	9.819	11.781	13.749
0.96	1.963	3.924	5.882	7.836	9.789	11.742	13.699
0.98	1.958	3.914	5.866	7.814	9.758	11.702	13.648

Table 4.5.2-1c ($p_1 = 1 \text{ atm}$
(continued)

Inlet Vold Fraction α_1	v_{g2} Gas Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	2.211	3.127	4.748	6.669	10.031	12.381	14.531
0.04	2.257	3.089	4.719	6.594	9.619	12.234	14.361
0.06	2.314	3.064	4.689	6.518	9.313	12.089	14.192
0.08	2.344	3.042	4.659	6.455	9.045	11.946	14.026
0.10	2.374	3.022	4.629	6.395	8.847	11.804	13.861
0.12	2.400	3.003	4.599	6.339	8.641	11.665	13.699
0.14	2.429	2.984	4.569	6.285	8.462	11.528	13.539
0.16	2.478	2.966	4.539	6.229	8.307	11.393	13.383
0.18	2.511	2.947	4.509	6.179	8.172	11.261	13.229
0.20	2.508	2.929	4.479	6.131	8.052	11.131	13.078
0.22	2.505	4.562	4.450	6.084	7.946	11.005	12.931
0.24	2.502	4.630	4.422	6.038	7.860	10.677	12.787
0.26	2.509	4.654	5.872	5.996	7.773	10.369	12.648
0.28	2.503	4.673	5.946	7.373	7.696	10.138	12.514
0.30	2.491	4.691	6.036	7.408	9.035	10.800	12.389
0.32	2.491	4.705	6.172	7.464	9.035	10.765	12.580
0.34	2.484	4.717	6.400	7.541	9.059	10.751	12.540
0.36	2.477	4.728	6.496	7.639	9.110	10.760	12.522
0.38	2.469	4.736	6.571	7.759	9.190	10.799	12.532
0.40	2.462	4.743	6.637	7.912	9.301	10.871	12.574
0.42	2.455	4.748	6.695	8.203	9.443	10.980	12.655
0.44	2.448	4.751	6.746	8.401	9.623	11.130	12.780
0.46	2.440	4.753	6.792	8.534	9.886	11.327	12.957
0.48	2.433	4.753	6.833	8.649	10.250	11.604	13.206
0.50	2.426	4.752	6.868	8.752	10.449	12.059	13.668
0.52	2.419	4.749	6.899	8.844	10.622	12.324	14.048
0.54	2.412	4.746	6.925	8.926	10.779	12.557	14.341
0.56	2.405	4.741	6.946	8.998	10.920	12.771	14.619
0.58	2.397	4.735	6.962	9.060	11.047	12.968	14.882
0.60	2.390	4.728	6.975	9.113	11.158	13.147	15.126
0.62	2.383	4.721	6.984	9.157	11.254	13.305	15.349
0.64	2.375	4.713	6.989	9.193	11.336	13.443	15.547
0.66	2.368	4.704	6.991	9.220	11.403	13.560	15.718
0.68	2.360	4.694	6.989	9.241	11.457	13.656	15.862
0.70	2.353	4.684	6.985	9.254	11.498	13.733	15.979
0.72	2.346	4.674	6.979	9.261	11.527	13.791	16.070
0.74	2.338	4.663	6.970	9.262	11.546	13.832	16.136
0.76	2.331	4.651	6.960	9.259	11.555	13.858	16.180
0.78	2.324	4.640	6.947	9.250	11.555	13.870	16.204
0.80	2.317	4.627	6.933	9.238	11.548	13.870	16.211
0.82	2.310	4.615	6.918	9.223	11.534	13.859	16.203
0.84	2.303	4.603	6.902	9.204	11.515	13.839	16.182
0.86	2.296	4.590	6.884	9.183	11.491	13.812	16.149
0.88	2.289	4.577	6.866	9.160	11.463	13.777	16.107
0.90	2.283	4.564	6.847	9.135	11.431	13.738	16.058
0.92	2.276	4.551	6.827	9.109	11.397	13.694	16.002
0.94	2.269	4.537	6.807	9.081	11.360	13.647	15.941
0.96	2.262	4.524	6.787	9.053	11.322	13.597	15.877
0.98	2.255	4.511	6.767	9.024	11.284	13.546	15.810

Table 4.5.2-1c ($p_1 = 1 \text{ atm}$)
(continued)

Inlet Void Fraction α_1	α_2 Void Fraction						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.020	0.010	0.010	0.010	0.008	0.008	0.009
0.04	0.039	0.020	0.020	0.020	0.018	0.017	0.018
0.06	0.056	0.030	0.031	0.030	0.027	0.026	0.027
0.08	0.071	0.041	0.041	0.041	0.038	0.036	0.037
0.10	0.086	0.053	0.053	0.052	0.049	0.045	0.047
0.12	0.098	0.065	0.065	0.064	0.061	0.056	0.057
0.14	0.114	0.077	0.077	0.076	0.073	0.066	0.068
0.16	0.137	0.090	0.089	0.089	0.086	0.077	0.079
0.18	0.156	0.103	0.102	0.102	0.099	0.089	0.091
0.20	0.173	0.117	0.116	0.116	0.113	0.101	0.103
0.22	0.191	0.176	0.130	0.130	0.127	0.113	0.115
0.24	0.209	0.200	0.145	0.144	0.142	0.129	0.129
0.26	0.228	0.220	0.198	0.160	0.158	0.145	0.142
0.28	0.246	0.239	0.222	0.183	0.174	0.162	0.157
0.30	0.264	0.259	0.245	0.207	0.190	0.185	0.172
0.32	0.284	0.279	0.266	0.232	0.211	0.205	0.203
0.34	0.304	0.299	0.282	0.258	0.235	0.226	0.223
0.36	0.323	0.319	0.304	0.285	0.259	0.248	0.244
0.38	0.342	0.338	0.325	0.311	0.286	0.272	0.266
0.40	0.362	0.358	0.347	0.336	0.313	0.298	0.290
0.42	0.381	0.378	0.369	0.354	0.340	0.324	0.315
0.44	0.401	0.399	0.391	0.375	0.367	0.351	0.342
0.46	0.420	0.419	0.412	0.399	0.390	0.379	0.369
0.48	0.440	0.439	0.434	0.422	0.409	0.404	0.395
0.50	0.460	0.459	0.455	0.446	0.434	0.423	0.416
0.52	0.480	0.480	0.476	0.469	0.459	0.448	0.440
0.54	0.501	0.500	0.498	0.491	0.483	0.474	0.466
0.56	0.521	0.521	0.519	0.514	0.507	0.500	0.493
0.58	0.541	0.541	0.540	0.536	0.531	0.525	0.519
0.60	0.562	0.562	0.561	0.558	0.554	0.549	0.544
0.62	0.583	0.583	0.582	0.580	0.577	0.573	0.569
0.64	0.604	0.604	0.603	0.602	0.599	0.596	0.593
0.66	0.625	0.625	0.625	0.623	0.621	0.619	0.617
0.68	0.646	0.646	0.646	0.645	0.643	0.642	0.640
0.70	0.667	0.668	0.667	0.667	0.665	0.664	0.663
0.72	0.689	0.689	0.689	0.688	0.687	0.687	0.686
0.74	0.710	0.710	0.710	0.710	0.709	0.709	0.708
0.76	0.732	0.732	0.732	0.732	0.731	0.731	0.731
0.78	0.753	0.754	0.754	0.753	0.753	0.753	0.753
0.80	0.775	0.775	0.775	0.775	0.775	0.775	0.775
0.82	0.797	0.797	0.797	0.797	0.797	0.797	0.797
0.84	0.819	0.819	0.819	0.819	0.819	0.819	0.819
0.86	0.841	0.842	0.841	0.841	0.841	0.841	0.842
0.88	0.864	0.864	0.864	0.864	0.864	0.864	0.864
0.90	0.886	0.886	0.886	0.886	0.886	0.886	0.886
0.92	0.909	0.909	0.909	0.909	0.909	0.909	0.909
0.94	0.931	0.931	0.931	0.931	0.931	0.931	0.931
0.96	0.954	0.954	0.954	0.954	0.954	0.954	0.954
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.977

Table 4.5.2-1d ($p_1 = 0.5$ atm)

