Best

Available

Copy

AD A951792

BRL

REPORT NO. 656

16 December 1947

WINDAGE JUMP OF A ROCKET FIRED NEARLY VERTICALLY

R. H. Kent

A. S. Galbraith

Copy available to DTIC does not permit fully legible reproduction

DTIC
ELECTE
JUL 23 1982
S A

DTIC FILE COPY

BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

82 07 23 025

[redacted]

BALLISTIC RESEARCH LABORATORIES
REPORT NO. 656

Kent/Galbraith/hln
Aberdeen Proving Ground, Md.
16 December 1947

Project No. TB3-06080

WINDAGE JUMP OF A ROCKET FIRED NEARLY VERTICALLY

Abstract

For reasons of safety there is a need for an adequate theory by means of which the effects of the wind on the unguided missiles fired nearly vertically at White Sands may be predicted. In addition, such a theory is needed in connection with the design of rockets and the analysis of their dispersion. In view of the practical importance of these matters, an independent attack on the development of a theory was undertaken. Our theoretical results are in complete agreement with those given by Blitzer (1). Our theory appears to be consistent also with that given by Peters (2) if the motion is referred to the air.

DTIC COPY INSPECTED 2

Letter on file

A 23 cl

UNANNOUNCED

(1) CIT/JPC 7, "Effect of Wind on the Mean Deflection of Rockets", by Leon Blitzer, February 1943.
(2) BRL Report No. 556, "An Analysis of the Trajectory of a Rocket Fired With Initial Angular Velocity and Small Initial Yaw", by A. S. Peters, August 1945.

[redacted]

In the classical wind theory (see Cranz, Lehrbuch der Ballistik, Volume I, p. 292) transformation is made to a coordinate system moving with the wind, the assumption being made that the missile immediately points nose on into the wind. In this way the problem of the motion with wind is reduced to a problem of the motion under standard conditions without wind. After the trajectory has been computed on the moving coordinate system, allowance is made for the distance the moving coordinate system has moved during the time of flight. An examination of the motion of a rocket, particularly one having very high acceleration, makes it apparent that the classical assumption that the rocket turns instantaneously into the wind at the end of the launcher is not valid*. It therefore becomes necessary to consider the effects of the failure of this assumption.

We assume that a rocket is launched nearly vertically with initial velocity v_0 and that there is a horizontal wind, constant with respect to altitude and direction, of velocity w, blowing towards the right as shown in Fig. 1.

Direction of launching

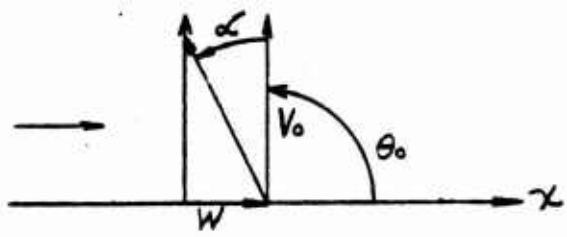

Fig. 1

If one transforms to axes moving with the wind, the direction of projection makes an angle α given by $\tan\alpha = +\frac{w}{v_0}$ with the direction of projection in the fixed axes if θ_0 the angle of projection is approximately $\frac{\pi}{2}$. (Angles are measured from the positive x axis in a counter clockwise direction.) As has been mentioned, however, the actual trajectory of the rocket will not coincide with the direction indicated except at the origin because of the cross forces acting on the rocket before it settles down. We shall assume that the rocket is acted on by the following system of forces: a restoring moment given by $\mu\delta$ where δ is the angle of yaw, and a thrust T acting along its axis which will therefore have a cross component approximately equal to $T\delta$ if δ is small. It will have a component along the trajectory of approximately T.

Let us now consider the yawing motion of the rocket under these conditions in the moving coordinate system. Let ϕ be the angle that the axis of the rocket makes with the horizontal, let θ be the angle that the

*The motion of the rocket including the effects of the initial yaw have been treated by Blitzer and Peters; see references (1) and (2).

tangent to the trajectory makes with the horizontal, and let δ be the angle of yaw so that $\phi = \theta + \delta$. See Fig. 2.

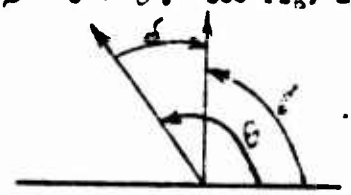

Fig. 2

The equation of motion is therefore

$$B\ddot{\phi} + \mu\delta = 0$$

or

$$\ddot{\phi} + \frac{\mu\delta}{B} = 0 \quad . \tag{1}$$

In this B is the moment of inertia about the transverse axis through the center of gravity. From the equation for centripetal force

$$\dot{\theta} = \frac{T\delta}{mv} \tag{2}$$

where v is the velocity of the rocket and m its mass. If $\frac{T}{m}$ is considered constant,* we have, upon differentiation,

$$\ddot{\theta} = \frac{T\dot{\delta}}{mv} - \frac{T\dot{v}\delta}{mv^2} .$$

By substituting $(\ddot{\theta} + \ddot{\delta})$ for $\ddot{\phi}$ one obtains

$$\ddot{\delta} + \frac{T\dot{\delta}}{mv} + \left(\frac{\mu}{B} - \frac{T\dot{v}}{mv^2}\right)\delta = 0. \tag{3}$$

If we have the solution for (3), the inclination of the trajectory in the moving system at any time t by virtue of (2) is found to be

$$\theta = \int_0^t \frac{T\delta}{mv}\,dt + \theta_0 \tag{4}$$

where θ_0 is the inclination of the trajectory when t = 0. If t_b is the time when the rocket stops burning

$$\theta_{t_b} = \int_0^{t_b} \frac{T\delta}{mv}\,dt + \theta_0 .$$

*It is plausible to assume that the actual thrust is constant while the mass is diminishing; however, the resultant accelerating force is equal to the thrust minus the drag, and since the drag is increasing it may very well turn out that the ratio of the resultant accelerating force to the mass will be nearly enough constant for most practical purposes.

$\theta_{t_b} - \theta_0$ or the difference between the initial and final inclinations of the trajectory is called the 'windage jump' of the rocket.*

For simplicity we assume that (in accordance with the assumption that T/m is constant)

$$v = a + bt$$

$$T = mb$$

$$\mu = nv^2$$

where

a is the velocity upon leaving the launcher

b is the acceleration assumed constant

and n is μ/v^2 assumed constant.

With these assumptions (3) becomes

$$\ddot{\delta} + \frac{b\dot{\delta}}{a + bt} + \left[\frac{n(a + bt)^2}{B} - \frac{b^2}{(a + bt)^2}\right]\delta = 0 \tag{4}$$

The general solution may be shown to be

$$\begin{aligned}\delta &= c_1 J_{\frac{1}{2}}(K^2(a+bt)^2) + c_2 J_{-\frac{1}{2}}(K^2(a+bt)^2) \\ &= c_1\sqrt{2/\pi}\cdot\frac{1}{K(a+bt)}\cos K^2(a+bt)^2 + c_2\sqrt{2/\pi}\,\frac{1}{K(a+bt)}\sin K^2(a+bt)^2\end{aligned} \tag{5}$$

where $K^2 = \sqrt{n/B}\cdot 1/2b$ and c_1 and c_2 are constants.