Inlet Void Fraction α_1	Static Pressure Increase, ($p_2 - p_1$) (psi)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	22.589	22.357	22.131	21.911	21.693	21.478	21.264
0.02	0.675	21.009	21.789	21.622	21.445	21.269	21.091
0.04	0.643	20.573	21.441	21.325	21.188	21.048	20.905
0.06	0.601	20.142	21.088	21.019	20.919	20.815	20.708
0.08	0.649	19.713	20.727	20.706	20.642	20.572	20.498
0.10	0.928	19.285	20.360	20.383	20.353	20.317	20.276
0.12	1.285	18.860	19.987	20.052	20.054	20.051	20.041
0.14	1.012	18.435	19.608	19.711	19.745	19.773	19.793
0.16	0.444	18.011	19.221	19.362	19.425	19.484	19.530
0.18	0.372	17.584	18.828	19.003	19.094	19.182	19.257
0.20	0.330	17.154	18.429	18.636	18.752	18.869	18.968
0.22	0.297	2.480	18.022	18.259	18.401	18.542	18.666
0.24	0.270	1.779	17.572	17.869	18.036	18.199	18.350
0.26	0.248	1.539	5.908	17.435	17.645	17.833	18.013
0.28	0.225	1.346	5.016	10.393	17.201	17.431	17.644
0.30	0.205	1.181	4.286	9.143	12.285	13.746	17.208
0.32	0.189	1.040	3.669	7.975	11.229	12.854	13.766
0.34	0.174	0.916	3.146	6.896	10.149	11.936	12.952
0.36	0.160	0.809	2.700	5.925	9.062	10.977	12.098
0.38	0.148	0.716	2.319	5.062	7.989	9.982	11.199
0.40	0.137	0.632	1.993	4.309	6.958	8.965	10.258
0.42	0.126	0.558	1.711	3.661	5.995	7.944	9.285
0.44	0.116	0.493	1.471	3.102	5.119	6.945	8.293
0.46	0.107	0.435	1.262	2.622	4.341	5.994	7.304
0.48	0.099	0.383	1.083	2.212	3.665	5.117	6.342
0.50	0.091	0.337	0.927	1.863	3.072	4.334	5.445
0.52	0.084	0.296	0.793	1.566	2.562	3.628	4.609
0.54	0.078	0.259	0.677	1.313	2.128	3.011	3.847
0.56	0.072	0.228	0.575	1.096	1.759	2.480	3.175
0.58	0.066	0.199	0.488	0.912	1.446	2.028	2.592
0.60	0.061	0.173	0.412	0.756	1.182	1.645	2.093
0.62	0.057	0.151	0.348	0.622	0.960	1.322	1.671
0.64	0.052	0.131	0.291	0.510	0.774	1.052	1.318
0.66	0.048	0.113	0.242	0.415	0.618	0.828	1.024
0.68	0.045	0.098	0.202	0.334	0.487	0.642	0.780
0.70	0.042	0.085	0.166	0.267	0.380	0.489	0.581
0.72	0.038	0.074	0.136	0.212	0.291	0.364	0.420
0.74	0.036	0.064	0.111	0.165	0.219	0.263	0.291
0.76	0.033	0.055	0.090	0.127	0.160	0.183	0.189
0.78	0.031	0.048	0.073	0.096	0.114	0.121	0.110
0.80	0.029	0.041	0.059	0.072	0.078	0.073	0.052
0.82	0.027	0.036	0.048	0.053	0.051	0.037	0.009
0.84	0.025	0.031	0.039	0.038	0.031	0.012	-0.020
0.86	0.023	0.027	0.031	0.028	0.017	-0.004	-0.038
0.88	0.021	0.024	0.026	0.020	0.008	-0.013	-0.045
0.90	0.020	0.022	0.022	0.016	0.003	-0.017	-0.045
0.92	0.018	0.020	0.019	0.013	0.002	-0.015	-0.039
0.94	0.017	0.017	0.017	0.012	0.003	-0.011	-0.029
0.96	0.016	0.016	0.015	0.012	0.006	-0.003	-0.016
0.98	0.014	0.014	0.014	0.013	0.010	0.005	-0.001

Table 4.5.2-1d ($p_1 = 0.5 \text{ atm}$)
(continued)

Inlet Void Fraction α_1	v_{12} Liquid Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	2.251	4.503	6.754	9.005	11.256	13.508	15.759
0.02	2.231	4.443	6.658	8.874	11.087	13.308	15.529
0.04	2.214	4.372	6.562	8.745	10.918	13.107	15.299
0.06	2.200	4.309	6.468	8.617	10.750	12.908	15.069
0.08	2.188	4.247	6.373	8.491	10.582	12.709	14.840
0.10	2.177	4.186	6.280	8.367	10.416	12.511	14.611
0.12	2.168	4.125	6.188	8.243	10.250	12.314	14.384
0.14	2.146	4.065	6.096	8.122	10.097	12.118	14.157
0.16	2.182	4.005	6.006	8.002	9.949	11.923	13.932
0.18	2.183	3.947	5.917	7.883	9.802	11.730	13.708
0.20	2.173	3.889	5.828	7.765	9.660	11.538	13.486
0.22	2.163	3.832	5.741	7.649	9.519	11.347	13.265
0.24	2.155	4.171	5.655	7.535	9.379	11.159	13.046
0.26	2.155	4.166	5.863	7.423	9.245	10.973	12.830
0.28	2.146	4.161	5.883	7.385	9.111	10.789	12.617
0.30	2.133	4.156	5.899	7.348	8.998	10.633	12.408
0.32	2.135	4.151	5.912	7.334	8.908	10.516	12.231
0.34	2.130	4.146	5.883	7.345	8.840	10.492	12.063
0.36	2.125	4.142	5.885	7.379	8.799	10.392	11.929
0.38	2.119	4.137	5.899	7.430	8.791	10.317	11.940
0.40	2.113	4.133	5.916	7.490	8.819	10.274	11.846
0.42	2.107	4.128	5.934	7.538	8.882	10.271	11.786
0.44	2.101	4.123	5.951	7.512	8.972	10.314	11.768
0.46	2.096	4.118	5.968	7.556	9.074	10.403	11.801
0.48	2.090	4.114	5.983	7.611	9.128	10.528	11.891
0.50	2.084	4.108	5.997	7.666	9.142	10.658	12.029
0.52	2.078	4.103	6.009	7.719	9.239	10.660	12.175
0.54	2.073	4.098	6.019	7.769	9.341	10.790	12.192
0.56	2.067	4.092	6.027	7.814	9.441	10.944	12.377
0.58	2.061	4.086	6.033	7.854	9.535	11.099	12.589
0.60	2.056	4.080	6.038	7.889	9.620	11.248	12.804
0.62	2.051	4.074	6.040	7.918	9.695	11.384	13.009
0.64	2.046	4.067	6.041	7.942	9.760	11.506	13.197
0.66	2.041	4.060	6.040	7.962	9.816	11.612	13.365
0.68	2.035	4.053	6.038	7.976	9.861	11.702	13.512
0.70	2.030	4.045	6.034	7.986	9.898	11.777	13.636
0.72	2.025	4.037	6.029	7.992	9.926	11.838	13.738
0.74	2.020	4.029	6.022	7.994	9.946	11.885	13.821
0.76	2.015	4.020	6.014	7.993	9.959	11.919	13.884
0.78	2.010	4.011	6.004	7.988	9.965	11.942	13.929
0.80	2.005	4.002	5.994	7.980	9.964	11.953	13.957
0.82	1.999	3.993	5.982	7.969	9.957	11.954	13.969
0.84	1.994	3.983	5.969	7.955	9.945	11.946	13.967
0.86	1.989	3.973	5.955	7.939	9.928	11.929	13.950
0.88	1.983	3.963	5.941	7.921	9.907	11.905	13.922
0.90	1.978	3.953	5.926	7.902	9.882	11.873	13.883
0.92	1.973	3.943	5.911	7.880	9.854	11.837	13.836
0.94	1.968	3.933	5.896	7.858	9.824	11.796	13.781
0.96	1.963	3.923	5.880	7.836	9.792	11.753	13.722
0.98	1.958	3.913	5.865	7.813	9.760	11.707	13.660

Table 4.5.2-1d ($p_1 = 0.5 \text{ atm}$)
(continued)

Inlet Vold Fraction α_1	v_{g2} Gas Flow Velocity (feet/sec)						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	3.485	3.267	4.847	7.147	10.230	12.335	14.477
0.04	3.325	3.187	4.768	6.955	10.072	12.146	14.255
0.06	3.166	3.100	4.693	6.780	9.915	11.957	14.034
0.08	3.010	3.036	4.627	6.599	9.759	11.770	13.814
0.10	2.855	2.985	4.559	6.456	9.604	11.583	13.595
0.12	2.704	2.940	4.493	6.323	9.429	11.398	13.378
0.14	2.556	2.897	4.429	6.189	9.043	11.214	13.162
0.16	2.457	2.856	4.365	6.076	8.652	11.031	12.947
0.18	2.497	2.817	4.305	5.962	8.350	10.849	12.735
0.20	2.495	2.780	4.246	5.862	8.047	10.670	12.524
0.22	2.492	2.744	4.189	5.767	7.812	10.491	12.315
0.24	2.490	4.510	4.133	5.672	7.602	10.315	12.108
0.26	2.497	4.536	5.493	5.583	7.397	10.142	11.904
0.28	2.492	4.559	5.563	6.813	7.231	9.970	11.702
0.30	2.480	4.579	5.643	6.797	8.309	9.642	11.505
0.32	2.481	4.598	5.754	6.809	8.237	9.542	11.340
0.34	2.474	4.614	6.000	6.854	8.188	9.729	11.183
0.36	2.467	4.629	6.134	6.931	8.170	9.647	11.058
0.38	2.460	4.642	6.229	7.041	8.190	9.594	11.127
0.40	2.453	4.654	6.314	7.185	8.255	9.577	11.056
0.42	2.446	4.664	6.391	7.382	8.369	9.607	11.024
0.44	2.439	4.673	6.463	7.733	8.535	9.695	11.042
0.46	2.432	4.680	6.529	7.924	8.756	9.850	11.125
0.48	2.425	4.686	6.591	8.086	9.100	10.078	11.288
0.50	2.419	4.690	6.647	8.236	9.506	10.401	11.548
0.52	2.412	4.692	6.697	8.374	9.764	10.964	11.945
0.54	2.405	4.694	6.743	8.502	10.003	11.336	12.604
0.56	2.398	4.694	6.783	8.619	10.225	11.674	13.054
0.58	2.391	4.692	6.818	8.726	10.432	11.994	13.485
0.60	2.384	4.690	6.847	8.820	10.621	12.295	13.902
0.62	2.377	4.687	6.872	8.904	10.792	12.573	14.298
0.64	2.370	4.682	6.892	8.976	10.943	12.825	14.664
0.66	2.363	4.677	6.908	9.037	11.075	13.049	14.994
0.68	2.356	4.671	6.919	9.088	11.188	13.243	15.285
0.70	2.349	4.664	6.926	9.129	11.282	13.407	15.534
0.72	2.342	4.656	6.930	9.160	11.358	13.543	15.740
0.74	2.335	4.647	6.930	9.183	11.417	13.650	15.906
0.76	2.328	4.638	6.927	9.197	11.460	13.732	16.033
0.78	2.322	4.628	6.921	9.205	11.489	13.790	16.125
0.80	2.315	4.618	6.913	9.205	11.505	13.827	16.185
0.82	2.308	4.607	6.903	9.200	11.510	13.844	16.216
0.84	2.301	4.596	6.890	9.190	11.505	13.845	16.223
0.86	2.295	4.584	6.876	9.175	11.491	13.832	16.207
0.88	2.288	4.573	6.860	9.156	11.469	13.805	16.173
0.90	2.281	4.560	6.843	9.134	11.441	13.769	16.123
0.92	2.275	4.548	6.825	9.110	11.408	13.723	16.061
0.94	2.268	4.535	6.806	9.083	11.370	13.671	15.990
0.96	2.262	4.523	6.786	9.054	11.330	13.615	15.911
0.98	2.255	4.510	6.766	9.025	11.288	13.555	15.826