If a is greater than 0, as it is in the present case, the solution takes the form

$$\delta = \frac{1}{a+bt}\left[\delta_0\left\{a\cos K^2(2abt + b^2t^2) + \frac{1}{2aK^2}\sin K^2(2abt + b^2t^2)\right\} + \frac{\dot{\delta}_0}{2bK^2}\sin K^2(2abt + b^2t^2)\right] \tag{6}$$

where δ_0 and $\dot{\delta}_0$ are the initial values of δ and $\dot{\delta}$ respectively.

*On the classical wind theory windage jump is negligible. From Fig. 3 one can get a good idea of the error involved by making the classical assumptions.

Initial Conditions

It is assumed that the rocket points in the direction of projection as observed by a stationary observer on the ground, while the direction of the trajectory as observed in the moving coordinate system makes an angle $\tan^{-1}(w/v_o)$ with the direction as observed from the ground. Thus the initial yaw δ_o is $-w/a$.

It is assumed that the initial value of $\dot{\phi}$, that is, $\dot{\phi}_o$, is zero. Thus $\dot{\delta}_o = -\dot{\theta}_o$ where $\dot{\theta}_o$ is the initial value of $\dot{\theta}$. Now $\dot{\theta} = T\delta/mv = b\delta/v$. Thus

$$\dot{\delta}_o = -\dot{\theta}_o = \frac{bw}{a^2} .$$

By virtue of the relation $\dot{\theta} = T\delta/mv = b\delta/(a+bt)$, it follows that

$$\theta_{t_b} = \theta_o + b \int_0^{t_b} \frac{\delta\, dt}{a + bt} ,$$

and the windage jump is

$$b \int_0^{t_b} \frac{\delta\, dt}{a + bt} .$$

It appears that, if $\Delta\theta_w$ is the windage jump, then

$$\Delta\theta_w = b \int_0^{t_b} \frac{\delta\, dt}{a + bt}$$

$$= -\frac{w}{a} \left\{ 1 - \frac{\cos\left[\frac{\pi}{2}(x_b^2 - x_o^2)\right]}{x_b/x_o} - \pi x_o \left[\cos\left(\frac{\pi}{2} x_o^2\right)\left\{S(x_b) - S(x_o)\right\} - \sin\left(\frac{\pi}{2} x_o^2\right)\left\{C(x_b) - C(x_o)\right\}\right] \right. \tag{7}$$

where $x_b = \sqrt{2/\pi} \cdot K(a + bt_b) = \sqrt{2/\pi} \cdot K\, v_b$

$x_o = \sqrt{2/\pi} \cdot a\, K$

$v_b = a + bt_b$ is the velocity at the end of burning.

$S(x)$ and $C(x)$ are the Fresnel integrals $\int_0^x \sin \frac{\pi}{2} v^2 dv$ and $\int_0^x \cos \frac{\pi}{2} v^2 dv$ respectively.

The results obtained for the windage jump are consistent with those given by Peters, reference (2).

It appears from (7) that $\Delta\theta_w/(w/a)$ depends upon two quantities only, x_b and x_o. Following a procedure similar to that adopted by Blitzer, it would be convenient to plot $\Delta\theta_w a/w$ against x_b for various values of x_o. However, it appears somewhat more convenient to use on the plot instead of x_o and x_b two quantities simply related to them, P/L instead of x_o and $v_b/\sqrt{bL}$ instead of x_b. In this P, the effective length of the launcher, $= a^2/2b$, and L is the length of the period of undamped oscillation of the rocket.

The equation for the undamped motion of the rocket in yaw is $\ddot{\delta} + \frac{\mu}{B}\delta = 0$. From this the period T is $2\pi/\sqrt{\mu/B} = 2\pi/\sqrt{nv^2/B}$. The length of the period or the "wave length" is $vT = 2\pi\sqrt{B/n} = L$.

In view of the fact that $K^2 = \sqrt{n/B}/2b$,

$$x_o = \sqrt{2/\pi}\, aK = \sqrt{2/\pi}\, \sqrt[4]{n/B}\; a/\sqrt{2b} = \sqrt{2/\pi}\,\sqrt{2\pi/L}\; a/\sqrt{2b} = 2\sqrt{a^2/2b}/\sqrt{L}.$$

Since $a^2/2b = P$,

$$x_o = 2\sqrt{P/L}\,.$$

Furthermore

$$x_b = \sqrt{2/\pi}\, K\, v_b = \sqrt{2/\pi}\cdot\sqrt{1/2b}\;\sqrt{2\pi/L}\cdot v_b = \frac{\sqrt{2}\, v_b}{\sqrt{bL}}\,.$$

In Fig. 3 are plotted $(\Delta\theta_w \cdot a/w)$ vs. $v_b/\sqrt{bL}$ for various values of P/L.

Deviations

Since the angle of projection was taken as $\pi/2$, the angular deviation from the vertical in the moving reference frame at time t_b is

$$\theta - \pi/2 = w/a + \text{windage jump} \tag{8}$$

This is to be transformed to the fixed reference frame. If x,y are the coordinates of a point in the fixed frame and x',y' those of a point in the moving reference frame (moving to the right with the wind)

$$x = x' + wt, \qquad y = y'.$$

From this,

$$\frac{dx}{dy} = \frac{\dfrac{d(x' + wt)}{dt}}{\dfrac{dy'}{dt}} = \frac{dx'}{dy'} + \frac{w}{a + bt} \tag{9}$$

If the deviation of the trajectory from the vertical is small, $-dx/dy$ is the deviation in the fixed reference frame and $-dx'/dy'$ in the moving frame. From (8)

$$-\frac{dx'}{dy'} = \theta = \pi/2 = w/a + \text{windage jump}.$$

If the deviation from the vertical on the fixed coordinate frame is designated β,

$$\beta = -\left(\frac{dx}{dy}\right)_{t=t_b} = w/a + \text{windage jump} - w/(a+bt). \qquad (10)$$

By virtue of equations (7) and (9) the deviation from the vertical is

$$\beta = -\frac{w}{a}\left[\frac{1-\cos\left\{\frac{\pi}{2}(x_b^2 - x_o^2)\right\}}{\frac{x_b}{x_o}} - \pi x_o\left\{\cos\left(\frac{\pi}{2}x_o^2\right)\cdot(S(x_b) - S(x_o)) - \sin\left(\frac{\pi}{2}x_o^2\right)\cdot(C(x_b) - C(x_o))\right\}\right]$$

$\beta/(w/a)$ depends upon the same two quantities as $\Delta\theta_w/(w/a)$. Accordingly in Fig. 4 are plotted values of $\beta a/w$ vs. $v_b/\sqrt{bL}$ for various values of P/L.