Table 4.5.2-1d (p₁ = 0.5 atm)
(continued)

Inlet Void Fraction α_1	α_2 Void Fraction						
	Homologous Parameter						
	0.2	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.02	0.012	0.006	0.006	0.005	0.005	0.005	0.005
0.04	0.025	0.012	0.012	0.011	0.010	0.011	0.011
0.06	0.039	0.018	0.018	0.018	0.016	0.016	0.017
0.08	0.054	0.025	0.025	0.024	0.021	0.022	0.023
0.10	0.070	0.031	0.032	0.031	0.027	0.028	0.029
0.12	0.088	0.038	0.039	0.039	0.034	0.035	0.036
0.14	0.106	0.047	0.047	0.046	0.041	0.041	0.043
0.16	0.125	0.056	0.055	0.055	0.050	0.048	0.050
0.18	0.146	0.064	0.064	0.063	0.058	0.056	0.057
0.20	0.169	0.073	0.073	0.072	0.068	0.063	0.065
0.22	0.187	0.083	0.082	0.082	0.078	0.071	0.073
0.24	0.205	0.179	0.092	0.092	0.088	0.080	0.082
0.26	0.224	0.200	0.150	0.102	0.099	0.089	0.091
0.28	0.242	0.220	0.175	0.121	0.110	0.099	0.101
0.30	0.261	0.241	0.200	0.142	0.124	0.111	0.111
0.32	0.281	0.262	0.224	0.165	0.140	0.127	0.124
0.34	0.300	0.283	0.243	0.191	0.159	0.150	0.138
0.36	0.320	0.304	0.266	0.219	0.181	0.168	0.154
0.38	0.339	0.325	0.291	0.249	0.206	0.188	0.182
0.40	0.359	0.346	0.315	0.279	0.234	0.211	0.202
0.42	0.379	0.367	0.340	0.307	0.265	0.237	0.224
0.44	0.398	0.388	0.365	0.329	0.297	0.266	0.250
0.46	0.418	0.409	0.389	0.357	0.330	0.299	0.279
0.48	0.438	0.431	0.413	0.385	0.359	0.333	0.311
0.50	0.458	0.452	0.437	0.413	0.384	0.366	0.345
0.52	0.479	0.473	0.461	0.440	0.415	0.392	0.379
0.54	0.499	0.494	0.484	0.467	0.446	0.424	0.405
0.56	0.520	0.516	0.507	0.493	0.475	0.457	0.440
0.58	0.540	0.537	0.530	0.518	0.504	0.489	0.474
0.60	0.561	0.558	0.553	0.543	0.532	0.520	0.508
0.62	0.582	0.580	0.575	0.568	0.559	0.549	0.540
0.64	0.603	0.601	0.598	0.592	0.585	0.577	0.570
0.66	0.624	0.623	0.620	0.615	0.610	0.604	0.599
0.68	0.645	0.644	0.642	0.639	0.635	0.631	0.627
0.70	0.667	0.666	0.664	0.662	0.659	0.656	0.653
0.72	0.688	0.688	0.686	0.684	0.682	0.680	0.679
0.74	0.710	0.709	0.708	0.707	0.706	0.704	0.704
0.76	0.731	0.731	0.730	0.730	0.729	0.728	0.728
0.78	0.753	0.753	0.753	0.752	0.751	0.751	0.751
0.80	0.775	0.775	0.775	0.774	0.774	0.774	0.774
0.82	0.797	0.797	0.797	0.797	0.796	0.797	0.797
0.84	0.819	0.819	0.819	0.819	0.819	0.819	0.819
0.86	0.841	0.841	0.841	0.841	0.841	0.841	0.842
0.88	0.864	0.864	0.864	0.864	0.864	0.864	0.864
0.90	0.886	0.886	0.886	0.886	0.886	0.886	0.886
0.92	0.909	0.909	0.909	0.909	0.909	0.909	0.909
0.94	0.931	0.931	0.931	0.931	0.931	0.931	0.931
0.96	0.954	0.954	0.954	0.954	0.954	0.954	0.954
0.98	0.977	0.977	0.977	0.977	0.977	0.977	0.977

5. **SRPRP Head and Torque Characteristics Under Steam/Water and Steam/Air/Water Conditions for Both AC and DC Motor Operations without Diffuser Section (Tasks 4, 8, 11 and 12)**

5.1 **Theoretical Basis**

The theory for determining the performance of the pump operating under the steam/water two-phase condition has been developed for the Electric Power Research Institute and described in one of the EPRI reports (EPRI NP-5529SP(November, 1987)). The basic difference of these formula from those of the air/water two-phase flow case are as follows:

- i) The mass conservation equations for the gas phase and liquid phase have the source (or sink) terms due to the condensation and evaporation effects of the flow media.
- ii) The energy equation is needed to define the energy balance between two phases, or equivalently to determine the amount of the condensation or evaporation.
- iii) The table of enthalpy for the steam and liquid phases is needed for actual computations.

These formula have been used many times to date to determine the characteristics of the condensable two-phase flow pumps and provided good correlation with experimental data. One of such comparisons has recently been made when the MIST pump was tested by Babcock & Wilcox (see B&W Report No. NRC-04-83-168/RP 2399-1, January 1988).

One of the major differences in the present SRPRP case from the PWR (pressurized water reactor) primary coolant pump is that the line static pressure of the former is 1/3000 to 1/50 that of the latter. More specifically, the range of the line pressures to be investigated is from 0.05 atm (= 0.7 psi) to 3 atm (= 44 psi) compared to, e.g., 2500 psi of the PWR. The gradient of the enthalpy of the water (or the heavy water in this case) is extremely large and the density of the steam is very small. This sometimes causes the instability for the numerical calculations. A slight change of the static pressure generates an enormous amount of vapor or water through vaporization or condensation process, depending on the sign of the pressure gradient. Therefore, although the governing equations remain the same, the numerical computations become totally different at such low static pressure case. As a matter of fact, the computation becomes extremely unstable.

Let us explain the problem described above in more specific terms; two key quantities at these low line pressures different from those of the PWR cases are the steam density and the dh/dp where h is the saturated enthalpy and p is the static pressure as is shown in Table below.

	PWR (at $p = 2500$ psi)	SRP (at $p = 0.7$ psi)
Steam Density (lbm/cubic feet)	7.65	0.0037
dh/dp	A	$10 \times A$

The amount of condensation of steam is proportional to $dh/dp/\rho_g$ as can be seen from the mass conservation equation (see Eqn. (2), p2-1, of EPRI NP-5529SP) where ρ_g is the steam density. Therefore, that of the SRP cases becomes $7.65/0.0037 \times (10 \times A / A) = 20,675$ times that of the PWR cases where A is a representative constant, as shown in Table above.

5.2 Numerical Results for Steam/Water Two-Phase Flow Cases Under the AC and DC Motor Operation---Without Diffuser

5.2.1 Flow Parameters

The single-phase pump H-Q curve, the range of line static pressure, homologous flow parameter and inlet void fraction used for these computations are the same as those used for the air/water cases (refer to Section 3.3.1 for the AC motor case and Section 4.3.1 for the DC motor case). However, for the sake of convenience, these parameters are listed herein again.

1) Pump

The SRPR pump is a double suction, double-volute centrifugal pump manufactured by Bingham Corp. having the rated flow rate of 25,000 gpm (12,500 gpm/volute) with the total head of 420 feet at the rated rotational speed of 1,000 rpm. The specific speed N_s is 1,205 in the English units,

indicating that the pump is a typical centrifugal pump:

$$N_s = N Q^{1/2} / H^{3/4}$$

$$= 1,000 \times 12,500^{1/2} / 420^{3/4} = 1,205$$

The head vs. flow rate curve driven by the AC motor at 1,000 rpm is given in Figure 3.3.1-1.

On the other hand, when this pump is operated by the DC motor at the rotation speed of 300 rpm, the flow rate is 6,200 gpm (3,100 gpm/volute).

The head vs. flow rate curve driven by the AC motor at 1,000 rpm and by the DC motor at 300 rpm are given in Figures 4.3.1-1 and 4.3.1-2, respectively. In these figures both the total pump dynamic head and that of fluid flowing are given for the AC motor pump performance while only the latter is given for the DC motor case. The correction is thus to be made for the DC motor head curve as follows:

$$H_{1\phi \text{ DC}} = 47.7 - 0.4289 \times (Q / 1000)^{0.943} + \Delta H \quad (5.3.1-1)$$

$$\Delta H = 4.236 \times (Q / 10,000)^2 \quad (5.3.1-2)$$

where the formula for Equations (5.3.1-1) and (5.3.1-2) were given by the report No. DPS-83-282 and the Los Alamos National Laboratory. Therefore, the rated head at the DC motor operation will be readily calculated

$$H_{1\phi \text{ DC at } 300\text{rpm}} = 46.93 \text{ feet.}$$

It should be noted that the homologous flow parameters and head data presented hereafter for the DC motor operation are all normalized by using $N_{R300} = 300 \text{ rpm}$, $Q_{R300} = 6200 \text{ gpm}$ and $H_{R300} = 46.93 \text{ feet}$.