Although the methods of derivation are quite different from those previously used by Blitzer, the results are consistent with his.

On the classical wind theory

$$\frac{\beta}{w/a} = \left(1 - \frac{a}{v_b}\right).$$

By comparing $\beta a/w$ from the chart with $\left(1 - \frac{a}{v_b}\right)$ one evaluates the adequacy or inadequacy of the classical assumption for a given rocket-launcher combination. From Figs. 3 and 4 one can also prepare plots of β/w for various combinations of a, b, and L to investigate what types of launcher-rocket characteristics will minimize wind effects. This may be of importance in the design of rockets.

More general applications

The treatment of the motion of the rocket has been based on the assumption that the rocket is fired vertically or nearly vertically. However, this limitation on the angle of projection may easily be removed. Whatever the angle of projection, the results may be applied without change to the angular effects in the slant plane produced by a crosswind. One obtains the change in azimuth by multiplying the change of angle in the slant plane by the secant of the angle of projection. To obtain the angular changes in the plane of fire one substitutes for the wind w its component normal to the trajectory in the plane of fire.

Variable Winds

So far the wind has been considered to be uniform, constant in direction, and independent of altitude. Actually, of course, this assumption does not hold. However, the windage jump is great enough to be of importance in comparison to w/a only in the case of high acceleration, e.g. greater than g, which usually lasts only a short time and for a relatively short trajectory. Thus the assumption of constant wind may be valid for short burning rockets and for the period in which the long-burning rockets are boosted. After the booster action stops, the assumption of the classical theory that the rocket turns immediately nose on into the wind should be sufficiently good. Under such conditions it will be feasible to consider the effects of a wind which varies with altitude. Such a discussion will be found in a forthcoming report on wind effects and weighting factors for rockets fired nearly vertically.

R. H. Kent

R. H. Kent

A. S. Galbraith

A. S. Galbraith

Table for P/L and $v_b/\sqrt{bL}$

From this table the parameter P/L and the abscissa $v_b/\sqrt{bL}$ needed to use the curves of Figures 3 and 4 can be read, given

a, the initial velocity of the rocket (that is, the velocity with which it leaves the launcher) in ft./sec.,

b, the acceleration, in ft./sec.^{2},

t_b, the time of burning, in seconds,

n/B, in ft.$^{-2}$

In each block of the table P/L is the same for a column, and the abscissa $x_b = v_b/\sqrt{bL}$ appears in the column opposite t_b. For example, if a = 200, b = 100, t_b = 0.18, n/B = 2.5×10^{-4}, the table gives P/L = 0.504, x_b = 1.094.

$$x_b = v_b / \sqrt{bL}$$

a = 25 (ft./sec.) 10^4 n/B = 0.25 (ft.$^{-2}$)

P/L	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.085	0.067	0.063	0.067	0.073	0.079	0.085	0.090	0.095	.100
.10	.099	.089	.095	.112	.128	.142	.155	.167	.179	.190
.15	.113	.111	.126	.156	.182	.205	.225	.244	.262	.279
.16	.116	.116	.132	.165	.193	.218	.240	.260	.279	.297
.17	.118	.120	.139	.174	.204	.230	.254	.276	.296	.314
.18	.121	.125	.145	.183	.215	.243	.268	.291	.312	.332
.19	.124	.129	.151	.192	.226	.255	.282	.306	.329	.350
.20	.127	.134	.158	.201	.237	.268	.296	.322	.346	.368

a = 25 (ft./sec.) 10^4 n/B = 0.50 (ft.$^{-2}$)

P/L	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.100	0.079	0.075	0.080	0.087	0.094	0.101	0.107	0.113	0.119
.10	.117	.106	.113	.133	.152	.169	.185	.199	.213	.225
.15	.134	.133	.150	.186	.217	.244	.268	.291	.312	.331
.16	.138	.138	.158	.196	.230	.259	.285	.309	.332	.353
.17	.141	.143	.165	.206	.243	.274	.302	.328	.352	.374
.18	.144	.149	.173	.217	.256	.289	.319	.346	.371	.395
.19	.148	.154	.180	.228	.269	.304	.335	.364	.391	.416
.20	.151	.159	.188	.239	.282	.319	.352	.383	.411	.438

a = 25 (ft./sec.) 10^4 n/B = 0.75 (ft.$^{-2}$)

P/L	0.004	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.111	0.088	0.083	0.088	0.096	0.104	0.111	0.118	0.125	0.132
.10	.130	.117	.125	.147	.168	.187	.204	.220	.235	.250
.15	.149	.146	.166	.205	.240	.270	.297	.322	.345	.367
.16	.152	.152	.174	.217	.254	.286	.316	.342	.367	.390
.17	.156	.158	.183	.229	.268	.303	.334	.363	.389	.414
.18	.160	.164	.191	.241	.283	.320	.353	.383	.411	.437
.19	.163	.170	.199	.252	.297	.336	.371	.403	.433	.461
.20	.167	.176	.208	.264	.312	.353	.390	.424	.455	.484

a = 25 (ft./sec.) 10^4 n/B = 1.00 (ft.$^{-2}$)

P/L	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.120	0.094	0.089	0.095	0.103	0.112	0.120	0.127	0.135	0.142
.10	.140	.126	.134	.158	.180	.201	.220	.237	.253	.268
.15	.160	.158	.178	.221	.257	.290	.319	.346	.371	.394
.16	.164	.164	.187	.233	.273	.308	.339	.368	.394	.419
.17	.168	.170	.196	.246	.289	.326	.359	.390	.418	.445
.18	.172	.177	.205	.259	.304	.343	.379	.412	.442	.470
.19	.176	.183	.214	.271	.319	.361	.399	.433	.465	.495
.20	.180	.189	.223	.284	.335	.379	.419	.455	.489	.520

$$x_b = \tau_b / \sqrt{bL}$$

a = 25 (ft./sec.) 10^4 n/B = 1.25 (ft.$^{-2}$)

P/L	0.005	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.127	0.100	0.094	0.100	0.109	0.118	0.127	0.135	0.142	0.150
.10	.148	.133	.141	.167	.191	.212	.232	.250	.267	.284
.15	.169	.166	.188	.234	.272	.306	.337	.365	.392	.417
.16	.173	.173	.198	.247	.289	.325	.359	.389	.417	.444
.17	.177	.180	.208	.260	.305	.344	.380	.412	.442	.470
.18	.181	.187	.217	.273	.321	.363	.401	.435	.467	.497
.19	.185	.195	.226	.286	.338	.382	.422	.458	.492	.524
.20	.190	.200	.236	.300	.354	.401	.443	.481	.517	.550

a = 25 (ft./sec.) 10^4 n/B = 1.50 (ft.$^{-2}$)

P/L	0.006	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.132	0.105	0.099	0.105	0.114	0.123	0.132	0.141	0.149	0.157
.10	.155	.140	.148	.175	.200	.222	.243	.262	.280	.297
.15	.177	.175	.197	.244	.285	.321	.353	.383	.410	.436
.16	.181	.181	.207	.258	.302	.341	.375	.407	.437	.464
.17	.185	.188	.217	.272	.319	.360	.397	.431	.463	.492
.18	.190	.195	.227	.286	.336	.380	.419	.455	.489	.520
.19	.194	.202	.237	.300	.353	.400	.441	.479	.515	.548
.20	.199	.209	.247	.314	.370	.420	.464	.504	.541	.576

a = 25 (ft./sec.) 10^4 n/B = 1.75 (ft.$^{-2}$)

P/L	0.006	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.138	0.109	0.103	0.108	0.118	0.128	0.137	0.146	0.155	0.163
.10	.161	.145	.154	.181	.207	.231	.252	.272	.291	.308
.15	.184	.181	.205	.254	.296	.333	.367	.398	.427	.453
.16	.188	.189	.215	.268	.314	.354	.390	.423	.454	.482
.17	.193	.196	.226	.283	.332	.374	.413	.448	.481	.511
.18	.197	.203	.236	.297	.350	.395	.436	.473	.508	.541
.19	.202	.210	.246	.312	.368	.416	.459	.498	.535	.570
.20	.206	.218	.257	.326	.385	.436	.482	.524	.562	.599

a = 25 (ft./sec.) 10^4 n/B = 2.00 (ft.$^{-2}$)

P/L	0.007	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.142	0.112	0.106	0.113	0.122	0.133	0.143	0.152	0.160	0.168
.10	.166	.150	.159	.188	.214	.239	.261	.282	.301	.319
.15	.190	.188	.212	.263	.306	.345	.379	.411	.441	.469
.16	.194	.195	.223	.278	.325	.366	.403	.437	.469	.499
.17	.199	.203	.234	.293	.343	.387	.427	.463	.497	.529
.18	.204	.210	.244	.308	.361	.408	.451	.489	.525	.559
.19	.209	.218	.255	.323	.380	.430	.475	.515	.553	.589
.20	.213	.225	.265	.338	.398	.451	.498	.541	.581	.619

$$x_b = v_b / \sqrt{bL}$$

a = 25 (ft./sec.) 10^4 n/B = 2.25 ($ft.^{-2}$)

P/L	0.007	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.147	0.116	0.109	0.116	0.126	0.137	0.147	0.156	0.165	0.174
.10	.171	.155	.164	.193	.221	.246	.269	.290	.310	.329
.15	.195	.193	.219	.270	.315	.355	.391	.424	.454	.483
.16	.200	.201	.229	.286	.334	.377	.415	.450	.483	.514
.17	.205	.209	.240	.301	.353	.399	.440	.477	.512	.545
.18	.210	.218	.251	.317	.372	.421	.464	.504	.541	.576
.19	.215	.224	.262	.332	.391	.443	.489	.531	.570	.606
.20	.220	.232	.273	.348	.410	.464	.513	.558	.599	.637

a = 25 (ft./sec.) 10^4 n/B = 2.50 ($ft.^{-2}$)

P/L	0.008	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.150	0.119	0.112	0.119	0.130	0.140	0.150	0.160	0.169	0.178
.10	.176	.159	.168	.198	.227	.253	.276	.298	.318	.337
.15	.201	.198	.224	.277	.324	.365	.401	.435	.466	.496
.16	.206	.206	.236	.293	.343	.387	.426	.463	.496	.528
.17	.211	.214	.247	.309	.362	.409	.451	.490	.526	.559
.18	.216	.222	.258	.325	.382	.432	.477	.517	.555	.591
.19	.221	.230	.269	.341	.402	.455	.502	.545	.585	.623
.20	.226	.238	.280	.357	.421	.477	.527	.572	.615	.654

a = 25 (ft./sec.) 10^4 n/B = 2.75 ($ft.^{-2}$)

P/L	0.008	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.154	0.121	0.115	0.122	0.132	0.143	0.154	0.164	0.174	0.183
.10	.180	.162	.172	.203	.232	.258	.283	.305	.326	.345
.15	.206	.203	.229	.284	.332	.373	.411	.446	.478	.507
.16	.211	.211	.241	.301	.352	.396	.437	.474	.508	.540
.17	.216	.219	.253	.317	.371	.419	.462	.502	.538	.573
.18	.221	.227	.264	.333	.391	.442	.488	.530	.568	.605
.19	.226	.236	.276	.350	.411	.465	.514	.558	.599	.638
.20	.231	.244	.287	.366	.431	.488	.539	.586	.630	.670

a = 25 (ft./sec.) 10^4 n/B = 3.00 ($ft.^{-2}$)

P/L	0.008	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.158	0.124	0.117	0.125	0.135	0.146	0.157	0.168	0.178	0.187
.10	.184	.166	.176	.208	.237	.264	.289	.312	.333	.353
.15	.210	.208	.235	.291	.339	.382	.420	.455	.488	.519
.16	.215	.216	.247	.307	.359	.405	.446	.484	.519	.552
.17	.221	.224	.259	.324	.380	.429	.473	.513	.550	.585
.18	.226	.232	.270	.340	.400	.452	.499	.542	.581	.618
.19	.231	.241	.282	.357	.420	.475	.525	.570	.612	.652
.20	.236	.249	.294	.374	.441	.499	.551	.599	.643	.685

$$x_b = v_b / \sqrt{bL}$$

a = 50 (ft. / sec.) $10^4 n/B = 0.25$ (ft.$^{-2}$)

P/L	0.010	0.004	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.155	0.111	0.094	0.089	0.091	0.095	0.099	0.103	0.107	0.111
.10	0.169	0.134	0.126	0.134	0.146	0.158	0.169	0.181	0.191	0.201
.15	0.183	0.156	0.158	0.178	0.200	0.221	0.242	0.262	0.274	0.290
.16	0.186	0.161	0.164	0.187	0.211	0.233	0.254	0.272	0.291	0.308
.17	0.189	0.165	0.170	0.196	0.222	0.245	0.268	0.286	0.308	0.326
.18	0.192	0.169	0.177	0.205	0.233	0.259	0.282	0.304	0.324	0.343
.19	0.195	0.174	0.183	0.214	0.244	0.271	0.296	0.319	0.341	0.361
.20	0.197	0.178	0.189	0.223	0.255	0.284	0.310	0.335	0.358	0.379

a = 50 (ft. / sec.) $10^4 n/B = 0.50$ (ft.$^{-2}$)