The pump performance curves nondimensionalized by using the unified rated parameters (i.e., N_R , Q_R and H_R at 1,000 rpm) show a clear difference between the AC and DC motor operations (see Figure 4.3.1-3)).

2) Line Static Pressure (p_1)

The following line static pressures were used for the present calculations:

0.05 atm

1.00 atm

2.00 atm

3.00 atm

3) Flow Rate (Q) and Pump Rotational Speed (N)

Since the pump performance only depends on the ratio between the flow rate and the rotational speed, the range of these parameters is expressed in terms of the homologous flow parameter defined by ν / α_N where

$$\nu = Q / Q_R$$

$$\alpha_N = N / N_R .$$

The range of the homologous parameter used for the calculations is

$$\nu / \alpha_N = 0.4$$

0.6

0.8

1.0

1.2

1.4

With these homologous parameters, the range of the actual flow rate will be 10,000 gpm to 35,000 gpm assuming the constant rotational speed (i.e., 1,000 rpm).

4) Inlet Void Fraction (α_1)

$$\alpha_1 = 0.00 \text{ to } 0.98$$

5.2.2 Properties of D_2O

The steam and liquid densities and enthalpies of D_2O were provided by the Los Alamos National Laboratory and a partial table of these quantities is given in Table 5.2.1.

5.2.3 Numerical Results for AC and DC Motor Operations

Figures 5.2.1 through 5.2.4 show the homologous head parameters as functions of the inlet void fraction and the homologous flow parameter for the static line pressures 3, 2, 1 and 0,05 atms, respectively, for the SRPRP operating with the AC motor, whereas Figures 5.2.5 through 5.2.8 show the same for the DC motor operation. Tables 5.2.2 through 5.2.5 show the detailed results corresponding to the AC operation, and Tables 5.2.6 through 5.2.9 show the same corresponding to the DC motor operation. Each set of the tables (i.e., for each static line pressure case) comprises the homologous head parameters, the static pressure rise, the normalized relative velocities of water and steam and the void fraction all at exit of the blade.

Although the results for the AC motor operation cases seem to be reasonable in terms of the numerical stability, those of the DC motor cases indicate a strong numerical instability, particularly for lower static cases as has been discussed in Section 5.1. Such instability is seen even in Figure 5.2.5 at $\nu/\alpha_N = 0.6$; at a certain α_1 the calculated homologous head suddenly deviates from a smooth curve. This instability becomes so violent in the case of $p_1 = 2$ atm where the homologous head shoots out of the scale of the graph.

Substantial effort has been made in finding the exact cause of this numerical instability problem, including 1) change of the number of control points along the stream tube of the blade flow passage and 2) change of the method of solving the system of the nonlinear ordinary differential equations from the Runge-Kutta method (i.e., an "explicit" method) to the Gear's method (i.e., an "implicit method").

The reason for using the Gear's method is that the implicit method is said to be more stable even for the "stiff" differential equations which seem to be the case.

Despite such effort, the numerical instability problem existed in the present numerical computations, requiring further study possibly by using a super computer in which the increment size and truncation errors will be eliminated from the possible cause of the instability problem. Fixing this numerical

instability problem will become imperative if the present two-phase flow pump computer code is to be incorporated into a system code such as TRAC code for the PWR coolant system safety analysis.

The torque calculations (Tasks 9 and 10) would be made based on the results of computations by using the computer code specially written for that purpose. However, due to the reasons described above, such torque computations have not been presently carried out.

Table 5.2.1

Steam Table for D₂OProperties of saturated D₂O

P(psia)	Tsat(f)	v _l	v _v	h _l	h _v	h _{vl}
0.7350E+00	0.9604E+02	0.1454E-01	0.4047E+03	0.5747E+02	0.1023E+04	0.9654E+03
0.1543E+02	0.2172E+03	0.1508E-01	0.2282E+02	0.1791E+03	0.1064E+04	0.8847E+03
0.3013E+02	0.2528E+03	0.1533E-01	0.1227E+02	0.2147E+03	0.1079E+04	0.8610E+03
0.4483E+02	0.2762E+03	0.1552E-01	0.8509E+01	0.2381E+03	0.1087E+04	0.8454E+03
0.5954E+02	0.2941E+03	0.1568E-01	0.6542E+01	0.2558E+03	0.1093E+04	0.8334E+03
0.7424E+02	0.3087E+03	0.1581E-01	0.5320E+01	0.2702E+03	0.1097E+04	0.8237E+03
0.8894E+02	0.3211E+03	0.1593E-01	0.4483E+01	0.2825E+03	0.1100E+04	0.8154E+03
0.1036E+03	0.3320E+03	0.1604E-01	0.3873E+01	0.2933E+03	0.1102E+04	0.8082E+03
0.1183E+03	0.3417E+03	0.1614E-01	0.3408E+01	0.3030E+03	0.1104E+04	0.8017E+03
0.1330E+03	0.3505E+03	0.1623E-01	0.3042E+01	0.3118E+03	0.1105E+04	0.7959E+03
0.1477E+03	0.3585E+03	0.1632E-01	0.2746E+01	0.3199E+03	0.1106E+04	0.7905E+03
0.1624E+03	0.3659E+03	0.1640E-01	0.2502E+01	0.3275E+03	0.1107E+04	0.7856E+03
0.1771E+03	0.3728E+03	0.1648E-01	0.2297E+01	0.3346E+03	0.1108E+04	0.7810E+03
0.1918E+03	0.3792E+03	0.1655E-01	0.2124E+01	0.3412E+03	0.1109E+04	0.7767E+03
0.2065E+03	0.3853E+03	0.1662E-01	0.1974E+01	0.3476E+03	0.1109E+04	0.7727E+03
0.2212E+03	0.3910E+03	0.1669E-01	0.1844E+01	0.3537E+03	0.1110E+04	0.7689E+03
0.2359E+03	0.3964E+03	0.1672E-01	0.1730E+01	0.3595E+03	0.1110E+04	0.7653E+03
0.2506E+03	0.4015E+03	0.1672E-01	0.1629E+01	0.3651E+03	0.1111E+04	0.7618E+03
0.2653E+03	0.4065E+03	0.1672E-01	0.1540E+01	0.3704E+03	0.1111E+04	0.7586E+03
0.2800E+03	0.4112E+03	0.1672E-01	0.1459E+01	0.3757E+03	0.1111E+04	0.7554E+03

Unit for v_l and v_v [ft**3/lbm]
 h_l and h_v [btu/lbm]

Figure 5.2.1

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 3$ atm)

Head Degradation of SRPRP

Steam-Water Case, AC Motor, $P_1=3.0$ atm

Figure 5.2.2

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 2$ atm)

Head Degradation of SRPRP

Steam-Water Case, AC Motor, $P_1=2.0$ atm

Figure 5.2.3

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 1 \text{ atm}$)

Head Degradation of SRPRP

Steam-Water Case, AC Motor, $P_1 = 1.0 \text{ atm}$

Figure 5.2.4

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 0.05$ atm)

Head Degradation of SRPRP

Steam-Water Case, AC Motor, $P_1 = 0.05$ atm

Table 5.2.2

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 3$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.228	1.184	1.117	1.000	0.794	0.452
0.05	1.327	1.250	1.223	1.103	0.883	0.507
0.10	1.334	1.292	1.226	1.115	0.895	0.517
0.15	1.500	1.293	1.236	1.128	0.908	0.526
0.20	1.321	1.286	1.214	1.131	0.917	0.534
0.25	1.307	1.280	1.242	1.140	0.927	0.540
0.30	1.406	1.284	1.202	1.143	0.934	0.547
0.35	1.236	1.228	1.201	1.118	0.923	0.546
0.40	1.224	1.219	1.200	1.115	0.920	0.554
0.45	1.208	1.192	1.181	1.104	0.924	0.556
0.50	1.193	1.173	1.152	1.091	0.919	0.545
0.55	1.171	1.153	1.123	1.073	0.896	0.547
0.60	1.140	1.113	1.090	1.026	0.859	0.525
0.65	1.092	1.064	1.039	0.983	0.816	0.501
0.70	-0.225	0.986	0.966	0.908	0.767	0.462
0.75	-0.133	-0.291	0.838	0.795	0.674	0.408
0.80	-0.079	-0.134	-0.231	-0.367	0.502	0.313
0.85	-0.046	-0.055	-0.081	-0.114	-0.138	-0.115
0.90	-0.021	-0.011	-0.012	-0.019	-0.028	-0.026
0.95	0.019	0.032	0.036	0.034	0.023	0.008

Table 5.2.2

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 3$ atm)
(continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	162.54	163.31	164.40	165.79	167.49	169.51
0.05	187.09	179.03	189.26	191.11	193.34	196.04
0.10	189.45	189.02	189.17	192.91	195.53	198.98
0.15	230.58	189.56	191.26	195.35	198.08	201.87
0.20	188.62	188.58	185.95	195.46	199.78	205.01
0.25	187.14	188.02	192.99	197.64	202.19	206.91
0.30	213.41	190.45	184.21	198.46	203.98	209.59
0.35	175.07	179.21	185.32	192.87	200.58	208.39
0.40	176.07	179.88	187.07	193.50	200.62	213.08
0.45	176.76	177.21	185.68	193.07	203.66	215.30
0.50	179.22	177.93	182.90	193.23	204.94	212.24
0.55	181.63	179.96	181.95	193.92	202.54	216.93
0.60	184.34	179.77	182.37	189.64	198.12	212.06
0.65	186.30	180.54	182.03	189.60	195.20	209.25
0.70	1.52	179.72	181.30	186.38	195.37	203.85
0.75	0.94	2.07	175.44	181.47	190.08	198.84
0.80	0.61	1.08	1.79	2.84	174.94	187.18
0.85	0.42	0.60	0.84	1.13	1.45	1.83
0.90	0.34	0.39	0.45	0.53	0.60	0.68
0.95	0.30	0.31	0.32	0.33	0.35	0.36