P/L	0.014	0.006	0.003	0.001	0.001	0.001	0.001	0.000	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.184	0.133	0.112	0.106	0.108	0.113	0.118	0.123	0.128	0.133
.10	.201	.159	.150	.159	.173	.188	.202	.215	.227	.239
.15	.218	.185	.188	.212	.238	.263	.285	.306	.326	.345
.16	.221	.191	.195	.222	.251	.278	.302	.325	.346	.366
.17	.225	.197	.203	.233	.264	.293	.319	.343	.366	.387
.18	.228	.202	.210	.244	.277	.308	.335	.361	.386	.408
.19	.231	.207	.218	.255	.290	.323	.352	.380	.406	.430
.20	.235	.212	.225	.265	.303	.338	.369	.398	.425	.451

a = 50 (ft. / sec.) $10^4 n/B = 0.75$ (ft.$^{-2}$)

P/L	0.017	0.007	0.003	0.002	0.001	0.001	0.001	0.001	0.000	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.204	0.147	0.124	0.117	0.120	0.125	0.130	0.135	0.141	0.146
.10	.223	.176	.166	.176	.192	.208	.223	.237	.251	.264
.15	.241	.205	.208	.235	.264	.291	.316	.339	.361	.382
.16	.245	.211	.216	.247	.278	.307	.334	.359	.383	.405
.17	.249	.217	.224	.258	.292	.324	.353	.380	.405	.429
.18	.252	.223	.232	.270	.307	.340	.371	.400	.427	.452
.19	.256	.229	.241	.282	.321	.357	.390	.420	.449	.475
.20	.260	.235	.249	.294	.335	.373	.408	.441	.471	.499

a = 50 (ft./sec.) $10^4 n/B = 1.00$ (ft.$^{-2}$)

P/L	0.020	0.008	0.004	0.002	0.001	0.001	0.001	0.001	0.001	0.000
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.219	0.157	0.133	0.126	0.129	0.134	0.140	0.146	0.152	0.158
.10	.239	.189	.178	.189	.206	.223	.239	.255	.270	.284
.15	.259	.221	.223	.252	.283	.312	.339	.364	.388	.410
.16	.263	.227	.232	.265	.299	.330	.359	.386	.411	.435
.17	.267	.233	.241	.278	.314	.348	.379	.408	.435	.460
.18	.271	.240	.250	.290	.330	.366	.399	.430	.459	.486
.19	.275	.246	.259	.303	.345	.384	.419	.452	.482	.511
.20	.279	.252	.268	.315	.360	.401	.438	.473	.506	.536

$x_b = v_b / \sqrt{bL}$

a = 50 (ft. /sec) $10^4 n/B = 1.25$ (ft.$^{-2}$)

P/L	0.022	0.009	0.004	0.002	0.001	0.001	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.132	0.167	0.141	0.133	0.136	0.141	0.147	0.154	0.160	0.166
.10	.253	.200	.189	.200	.218	.236	.253	.270	.285	.300
.15	.274	.233	.236	.267	.300	.330	.359	.385	.410	.434
.16	.278	.240	.245	.280	.316	.349	.380	.408	.435	.460
.17	.283	.247	.255	.293	.332	.368	.401	.431	.460	.487
.18	.287	.253	.264	.307	.349	.387	.422	.454	.485	.514
.19	.291	.260	.274	.320	.365	.406	.443	.477	.510	.540
.20	.295	.267	.283	.333	.381	.424	.464	.501	.535	.567

a = 50 (ft./sec) $10^4 n/B = 1.50$ (ft^{-2})

P/L	0.024	0.010	0.005	0.002	0.002	0.001	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.243	0.174	0.148	0.139	0.142	0.148	0.155	0.161	0.168	0.174
.10	.265	.209	.198	.209	.228	.247	.265	.282	.299	.314
.15	.287	.244	.247	.279	.313	.346	.375	.403	.429	.454
.16	.291	.251	.257	.293	.331	.365	.397	.427	.455	.482
.17	.296	.258	.267	.307	.348	.385	.419	.451	.481	.510
.18	.300	.265	.276	.321	.365	.405	.441	.476	.507	.538
.19	.305	.272	.286	.335	.382	.425	.464	.500	.533	.565
.20	.309	.279	.296	.349	.399	.444	.486	.524	.560	.593

a = 50 (ft./sec.) $10^4 n/B = 1.75$ (ft.$^{-2}$)

P/L	0.026	0.011	0.005	0.003	0.002	0.001	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.252	0.181	0.154	0.145	0.148	0.154	0.160	0.167	0.174	0.181
.10	.275	.218	.205	.218	.237	.257	.275	.293	.310	.327
.15	.298	.254	.256	.290	.326	.359	.390	.419	.446	.472
.16	.303	.261	.267	.305	.344	.380	.413	.444	.473	.501
.17	.307	.268	.277	.319	.361	.400	.436	.469	.500	.530
.18	.312	.276	.287	.334	.379	.421	.459	.494	.527	.559
.19	.317	.283	.298	.348	.397	.441	.482	.520	.555	.588
.20	.321	.290	.308	.362	.415	.462	.505	.545	.582	.617

a = 50 (ft./sec.) $10^4 n/B = 2.00$ (ft.$^{-2}$)

P/L	0.028	0.011	0.006	0.003	0.002	0.001	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.261	0.188	0.159	0.150	0.153	0.159	0.166	0.173	0.180	0.187
.10	.285	.225	.212	.225	.245	.265	.285	.303	.321	.338
.15	.308	.263	.265	.300	.337	.371	.403	.433	.461	.488
.16	.313	.270	.276	.315	.355	.392	.427	.459	.489	.518
.17	.318	.278	.286	.330	.374	.414	.451	.485	.517	.548
.18	.323	.285	.297	.345	.392	.435	.474	.511	.545	.578
.19	.327	.293	.308	.360	.410	.456	.498	.537	.573	.608
.20	.332	.300	.318	.375	.428	.477	.522	.563	.601	.638

$x_b = v_b / \sqrt{bL}$

a = 50 (ft./sec.) $10^4 n/B = 2.25$ (ft.$^{-2}$)

P/L	0.030	0.012	0.006	0.003	0.002	0.001	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.268	0.193	0.164	0.155	0.157	0.164	0.171	0.178	0.186	0.193
.10	.293	.232	.219	.232	.252	.273	.293	.312	.330	.348
.15	.318	.270	.273	.309	.347	.382	.415	.446	.475	.502
.16	.322	.278	.284	.324	.366	.404	.440	.473	.504	.533
.17	.327	.286	.295	.340	.385	.426	.464	.500	.533	.564
.18	.332	.294	.306	.355	.404	.448	.489	.526	.562	.595
.19	.337	.301	.317	.371	.423	.470	.513	.553	.591	.626
.20	.342	.309	.328	.386	.442	.492	.537	.579	.619	.657

a = 50 (ft./sec.) $10^4 n/B = 2.50$ (ft.$^{-2}$)

P/L	0.031	0.012	0.006	0.003	0.002	0.002	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.276	0.198	0.168	0.159	0.162	0.168	0.176	0.183	0.190	0.198
.10	.301	.238	.224	.238	.259	.280	.301	.321	.339	.357
.15	.326	.278	.280	.317	.356	.393	.426	.458	.488	.516
.16	.331	.286	.292	.333	.376	.415	.451	.485	.517	.547
.17	.336	.293	.303	.349	.395	.437	.477	.513	.547	.579
.18	.341	.301	.314	.365	.414	.460	.502	.541	.577	.611
.19	.346	.309	.325	.381	.434	.482	.527	.568	.606	.642
.20	.351	.317	.337	.397	.453	.505	.552	.595	.636	.674

a = 50 (ft./sec.) $10^4 n/B = 2.75$ (ft.$^{-2}$)

P/L	0.033	0.013	0.007	0.003	0.002	0.002	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.282	0.203	0.172	0.162	0.165	0.172	0.179	0.187	0.195	0.203
.10	.308	.244	.230	.244	.265	.287	.308	.328	.347	.366
.15	.334	.284	.287	.325	.365	.402	.437	.469	.499	.528
.16	.339	.292	.299	.341	.385	.425	.462	.497	.530	.560
.17	.344	.301	.310	.357	.405	.448	.488	.525	.560	.593
.18	.349	.309	.322	.374	.425	.471	.514	.553	.590	.625
.19	.354	.317	.333	.390	.444	.494	.540	.582	.621	.658
.20	.360	.325	.345	.406	.464	.517	.565	.610	.651	.690

a = 50 (ft./sec.) $10^4 n/B = 3.00$ (ft.$^{-2}$)

P/L	0.034	0.014	0.008	0.003	0.002	0.002	0.001	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.289	0.207	0.176	0.166	0.169	0.176	0.184	0.192	0.200	0.208
.10	.315	.249	.235	.249	.271	.294	.315	.336	.355	.374
.15	.341	.291	.294	.332	.373	.411	.446	.479	.510	.540
.16	.347	.299	.305	.349	.393	.435	.473	.508	.541	.573
.17	.352	.307	.317	.365	.413	.458	.499	.537	.572	.606
.18	.357	.315	.329	.382	.434	.482	.525	.565	.603	.639
.19	.362	.324	.340	.398	.454	.505	.551	.594	.634	.672
.20	.368	.332	.352	.415	.474	.528	.578	.623	.666	.706

$x_b = v_b/\sqrt{gL}$

a = 100 (ft./sec.) 10^4 n/B = 0.25(ft.$^{-2}$)

P/L	0.040	0.016	0.008	0.004	0.003	0.003	0.002	0.001	0.001	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.296	0.201	0.157	0.133	0.127	0.126	0.127	0.129	0.131	0.133
.10	.310	.223	.189	.176	.182	.189	.197	.206	.215	.223
.15	.324	.245	.221	.223	.237	.252	.269	.283	.298	.312
.16	.327	.250	.227	.232	.243	.265	.282	.299	.315	.330
.17	.330	.254	.233	.241	.259	.278	.296	.314	.331	.348
.18	.333	.259	.240	.250	.269	.290	.310	.330	.348	.366
.19	.336	.263	.246	.259	.280	.302	.324	.345	.365	.384
.20	.339	.268	.252	.268	.291	.315	.339	.361	.381	.401

a = 100 (ft./sec.) 10^4 n/B = 0.50 (ft.$^{-2}$)

P/L	0.056	0.022	0.011	0.006	0.004	0.003	0.002	0.002	0.002	0.001
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.352	9.238	0.187	0.159	0.152	0.150	0.151	0.153	0.156	0.159
.10	.369	.265	.225	.212	.217	.225	.235	.245	.255	.265
.15	.386	.292	.263	.265	.282	.300	.319	.337	.354	.371
.16	.389	.297	.270	.276	.294	.315	.335	.355	.374	.393
.17	.392	.302	.277	.286	.307	.330	.352	.374	.394	.414
.18	.396	.308	.285	.297	.320	.345	.369	.392	.414	.435
.19	.399	.313	.293	.308	.333	.360	.386	.410	.434	.456
.20	.403	.318	.300	.318	.346	.375	.403	.429	.454	.477

a = 100 (ft./sec.) 10^4 n/B = 0.75 (ft.$^{-2}$)

P/L	0.069	0.028	0.014	0.007	0.005	0.003	0.003	0.002	0.002	0.002
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.389	0.264	0.207	0.176	0.168	0.166	0.167	0.169	0.172	0.176
.10	.408	.294	.249	.235	.240	.249	.260	.271	.282	.294
.15	.427	.323	.291	.294	.312	.332	.353	.373	.392	.411
.16	.431	.329	.299	.305	.326	.349	.371	.393	.414	.434
.17	.434	.335	.307	.317	.340	.365	.390	.413	.436	.458
.18	.438	.340	.315	.329	.355	.382	.408	.434	.458	.481
.19	.442	.346	.324	.340	.369	.398	.427	.454	.480	.505
.20	.446	.352	.332	.352	.383	.415	.445	.474	.502	.528

a = 100 (ft./sec.) 10^4 n/B = 1.00 (ft.$^{-2}$)

P/L	0.080	0.032	0.016	0.008	0.005	0.004	0.003	0.003	0.002	0.002
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.419	0.283	0.223	0.189	0.180	0.178	0.180	0.182	0.185	0.189
.10	.439	.315	.268	.252	.258	.268	.279	.291	.303	.315
.15	.459	.347	.312	.315	.335	.357	.379	.401	.421	.442
.16	.463	.353	.321	.328	.350	.375	.399	.422	.445	.467
.17	.467	.360	.330	.341	.366	.393	.419	.444	.469	.492
.18	.471	.366	.339	.353	.381	.410	.439	.466	.492	.517
.19	.475	.372	.348	.366	.397	.428	.459	.488	.516	.542
.20	.479	.378	.357	.378	.412	.446	.479	.510	.539	.567

$$x_b = v_b\sqrt{5L}$$

a = 100 (ft./sec.) 10^4 n/B = 1.25 (ft.$^{-2}$)

P/L	0.090	0.036	0.018	0.009	0.006	0.004	0.004	0.003	0.003	0.002
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.443	0.300	0.236	0.200	0.190	0.189	0.190	0.193	0.196	0.200
.10	.464	.334	.283	.267	.272	.283	.295	.308	.321	.334
.15	.485	.367	.330	.333	.354	.377	.401	.424	.446	.467
.16	.489	.373	.340	.347	.371	.396	.422	.447	.471	.494
.17	.494	.380	.349	.360	.387	.415	.443	.470	.496	.520
.18	.498	.387	.358	.373	.403	.434	.464	.493	.521	.547
.19	.502	.394	.368	.387	.420	.453	.485	.516	.546	.574
.20	.506	.400	.377	.400	.436	.471	.506	.539	.570	.600

a = 100 (ft./sec.) 10^4 n/B = 1.50 (ft.$^{-2}$)