Table S.2.2

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 3$ atm)
(continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.111	0.167	0.222	0.278	0.334	0.389
0.05	0.106	0.159	0.211	0.264	0.317	0.370
0.10	0.100	0.150	0.200	0.250	0.300	0.350
0.15	0.095	0.142	0.189	0.236	0.284	0.331
0.20	0.089	0.134	0.178	0.223	0.267	0.312
0.25	0.083	0.125	0.167	0.209	0.250	0.292
0.30	0.078	0.117	0.156	0.195	0.234	0.273
0.35	0.072	0.109	0.145	0.181	0.217	0.253
0.40	0.067	0.100	0.134	0.167	0.200	0.234
0.45	0.061	0.092	0.123	0.153	0.184	0.214
0.50	0.056	0.084	0.111	0.139	0.167	0.195
0.55	0.050	0.075	0.100	0.125	0.150	0.176
0.60	0.045	0.067	0.089	0.112	0.134	0.156
0.65	0.039	0.059	0.078	0.098	0.117	0.137
0.70	0.842	0.050	0.067	0.084	0.100	0.117
0.75	0.860	0.838	0.056	0.070	0.084	0.098
0.80	0.872	0.867	0.862	0.856	0.067	0.078
0.85	0.861	0.884	0.890	0.901	0.917	0.935
0.90	0.887	0.894	0.906	0.922	0.942	0.966
0.95	0.890	0.900	0.914	0.932	0.954	0.979

Table 5.2.2

Steam/Water 2- ϕ Flow Cases
 (AC Motor, $p_1 = 3$ atm)
 (continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
 AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.031	0.000	0.000	0.000	0.000	0.000
0.75	0.059	0.048	0.000	0.000	0.000	0.000
0.80	0.077	0.102	0.109	0.084	0.000	0.000
0.85	0.088	0.130	0.168	0.200	0.226	0.245
0.90	0.097	0.146	0.195	0.243	0.291	0.338
0.95	0.105	0.158	0.211	0.264	0.318	0.371

Table 5.2.9

Steam/Water 2- ϕ Flow Cases
 (DC Motor, $p_1 = 0.05$ atm)
 (continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
 for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
 DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	15.58	15.63	15.70	15.79	15.91	16.04
0.05	15.96	16.04	16.11	14.10	16.43	16.62
0.10	15.98	16.08	16.19	15.88	16.57	16.83
0.15	15.99	16.11	16.26	16.31	16.70	16.99
0.20	16.02	16.15	16.32	16.51	16.83	17.16
0.25	16.02	16.17	16.37	16.61	16.50	17.32
0.30	16.04	16.20	16.43	16.70	16.96	17.46
0.45	16.28	16.48	16.70	17.10	17.54	17.57
0.50	16.42	16.63	16.92	17.25	16.80	17.96
0.55	16.59	16.82	17.12	17.51	17.99	18.56
0.60	16.81	17.02	17.35	17.76	18.26	18.85
0.65	17.08	17.20	17.60	18.03	18.57	19.18
0.70	17.43	17.38	17.71	18.29	18.90	19.56
0.75	17.91	17.72	18.03	18.36	19.26	19.97
0.80	18.64	18.12	18.27	18.68	19.19	20.17
0.85	19.86	18.91	18.61	18.74	19.41	20.15
0.90	22.30	20.67	19.83	19.64	19.76	20.22
0.95	29.64	0.00	0.00	0.00	0.00	0.00

Table 5.2.9

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)
(continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.092	0.138	0.184	0.230	0.276	0.322
0.05	0.087	0.131	0.175	0.218	0.262	0.306
0.10	0.083	0.124	0.166	0.207	0.248	0.290
0.15	0.078	0.117	0.156	0.195	0.234	0.273
0.20	0.073	0.110	0.147	0.184	0.221	0.257
0.25	0.069	0.103	0.138	0.172	0.207	0.241
0.30	0.064	0.097	0.129	0.161	0.193	0.225
0.45	0.050	0.076	0.101	0.126	0.152	0.177
0.50	0.046	0.069	0.092	0.115	0.138	0.161
0.55	0.041	0.062	0.083	0.103	0.124	0.145
0.60	0.037	0.055	0.073	0.092	0.110	0.129
0.65	0.032	0.048	0.064	0.080	0.097	0.113
0.70	0.028	0.041	0.055	0.069	0.083	0.097
0.75	0.023	0.034	0.046	0.057	0.069	0.080
0.80	0.018	0.028	0.037	0.046	0.055	0.064
0.85	0.014	0.021	0.028	0.034	0.041	0.048
0.90	0.009	0.014	0.018	0.023	0.028	0.032
0.95	0.005	0.005	0.005	0.005	0.005	0.005

Table 5.2.9

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)
(continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000
0.85	0.000	0.000	0.000	0.000	0.000	0.000
0.90	0.000	0.000	0.000	0.000	0.000	0.000
0.95	0.000	0.120	0.153	0.179	0.197	0.206

Table 5.2.9

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)
(continued)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000
0.85	0.000	0.000	0.000	0.000	0.000	0.000
0.90	0.000	0.000	0.000	0.000	0.000	0.000
0.95	0.000	0.992	0.990	0.987	0.985	0.983

Table 5.2.2

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 3$ atm)
(continued)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.960	0.000	0.000	0.000	0.000	0.000
0.75	0.968	0.950	0.000	0.000	0.000	0.000
0.80	0.974	0.961	0.948	0.935	0.000	0.000
0.85	0.981	0.972	0.962	0.954	0.945	0.937
0.90	0.987	0.981	0.975	0.970	0.965	0.960
0.95	0.994	0.991	0.988	0.985	0.983	0.980

Table 5.2.3

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 2$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.228	1.184	1.117	1.000	0.794	0.452
0.05	1.275	1.257	1.192	1.074	0.859	0.493
0.10	1.293	1.261	1.202	1.086	0.874	0.504
0.15	1.304	1.268	1.211	1.100	0.888	0.514
0.20	1.290	1.274	1.221	1.113	0.902	0.524
0.25	1.292	1.277	1.227	1.123	0.914	0.534
0.30	1.284	1.274	1.233	1.134	0.925	0.542
0.35	1.267	1.260	1.228	1.136	0.931	0.551
0.40	1.258	1.261	1.233	1.139	0.951	0.562
0.45	1.253	1.259	1.229	1.160	0.952	0.574
0.50	1.242	1.250	1.229	1.158	0.971	0.584
0.55	1.228	1.223	1.209	1.149	0.956	0.587
0.60	1.208	1.202	1.190	1.119	0.959	0.582
0.65	1.181	1.172	1.162	1.094	0.941	0.570
0.70	1.139	1.126	1.117	1.059	0.892	0.544
0.75	-0.172	1.053	1.045	0.987	0.836	0.512
0.80	-0.092	-0.189	0.910	0.872	0.741	0.455
0.85	-0.049	-0.072	-0.117	-0.176	-0.227	-0.206
0.90	-0.023	-0.017	-0.022	-0.033	-0.044	-0.039
0.95	0.004	0.017	0.024	0.023	0.013	0.003

Table 5.2.3

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 2$ atm)
(continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	164.53	165.32	166.41	167.83	169.55	171.59
0.05	180.76	181.98	183.06	185.06	187.20	190.23
0.10	180.15	182.04	183.98	186.14	189.47	193.05
0.15	182.91	183.22	184.82	187.90	191.56	195.82
0.20	179.66	184.02	186.20	189.42	193.59	198.23
0.25	180.72	184.46	186.56	190.52	195.37	200.96
0.30	184.57	183.80	187.38	192.20	197.11	203.13
0.35	176.73	180.97	186.06	191.56	197.52	205.36
0.40	176.32	182.16	187.40	192.02	202.56	209.59
0.45	177.48	183.32	187.16	197.54	202.26	214.53
0.50	178.21	183.52	188.85	198.00	208.58	219.39
0.55	179.40	180.55	186.90	197.57	205.21	221.98
0.60	180.49	180.81	186.43	193.30	209.01	221.57
0.65	182.37	181.12	186.35	192.69	208.34	219.30
0.70	183.98	180.91	185.32	192.82	201.54	213.64
0.75	0.89	179.51	183.15	188.51	197.81	210.05
0.80	0.52	1.05	175.12	182.83	191.39	202.77
0.85	0.33	0.52	0.78	1.12	1.58	2.22
0.90	0.24	0.29	0.36	0.43	0.51	0.59
0.95	0.21	0.21	0.22	0.23	0.24	0.25

Table 5.2.3

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 2$ atm)
(continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void
Fraction for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.111	0.167	0.222	0.278	0.334	0.389
0.05	0.106	0.159	0.211	0.264	0.317	0.370
0.10	0.100	0.150	0.200	0.250	0.300	0.350
0.15	0.095	0.142	0.189	0.236	0.284	0.331
0.20	0.089	0.134	0.178	0.223	0.267	0.312
0.25	0.083	0.125	0.167	0.209	0.250	0.292
0.30	0.078	0.117	0.156	0.195	0.234	0.273
0.35	0.072	0.108	0.145	0.181	0.217	0.253
0.40	0.067	0.100	0.134	0.167	0.200	0.234
0.45	0.061	0.092	0.122	0.153	0.184	0.214
0.50	0.056	0.083	0.111	0.139	0.167	0.195
0.55	0.050	0.075	0.100	0.125	0.150	0.175
0.60	0.045	0.067	0.089	0.111	0.134	0.156
0.65	0.039	0.059	0.078	0.098	0.117	0.137
0.70	0.033	0.050	0.067	0.084	0.100	0.117
0.75	0.858	0.042	0.056	0.070	0.084	0.098
0.80	0.872	0.864	0.045	0.056	0.067	0.078
0.85	0.881	0.883	0.889	0.898	0.908	0.918
0.90	0.887	0.894	0.906	0.922	0.942	0.965
0.95	0.890	0.900	0.914	0.932	0.954	0.980