P/L	0.097	0.039	0.019	0.010	0.006	0.005	0.004	0.003	0.003	0.002
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.464	0.314	0.247	0.209	0.199	0.197	0.199	0.202	0.205	0.209
.10	.486	.349	.296	.279	.285	.296	.309	.322	.336	.349
.15	.508	.384	.345	.349	.371	.395	.419	.443	.466	.489
.16	.512	.391	.355	.363	.388	.415	.441	.468	.493	.517
.17	.517	.398	.365	.377	.405	.434	.464	.492	.519	.544
.18	.521	.405	.375	.391	.422	.454	.486	.516	.545	.572
.19	.525	.412	.385	.405	.439	.474	.508	.540	.571	.600
.20	.529	.419	.395	.419	.456	.494	.530	.564	.597	.628

a = 100 (ft./sec.) 10^4 n/B = 1.75 (ft.$^{-2}$)

P/L	0.105	0.042	0.021	0.011	0.007	0.005	0.004	0.004	0.003	0.003
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.482	0.326	0.257	0.217	0.207	0.205	0.206	0.209	0.213	0.218
.10	.505	.363	.308	.290	.296	.308	.321	.335	.349	.363
.15	.528	.399	.359	.363	.385	.410	.436	.461	.485	.508
.16	.532	.406	.369	.377	.403	.431	.459	.486	.512	.537
.17	.537	.414	.380	.392	.421	.451	.482	.511	.539	.566
.18	.541	.421	.390	.406	.438	.472	.505	.536	.566	.595
.19	.546	.428	.400	.421	.456	.492	.528	.561	.593	.624
.20	.551	.435	.410	.435	.474	.513	.551	.586	.620	.653

a = 100 (ft./sec.) 10^4 n/B = 2.00 (ft.$^{-2}$)

P/L	0.112	0.045	0.022	0.011	0.007	0.006	0.005	0.004	0.003	0.003
t_b \ b	100	250	500	1000	1500	1000	2500	3000	3500	4000
0.05	0.498	0.337	0.265	0.225	0.214	0.212	0.213	0.217	0.221	0.225
.10	.522	.375	.318	.300	.306	.318	.332	.347	.361	.375
.15	.546	.413	.371	.375	.398	.424	.451	.476	.501	.525
.16	.550	.420	.382	.390	.416	.446	.474	.502	.529	.555
.17	.555	.428	.393	.405	.435	.467	.498	.528	.557	.585
.18	.560	.435	.403	.420	.453	.488	.522	.554	.585	.615
.19	.565	.443	.414	.435	.472	.509	.546	.580	.613	.645
.20	.569	.450	.424	.450	.490	.530	.569	.606	.641	.675

$$x_b = v_b\sqrt{bL}$$

a = 100 (ft./sec.) 10^4 n/B = 2.25 (ft.$^{-2}$)

P/L	0.119	0.043	0.024	0.012	0.008	0.006	0.005	0.004	0.003	0.003
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.513	0.347	0.273	0.232	0.220	0.219	0.220	0.223	0.227	0.231
.10	.538	.386	.328	.309	.325	.328	.342	.357	.372	.386
.15	.562	.425	.383	.386	.410	.437	.464	.491	.516	.541
.16	.567	.433	.393	.402	.429	.459	.489	.517	.545	.572
.17	.572	.440	.404	.417	.448	.481	.513	.544	.574	.603
.18	.577	.448	.415	.433	.467	.503	.537	.571	.603	.634
.19	.581	.456	.426	.448	.486	.524	.562	.598	.632	.664
.20	.586	.464	.437	.464	.505	.546	.586	.624	.661	.695

a = 100 (ft./sec.) 10^4 n/B = 2.50 (ft.$^{-2}$)

P/L	0.126	0.050	0.025	0.013	0.008	0.006	0.005	0.004	0.004	0.003
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.527	0.357	0.280	0.238	0.227	0.224	0.225	0.229	0.233	0.238
.10	.552	.397	.337	.318	.324	.337	.351	.367	.382	.397
.15	.577	.436	.393	.397	.421	.449	.477	.504	.530	.555
.16	.582	.444	.404	.412	.440	.471	.502	.531	.560	.587
.17	.587	.452	.415	.428	.460	.494	.527	.559	.589	.619
.18	.592	.460	.426	.444	.479	.516	.552	.586	.619	.650
.19	.597	.468	.437	.460	.499	.539	.577	.614	.649	.682
.20	.602	.476	.448	.476	.518	.561	.602	.641	.678	.714

a = 100 (ft./sec.) 10^4 n/B = 2.75 (ft.$^{-2}$)

P/L	0.132	0.053	0.026	0.013	0.009	0.007	0.005	0.004	0.004	0.003
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.539	0.365	0.287	0.244	0.232	0.230	0.231	0.234	0.239	0.244
.10	.565	.406	.345	.325	.332	.345	.360	.375	.391	.406
.15	.591	.447	.402	.406	.431	.460	.488	.516	.543	.569
.16	.596	.455	.414	.422	.451	.482	.514	.544	.573	.601
.17	.601	.463	.425	.439	.471	.505	.539	.572	.604	.634
.18	.606	.471	.437	.455	.491	.528	.565	.600	.634	.666
.19	.611	.479	.448	.471	.511	.551	.591	.628	.664	.698
.20	.616	.487	.459	.487	.531	.574	.617	.657	.695	.731

a = 100 (ft./sec.) 10^4 n/B = 3.00 (ft.$^{-2}$)

P/L	0.138	0.055	0.028	0.014	0.009	0.007	0.005	0.005	0.004	0.003
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.551	0.373	0.293	0.249	0.237	0.235	0.236	0.239	0.244	0.249
.10	.578	.415	.352	.332	.339	.352	.368	.383	.399	.415
.15	.604	.457	.411	.415	.441	.470	.499	.527	.555	.581
.16	.609	.485	.423	.432	.461	.493	.525	.556	.586	.614
.17	.614	.473	.434	.448	.481	.517	.551	.585	.617	.648
.18	.620	.481	.446	.465	.501	.540	.577	.613	.648	.681
.19	.625	.490	.458	.481	.522	.564	.604	.642	.679	.714
.20	.630	.498	.470	.498	.542	.587	.630	.671	.710	.747

$$x_b = v_b/\sqrt{bI}$$

a = 150 (ft./sec.) 10^4 n/B = 0.25 (ft.$^{-2}$)

P/L	0.097	0.036	0.018	0.009	0.006	0.004	0.004	0.003	0.003	0.002
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.437	0.290	0.221	0.178	0.154	0.138	0.135	0.135	0.135	0.156
.10	.451	.312	.252	.223	.219	.221	.226	.232	.238	.245
.15	.465	.335	.284	.268	.273	.284	.296	.309	.322	.335
.16	.468	.339	.290	.277	.284	.296	.310	.324	.338	.353
.17	.471	.343	.296	.285	.295	.309	.324	.340	.355	.370
.18	.474	.343	.303	.294	.306	.322	.339	.356	.372	.388
.19	.477	.352	.309	.303	.317	.334	.353	.371	.389	.406
.20	.480	.357	.315	.312	.328	.347	.367	.386	.405	.424

a = 150 (ft./sec.) 10^4 n/B = 0.50 (ft.$^{-2}$)