Table 5.2.3

Steam/Water 2- ϕ Flow Cases
 (AC Motor, $p_1 = 2$ atm)
 (continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
 AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.037	0.000	0.000	0.000	0.000	0.000
0.80	0.067	0.070	0.000	0.000	0.000	0.000
0.85	0.085	0.120	0.144	0.154	0.143	0.097
0.90	0.096	0.143	0.189	0.234	0.277	0.318
0.95	0.104	0.157	0.209	0.262	0.315	0.368

Table 5.2.3

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 2$ atm)
(continued)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.968	0.000	0.000	0.000	0.000	0.000
0.80	0.974	0.961	0.000	0.000	0.000	0.000
0.85	0.981	0.972	0.962	0.953	0.945	0.936
0.90	0.987	0.981	0.975	0.970	0.965	0.960
0.95	0.994	0.991	0.988	0.985	0.983	0.980

Table 5.2.4

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 1$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.228	1.184	1.117	1.000	0.794	0.452
0.05	1.265	1.225	1.162	1.046	0.837	0.480
0.10	1.269	1.234	1.176	1.063	0.854	0.493
0.15	1.275	1.244	1.190	1.078	0.871	0.505
0.20	1.285	1.252	1.202	1.096	0.888	0.517
0.25	1.286	1.291	1.215	1.112	0.904	0.528
0.30	1.287	1.267	1.226	1.127	0.920	0.539
0.35	1.287	1.266	1.236	1.140	0.935	0.550
0.40	1.287	1.279	1.252	1.159	0.955	0.552
0.45	1.288	1.285	1.265	1.179	0.973	0.579
0.50	1.286	1.289	1.274	1.194	0.992	0.593
0.55	1.278	1.288	1.283	1.205	1.003	0.604
0.60	1.273	1.285	1.282	1.198	1.009	0.607
0.65	1.264	1.269	1.271	1.202	1.017	0.619
0.70	1.249	1.255	1.247	1.194	1.002	0.607
0.75	1.225	1.231	1.224	1.165	0.988	0.601
0.80	1.179	1.184	1.177	1.121	0.947	0.580
0.85	-0.068	-0.138	1.083	1.035	0.881	0.538
0.90	-0.028	-0.033	-0.052	-0.079	-0.103	-0.091
0.95	-0.004	0.007	0.012	0.010	0.002	-0.005

Table 5.2.4

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 1$ atm)
(continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	167.36	168.16	169.27	170.71	172.46	174.54
0.05	175.40	176.53	178.01	179.88	182.64	185.81
0.10	175.56	176.99	178.94	181.50	184.77	188.25
0.15	176.00	177.55	179.98	182.62	186.72	191.43
0.20	177.68	178.03	180.82	184.36	188.82	194.07
0.25	187.11	186.07	181.71	185.68	190.51	196.49
0.30	176.94	178.90	182.37	186.89	192.25	198.17
0.35	174.58	177.28	183.00	187.90	193.81	200.18
0.40	175.94	179.64	185.26	190.55	197.20	197.82
0.45	176.99	180.51	187.10	193.55	199.87	208.81
0.50	177.04	181.28	188.18	195.61	203.47	212.88
0.55	176.39	181.28	189.85	197.28	205.04	216.02
0.60	177.25	181.68	189.99	194.98	205.43	215.78
0.65	178.13	179.89	188.62	196.61	207.96	220.59
0.70	179.43	180.49	185.69	196.60	204.47	215.17
0.75	181.11	181.21	185.63	193.77	203.91	215.23
0.80	182.09	181.17	184.59	191.64	199.80	212.03
0.85	0.23	0.46	181.37	188.26	197.24	207.12
0.90	0.14	0.19	0.27	0.36	0.47	0.61
0.95	0.11	0.11	0.12	0.13	0.14	0.15

Table 5.2.4

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 1$ atm)
(continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.111	0.167	0.222	0.278	0.334	0.389
0.05	0.106	0.158	0.211	0.264	0.317	0.370
0.10	0.100	0.150	0.200	0.250	0.300	0.351
0.15	0.095	0.142	0.189	0.236	0.284	0.331
0.20	0.089	0.133	0.178	0.222	0.267	0.311
0.25	0.083	0.125	0.167	0.209	0.250	0.292
0.30	0.078	0.117	0.156	0.195	0.234	0.273
0.35	0.072	0.108	0.145	0.181	0.217	0.253
0.40	0.067	0.100	0.134	0.167	0.200	0.234
0.45	0.061	0.092	0.122	0.153	0.184	0.214
0.50	0.056	0.083	0.111	0.139	0.167	0.195
0.55	0.050	0.075	0.100	0.125	0.150	0.175
0.60	0.045	0.067	0.089	0.111	0.134	0.156
0.65	0.039	0.058	0.078	0.097	0.117	0.136
0.70	0.033	0.050	0.067	0.084	0.100	0.117
0.75	0.028	0.042	0.056	0.070	0.084	0.097
0.80	0.022	0.033	0.045	0.056	0.067	0.078
0.85	0.881	0.881	0.033	0.042	0.050	0.059
0.90	0.887	0.894	0.905	0.920	0.939	0.960
0.95	0.890	0.900	0.914	0.932	0.954	0.980

Table 5.2.4

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 1$ atm)
(continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000
0.85	0.069	0.067	0.000	0.000	0.000	0.000
0.90	0.090	0.130	0.164	0.189	0.202	0.199
0.95	0.102	0.154	0.205	0.256	0.307	0.357

Table 5.2.4

Steam/Water 2- ϕ Flow Cases
(AC Motor, $p_1 = 1$ atm)
(continued)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000
0.85	0.981	0.972	0.000	0.000	0.000	0.000
0.90	0.987	0.981	0.975	0.970	0.964	0.959
0.95	0.994	0.991	0.988	0.985	0.983	0.980

Table 5.2.5

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.228	1.184	1.117	1.000	0.794	0.452
0.05	1.237	1.198	1.135	1.021	0.815	0.466
0.10	1.246	1.211	1.152	1.041	0.835	0.481
0.15	1.255	1.223	1.169	1.061	0.855	0.495
0.20	1.263	1.236	1.186	1.081	0.875	0.509
0.25	1.271	1.249	1.203	1.101	0.895	0.523
0.30	1.276	1.262	1.220	1.121	0.915	0.537
0.35	1.276	1.274	1.237	1.141	0.936	0.551
0.40	1.291	1.288	1.254	1.161	0.956	0.565
0.45	1.305	1.300	1.271	1.181	0.976	0.580
0.50	1.306	1.313	1.289	1.201	0.996	0.594
0.55	1.308	1.326	1.306	1.222	1.017	0.608
0.60	1.330	1.339	1.323	1.242	1.037	0.622
0.65	1.339	1.337	1.340	1.261	1.057	0.637
0.70	1.347	1.365	1.357	1.282	1.077	0.651
0.75	1.355	1.378	1.357	1.302	1.090	0.665
0.80	1.362	1.388	1.391	1.322	1.118	0.680
0.85	1.364	1.396	1.404	1.341	1.136	0.694
0.90	1.364	1.399	1.409	1.348	1.149	0.702
0.95	1.349	1.383	1.395	1.337	1.140	0.698

Table 5.2.5

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)
(continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	173.37	174.20	175.36	176.84	178.66	180.81
0.05	173.94	175.09	176.69	178.76	181.30	184.30
0.10	174.20	175.66	177.71	180.36	183.57	187.40
0.15	172.10	176.20	178.67	181.85	185.74	190.33
0.20	174.85	176.70	179.57	183.26	187.77	193.09
0.25	174.88	177.19	180.43	184.59	189.68	195.70
0.30	174.16	177.64	181.22	185.83	191.47	198.12
0.35	174.16	178.09	182.00	187.02	193.17	200.44
0.40	174.40	178.59	182.78	188.19	194.80	202.62
0.45	175.82	179.02	183.52	189.29	196.34	204.66
0.50	173.70	179.48	184.23	190.32	197.76	206.54
0.55	172.76	179.89	185.12	191.30	199.10	208.30
0.60	176.58	180.36	185.55	192.20	200.30	209.89
0.65	176.91	176.93	186.21	193.11	201.50	211.41
0.70	177.43	181.23	186.90	194.04	202.68	212.87
0.75	177.77	181.95	183.41	194.95	203.85	214.33
0.80	178.10	182.22	188.55	195.96	205.14	216.01
0.85	177.63	182.18	188.90	197.07	206.18	217.64
0.90	177.90	182.14	188.51	196.12	206.60	217.41
0.95	179.25	182.25	187.68	195.06	204.25	215.29

Table 5.2.5

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)
(continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void
Fraction for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.111	0.167	0.222	0.278	0.334	0.389
0.05	0.106	0.158	0.211	0.264	0.317	0.370
0.10	0.100	0.150	0.200	0.250	0.300	0.350
0.15	0.095	0.142	0.189	0.236	0.284	0.331
0.20	0.089	0.133	0.178	0.222	0.267	0.311
0.25	0.083	0.125	0.167	0.209	0.250	0.292
0.30	0.078	0.117	0.156	0.195	0.234	0.272
0.35	0.072	0.108	0.145	0.181	0.217	0.253
0.40	0.067	0.100	0.133	0.167	0.200	0.234
0.45	0.061	0.092	0.122	0.153	0.184	0.214
0.50	0.056	0.083	0.111	0.139	0.167	0.195
0.55	0.050	0.075	0.100	0.125	0.150	0.175
0.60	0.045	0.067	0.089	0.111	0.133	0.156
0.65	0.039	0.058	0.078	0.097	0.117	0.136
0.70	0.033	0.050	0.067	0.083	0.100	0.117
0.75	0.028	0.042	0.056	0.070	0.085	0.097
0.80	0.022	0.033	0.045	0.056	0.067	0.080
0.85	0.017	0.025	0.033	0.042	0.050	0.058
0.90	0.011	0.017	0.022	0.028	0.033	0.039
0.95	0.006	0.008	0.011	0.014	0.017	0.019

Table 5.2.5

Steam/Water 2- ϕ Flow Cases
 (DC Motor, $p_1 = 0.05$ atm)
 (continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
 AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000
0.85	0.000	0.000	0.000	0.000	0.000	0.000
0.90	0.000	0.000	0.000	0.000	0.000	0.000
0.95	0.000	0.000	0.000	0.000	0.000	0.000

Table 5.2.5

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)
(continued)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
AC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000
0.85	0.000	0.000	0.000	0.000	0.000	0.000
0.90	0.000	0.000	0.000	0.000	0.000	0.000
0.95	0.000	0.000	0.000	0.000	0.000	0.000

Figure 5.2.5

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 3$ atm)

Head Degradation of SRPRP

Steam-Water Case, DC Motor, $P_1 = 0.05$ atm

Figure 5.2.7

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 1$ atm)

Head Degradation of SRPRP

Steam-Water Case, DC Motor, $P_1 = 2.0$ atm

Table 5.2.6

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 3$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.008	1.005	1.002	1.000	0.999	0.999
0.05	1.013	1.011	1.791	1.271	1.260	1.983
0.10	1.019	0.945	0.943	0.930		
0.15	1.024	0.889	0.910	0.903	1.692	1.706
0.20	1.030	0.833	0.793		2.663	2.726
0.25	1.027	0.773	0.709	0.873	2.421	2.481
0.30	1.042	0.920	0.572	0.707	0.910	1.299
0.35	1.047	0.973	0.741	0.600	0.540	0.478
0.40	1.053	0.966	0.684	0.479	0.374	0.303
0.45	1.059	0.951	0.626	0.361	0.203	0.128
0.50	1.065	0.935	0.556	0.241	0.017	-0.122
0.55	1.070	0.918	0.472	0.087	-0.191	-0.383
0.60	1.076	0.893	0.371	-0.097	-0.450	-0.714
0.65	1.082	0.862	0.206	-0.375	-0.807	-1.151
0.70	1.087	0.811	-0.516	-0.770	-1.105	-1.533
0.75	1.093	-0.227	-0.301	-0.416	-0.566	-0.747
0.80	1.098	-0.146	-0.161	-0.200	-0.258	-0.331
0.85	1.102	-0.080	-0.064	-0.063	-0.072	-0.092
0.90	1.107	0.003	0.033	0.051	0.059	0.066
0.95	1.143	0.217	0.237	0.269	0.285	0.306

Table 5.2.6

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 3$ atm)
(continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	14.61	14.66	14.73	14.81	14.92	15.04
0.05	16.93	16.96	36.66	23.41	22.97	38.92
0.10	19.51	17.59	17.65	17.43		
0.15	22.40	18.82	19.42	19.34	37.81	37.47
0.20	25.65	20.38	19.47		63.27	63.04
0.25	29.09	22.30	20.74	24.91	60.95	60.85
0.30	33.52	30.11	21.23	24.74	29.65	38.33
0.35	38.36	36.11	30.04	26.67	25.50	24.45
0.40	44.00	41.33	33.97	29.04	26.89	25.78
0.45	50.67	47.38	38.89	32.51	29.19	28.09
0.50	58.65	54.74	44.84	37.26	32.45	30.06
0.55	68.40	63.81	52.18	42.93	36.96	33.53
0.60	80.57	75.13	61.54	50.28	42.69	37.88
0.65	96.20	89.72	72.72	58.84	49.61	43.30
0.70	117.00	108.97	0.33	0.50	0.70	0.93
0.75	146.05	0.12	0.19	0.28	0.37	0.47
0.80	189.49	0.07	0.11	0.15	0.19	0.23
0.85	261.53	0.04	0.06	0.07	0.09	0.11
0.90	404.35	0.03	0.04	0.04	0.05	0.05
0.95	823.48	0.03	0.03	0.03	0.03	0.03

Table 5.2.6

Steam/Water 2- ϕ Flow Cases
 (DC Motor, $p_1 = 3$ atm)
 (continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void
 Fraction for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
 DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.092	0.138	0.184	0.230	0.276	0.322
0.05	0.087	0.131	0.175	0.218	0.262	0.306
0.10	0.083	0.124	0.166	0.207	0.248	0.290
0.15	0.078	0.117	0.156	0.195	0.235	0.274
0.20	0.073	0.110	0.147	0.184	0.221	0.258
0.25	0.069	0.103	0.138	0.173	0.207	0.242
0.30	0.064	0.097	0.129	0.161	0.193	0.226
0.35	0.060	0.090	0.120	0.150	0.179	0.209
0.40	0.055	0.083	0.110	0.138	0.166	0.193
0.45	0.051	0.076	0.101	0.127	0.152	0.177
0.50	0.046	0.069	0.092	0.115	0.138	0.161
0.55	0.041	0.062	0.083	0.104	0.124	0.145
0.60	0.037	0.055	0.074	0.092	0.111	0.129
0.65	0.032	0.048	0.065	0.081	0.097	0.113
0.70	0.028	0.042	0.816	0.799	0.784	0.772
0.75	0.023	0.856	0.847	0.842	0.842	0.846
0.80	0.019	0.871	0.870	0.873	0.879	0.890
0.85	0.014	0.882	0.886	0.894	0.905	0.920
0.90	0.009	0.890	0.898	0.908	0.922	0.939
0.95	0.005	0.894	0.904	0.916	0.931	0.949

Table 5.2.6

Steam/Water 2- ϕ Flow Cases
 (DC Motor, $p_1 = 3$ atm)
 (continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void
 Fraction for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
 DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.118	0.139	0.155	0.163
0.75	0.000	0.102	0.136	0.168	0.199	0.227
0.80	0.000	0.111	0.149	0.187	0.225	0.262
0.85	0.000	0.119	0.159	0.201	0.242	0.284
0.90	0.000	0.126	0.169	0.212	0.256	0.300
0.95	0.000	0.132	0.177	0.222	0.267	0.313

Table 5.2.6

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 3$ atm)
(continued)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 3.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.932	0.914	0.894	0.875
0.75	0.000	0.960	0.946	0.932	0.918	0.905
0.80	0.000	0.968	0.958	0.947	0.937	0.928
0.85	0.000	0.977	0.969	0.961	0.954	0.948
0.90	0.000	0.985	0.980	0.975	0.970	0.966
0.95	0.000	0.992	0.990	0.987	0.985	0.983

Table 5.2.7

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 2$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.008	1.005	1.002	1.000	0.999	0.999
0.05	1.013	1.265	1.611	1.615	1.700	1.673
0.10	1.019	1.365	1.495	1.623	1.458	1.605
0.15	1.025	1.028	1.676	1.486	2.032	1.572
0.20	1.030	0.945	1.397	1.488	1.458	1.550
0.25	1.036	0.880	1.318	1.452	1.411	1.430
0.30	1.042	0.899	1.006	0.889	1.310	1.283
0.35	1.048	0.987	0.847	0.776	0.741	0.760
0.40	1.054	0.979	0.804	0.718	0.677	0.635
0.45	1.059	0.968	0.757	0.622	0.565	0.522
0.50	1.065	0.954	0.704	0.527	0.431	0.373
0.55	1.071	0.935	0.639	0.416	0.279	0.175
0.60	1.076	0.916	0.560	0.282	0.088	-0.039
0.65	1.082	0.890	0.458	0.112	-0.143	-0.334
0.70	1.087	0.856	-0.693	-1.139	-0.479	-0.722
0.75	1.093	-0.244	-0.379	-0.572	-0.827	-1.150
0.80	1.098	-0.143	-0.190	-0.266	-0.366	-0.487
0.85	1.103	-0.069	-0.075	-0.092	-0.121	-0.160
0.90	1.108	0.000	0.013	0.020	0.021	0.014
0.95	1.135	0.172	0.182	0.185	0.203	0.213

Table 5.2.7

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 2$ atm)
(continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	14.79	14.84	14.91	14.99	15.10	15.22
0.05	16.34	23.05	31.71	31.32	32.81	31.61
0.10	18.07	27.21	30.22	32.93	28.51	31.44
0.15	20.00	20.03	36.50	31.19	43.58	32.23
0.20	22.17	19.80	31.30	33.08	31.89	33.50
0.25	24.63	20.31	31.47	34.34	32.86	32.84
0.30	27.43	23.41	26.05	23.01	32.93	31.92
0.35	30.67	28.73	24.96	23.14	22.37	22.95
0.40	34.44	32.07	27.33	25.15	24.25	23.46
0.45	38.89	36.02	30.30	26.92	25.68	24.92
0.50	44.23	40.76	33.99	29.56	27.45	26.44
0.55	50.74	46.56	38.57	33.00	29.97	28.03
0.60	58.87	53.96	44.41	37.51	33.20	30.88
0.65	69.32	63.50	51.97	43.42	37.79	34.18
0.70	83.24	76.29	0.34	0.55	43.38	38.86
0.75	102.68	0.11	0.19	0.28	0.39	0.52
0.80	131.79	0.06	0.10	0.14	0.19	0.24
0.85	180.14	0.04	0.05	0.07	0.09	0.10
0.90	276.29	0.02	0.03	0.03	0.04	0.04
0.95	560.75	0.02	0.02	0.02	0.02	0.02

Table 5.2.7

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 2$ atm)
(continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.092	0.138	0.184	0.230	0.276	0.322
0.05	0.087	0.131	0.175	0.218	0.262	0.306
0.10	0.083	0.124	0.166	0.207	0.248	0.290
0.15	0.078	0.117	0.156	0.195	0.234	0.273
0.20	0.073	0.110	0.147	0.184	0.221	0.257
0.25	0.069	0.103	0.138	0.173	0.207	0.241
0.30	0.064	0.097	0.129	0.161	0.193	0.225
0.35	0.060	0.090	0.120	0.150	0.179	0.209
0.40	0.055	0.083	0.110	0.138	0.166	0.193
0.45	0.051	0.076	0.101	0.126	0.152	0.177
0.50	0.046	0.069	0.092	0.115	0.138	0.161
0.55	0.041	0.062	0.083	0.104	0.124	0.145
0.60	0.037	0.055	0.074	0.092	0.110	0.129
0.65	0.032	0.048	0.065	0.081	0.097	0.113
0.70	0.028	0.042	0.0812	0.787	0.083	0.097
0.75	0.023	0.0856	0.847	0.840	0.836	0.834
0.80	0.019	0.872	0.871	0.873	0.879	0.889
0.85	0.014	0.883	0.888	0.895	0.906	0.920
0.90	0.009	0.891	0.899	0.909	0.923	0.940
0.95	0.005	0.895	0.905	0.918	0.933	0.950

Table 5.2.7

Steam/Water 2- ϕ Flow Cases
 (DC Motor, $p_1 = 2$ atm)
 (continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void
 Fraction for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
 DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.099	0.098	0.000	0.000
0.75	0.000	0.098	0.127	0.151	0.169	0.180
0.80	0.000	0.109	0.145	0.180	0.214	0.247
0.85	0.000	0.118	0.158	0.199	0.239	0.279
0.90	0.000	0.126	0.168	0.211	0.255	0.299
0.95	0.000	0.132	0.177	0.222	0.267	0.312

Table 5.2.7

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 2$ atm)
(continued)

Discharge Void Fraction vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 2.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.932	0.912	0.000	0.000
0.75	0.000	0.960	0.946	0.932	0.917	0.903
0.80	0.000	0.968	0.958	0.947	0.937	0.928
0.85	0.000	0.977	0.969	0.961	0.954	0.948
0.90	0.000	0.985	0.980	0.975	0.970	0.966
0.95	0.000	0.992	0.990	0.987	0.985	0.983

Table 5.2.8

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 1$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.008	1.005	1.002	1.000	0.999	0.999
0.05	1.249	1.289	1.302	1.319	1.286	1.344
0.10	1.244	1.272	1.259	1.279	1.313	1.325
0.15	1.168	1.237	1.253	1.267	1.293	1.307
0.20	1.260	1.238	1.224	1.231	1.267	1.285
0.25	1.261	1.151	1.248	1.218	1.241	1.251
0.30	1.042	1.052	1.172	1.170	1.194	1.222
0.35	1.047	1.014	0.985	0.986	1.024	1.071
0.40	1.053	1.015	0.970	0.966	0.992	1.026
0.45	1.059	1.007	0.944	0.927	0.928	0.989
0.50	1.065	0.992	0.902	0.858	0.852	0.916
0.55	1.071	0.982	0.857	0.803	0.779	0.769
0.60	1.076	0.966	0.810	0.730	0.683	0.658
0.65	1.082	0.946	0.749	0.625	0.550	0.521
0.70	1.088	0.922	0.671	0.502	0.394	0.313
0.75	1.093	0.389	0.551	0.319	0.160	0.048
0.80	1.099	-0.189	-0.319	-0.507	-0.761	-1.103
0.85	1.104	-0.083	-0.122	-0.181	-0.257	-0.349
0.90	1.109	-0.017	-0.017	-0.025	-0.039	-0.061
0.95	1.124	0.068	0.070	0.084	0.094	0.093

Table 5.2.8

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 1$ atm)
(continued)

Static Pressure Rise in psia at Vane Exit vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $F_1 = 1.0$ atm.

DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	15.04	15.09	15.16	15.25	15.36	15.49
0.05	22.37	23.30	23.45	23.68	22.67	23.82
0.10	22.93	23.49	22.94	23.24	23.83	23.86
0.15	21.63	23.30	23.48	23.58	23.97	24.03
0.20	25.14	24.20	23.56	23.45	24.06	24.21
0.25	26.24	22.88	25.12	24.03	24.31	24.25
0.30	21.41	21.41	24.29	23.91	24.20	24.57
0.35	23.03	21.79	20.78	20.60	21.38	22.31
0.40	24.92	23.49	21.99	21.65	22.09	22.72
0.45	27.16	25.27	23.26	22.57	22.39	23.64
0.50	29.84	27.33	24.56	23.17	22.84	24.20
0.55	33.10	30.11	26.37	24.71	23.96	23.63
0.60	37.18	33.52	28.94	26.60	25.31	24.67
0.65	42.42	38.00	32.31	28.88	26.95	26.30
0.70	49.40	44.10	36.97	32.41	29.75	28.01
0.75	59.17	52.76	43.31	37.25	33.48	31.18
0.80	73.79	0.05	0.09	0.14	0.20	0.28
0.85	98.13	0.03	0.04	0.06	0.08	0.10
0.90	146.66	0.01	0.02	0.02	0.03	0.03
0.95	291.39	0.01	0.01	0.01	0.01	0.01

Table 5.2.8

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 1$ atm)
(continued)

Normalized Relative Velocity of Water at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.092	0.138	0.184	0.230	0.276	0.322
0.05	0.087	0.131	0.175	0.218	0.262	0.306
0.10	0.083	0.124	0.166	0.207	0.248	0.290
0.15	0.078	0.117	0.156	0.195	0.234	0.273
0.20	0.073	0.110	0.147	0.184	0.221	0.257
0.25	0.069	0.103	0.138	0.172	0.207	0.241
0.30	0.064	0.097	0.129	0.161	0.193	0.225
0.35	0.060	0.090	0.120	0.150	0.179	0.209
0.40	0.055	0.083	0.110	0.138	0.166	0.193
0.45	0.051	0.076	0.101	0.126	0.152	0.177
0.50	0.046	0.069	0.092	0.115	0.138	0.161
0.55	0.041	0.062	0.083	0.103	0.124	0.145
0.60	0.037	0.055	0.074	0.092	0.110	0.129
0.65	0.032	0.048	0.064	0.080	0.097	0.113
0.70	0.028	0.041	0.055	0.069	0.083	0.097
0.75	0.023	0.035	0.046	0.058	0.069	0.081
0.80	0.018	0.027	0.036	0.046	0.056	0.066
0.85	0.014	0.021	0.028	0.036	0.044	0.052
0.90	0.009	0.014	0.019	0.025	0.031	0.037
0.95	0.005	0.008	0.011	0.014	0.017	0.021

Table 5.2.8

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 1$ atm)
(continued)

Normalized Relative Velocity of Steam at Vane Exit vs. Inlet Void Fraction for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.102	0.129	0.147	0.155	0.149
0.85	0.000	0.115	0.153	0.189	0.223	0.255
0.90	0.000	0.125	0.167	0.209	0.251	0.294
0.95	0.000	0.132	0.177	0.221	0.267	0.312

Table 5.2.8

Steam/Water 2- ϕ Flow Cases
 (DC Motor, $p_1 = 1$ atm)
 (continued)

Discharge Void Fraction vs. Inlet Void Fraction
 for Various Homologous Flow Parameters at $P_1 = 1.0$ atm.
 DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000
0.15	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000
0.25	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000
0.45	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000
0.55	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000
0.65	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000
0.75	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.968	0.958	0.947	0.937	0.926
0.85	0.000	0.977	0.969	0.961	0.954	0.947
0.90	0.000	0.985	0.980	0.975	0.970	0.966
0.95	0.000	0.992	0.990	0.987	0.985	0.983

Table 5.2.9

Steam/Water 2- ϕ Flow Cases
(DC Motor, $p_1 = 0.05$ atm)

Homologous Head Parameter vs. Inlet Void Fraction
for Various Homologous Flow Parameters at $P_1 = 0.05$ atm.
DC Motor Operation

Inlet Void Fraction	Homologous Flow Parameter					
	0.4	0.6	0.8	1.0	1.2	1.4
0.00	1.008	1.005	1.002	1.000	0.999	0.999
0.05	1.025	1.026	1.026	0.945	1.032	1.037
0.10	1.029	1.033	1.037	1.024	1.051	1.061
0.15	1.033	1.040	1.048	1.052	1.069	1.082
0.20	1.038	1.047	1.058	1.070	1.086	1.104
0.25	1.041	1.054	1.068	1.084	1.086	1.126
0.30	1.045	1.060	1.078	1.098	1.117	1.147
0.35						
0.40						
0.45	1.059	1.012	1.100	1.143	1.177	1.196
0.50	1.065	1.093	1.124	1.157	1.159	1.231
0.55	1.070	1.102	1.137	1.175	1.218	1.265
0.60	1.076	1.110	1.149	1.191	1.238	1.290
0.65	1.082	1.116	1.160	1.205	1.257	1.313
0.70	1.088	1.118	1.162	1.217	1.274	1.336
0.75	1.093	1.121	1.167	1.215	1.287	1.355
0.80	1.098	1.117	1.161	1.214	1.273	1.354
0.85	1.104	1.111	1.140	1.184	1.252	1.325
0.90	1.109	1.095	1.106	1.140	1.187	1.248
0.95	1.115	-0.019	-0.034	-0.061	-0.100	-0.153

END

DATE

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