P/L	0.127	0.051	0.025	0.013	0.008	0.006	0.005	0.004	0.004	0.003
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.520	0.345	0.262	0.212	0.195	0.186	0.184	0.184	0.185	0.186
.10	.537	.371	.300	.265	.260	.263	.268	.276	.284	.292
.15	.554	.398	.338	.318	.325	.338	.352	.367	.383	.398
.16	.557	.403	.345	.329	.338	.353	.369	.386	.403	.419
.17	.560	.408	.353	.339	.351	.368	.386	.404	.422	.440
.18	.564	.414	.360	.350	.364	.383	.403	.423	.442	.461
.19	.567	.419	.368	.361	.377	.398	.419	.441	.462	.483
.20	.570	.424	.375	.371	.390	.413	.436	.459	.482	.504

a = 150 (ft./sec.) 10^4 n/B = 0.75 (ft.$^{-2}$)

P/L	0.155	0.062	0.031	0.016	0.010	0.008	0.006	0.005	0.004	0.004
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.575	0.382	0.290	0.235	0.216	0.208	0.204	0.203	0.204	0.205
.10	.594	.411	.332	.294	.288	.291	.297	.305	.314	.323
.15	.613	.440	.374	.352	.359	.374	.390	.407	.424	.440
.16	.616	.446	.382	.364	.374	.390	.408	.427	.446	.464
.17	.620	.452	.390	.376	.388	.407	.427	.447	.467	.487
.18	.624	.458	.398	.387	.403	.424	.446	.468	.489	.510
.19	.627	.464	.407	.399	.417	.440	.464	.488	.511	.534
.20	.631	.470	.415	.411	.431	.457	.483	.508	.533	.558

a = 150 (ft./sec.) 10^4 n/B = 1.00 (ft.$^{-2}$)

P/L	0.179	0.072	0.036	0.018	0.012	0.009	0.007	0.006	0.005	0.004
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.618	0.410	0.312	0.252	0.232	0.223	0.219	0.219	0.219	0.221
.10	.638	.442	.357	.315	.309	.312	.319	.328	.337	.347
.15	.658	.473	.401	.378	.386	.401	.419	.437	.455	.473
.16	.662	.479	.410	.391	.402	.419	.439	.459	.479	.498
.17	.666	.486	.419	.404	.417	.437	.459	.481	.503	.524
.18	.670	.492	.428	.416	.433	.455	.479	.503	.526	.549
.19	.674	.498	.437	.429	.448	.473	.499	.525	.550	.574
.20	.678	.505	.446	.442	.464	.491	.519	.546	.573	.599

$x_b = v_b\sqrt{bL}$

a = 150 (ft./sec.) 10^4 n/B = 1.25 (ft.$^{-2}$)

P/L	0.200	0.080	0.040	0.020	0.013	0.010	0.008	0.007	0.006	0.005
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.654	0.434	0.330	0.266	0.245	0.238	0.232	0.231	0.232	0.233
.10	.675	.467	.377	.333	.327	.330	.337	.347	.357	.367
.15	.696	.500	.424	.400	.408	.424	.443	.462	.481	.500
.16	.700	.507	.434	.414	.425	.443	.464	.485	.506	.527
.17	.704	.514	.443	.427	.441	.462	.485	.508	.531	.554
.18	.709	.520	.453	.440	.457	.481	.506	.531	.556	.580
.19	.713	.527	.462	.454	.474	.500	.527	.554	.581	.607
.20	.717	.534	.472	.467	.490	.519	.549	.578	.606	.634

a = 150 (ft./sec.) 10^4 n/B = 1.50 (ft.$^{-2}$)

P/L	0.219	0.088	0.044	0.022	0.015	0.011	0.009	0.007	0.006	0.005
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.684	0.454	0.346	0.279	0.256	0.247	0.242	0.242	0.243	0.244
.10	.706	.489	.395	.349	.342	.346	.353	.363	.373	.384
.15	.728	.524	.444	.419	.427	.444	.464	.484	.504	.524
.16	.733	.531	.454	.433	.445	.464	.486	.508	.530	.551
.17	.737	.538	.464	.447	.462	.484	.508	.532	.556	.579
.18	.742	.545	.474	.461	.479	.503	.530	.556	.582	.607
.19	.746	.552	.484	.475	.496	.523	.552	.580	.608	.635
.20	.750	.558	.494	.489	.513	.543	.574	.604	.634	.663

a = 150 (ft./sec.) 10^4 n/B = 1.75 (ft.$^{-2}$)

P/L	0.237	0.095	0.047	0.024	0.016	0.012	0.010	0.008	0.007	0.006
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.711	0.472	0.359	0.290	0.266	0.256	0.252	0.251	0.252	0.254
.10	.734	.508	.411	.363	.355	.359	.367	.377	.388	.399
.15	.757	.544	.462	.435	.444	.462	.482	.503	.524	.544
.16	.762	.551	.472	.450	.462	.482	.505	.528	.551	.573
.17	.766	.559	.482	.464	.480	.503	.528	.553	.578	.602
.18	.771	.566	.492	.479	.498	.524	.551	.578	.605	.631
.19	.776	.573	.503	.493	.515	.544	.574	.603	.632	.660
.20	.780	.580	.513	.508	.533	.564	.596	.628	.659	.689

a = 150 (ft./sec.) 10^4 n/B = 2.00 (ft.$^{-2}$)

P/L	0.253	0.101	0.051	0.025	0.017	0.013	0.010	0.008	0.007	0.006
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.735	0.487	0.371	0.300	0.275	0.265	0.261	0.260	0.261	0.263
.10	.759	.525	.424	.375	.367	.371	.380	.390	.401	.413
.15	.783	.563	.477	.450	.459	.477	.498	.520	.541	.563
.16	.788	.570	.488	.465	.478	.499	.522	.546	.569	.593
.17	.792	.578	.499	.480	.496	.520	.546	.572	.597	.623
.18	.797	.585	.509	.495	.514	.541	.569	.598	.625	.653
.19	.802	.593	.520	.510	.533	.562	.593	.624	.654	.683
.20	.806	.600	.530	.525	.551	.584	.617	.650	.682	.713

$$x_b = v_b/\sqrt{bL}$$

a = 150 (ft./sec.) 10^4 n/B = 2.25 (ft.$^{-2}$)

P/L	0.268	0.107	0.054	0.027	0.018	0.013	0.011	0.009	0.008	0.007
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.757	0.502	0.382	0.309	0.304	0.273	0.269	0.268	0.268	0.270
.10	.782	.541	.407	.386	.378	.382	.391	.401	.413	.425
.15	.806	.579	.492	.464	.473	.492	.513	.535	.557	.579
.16	.811	.587	.503	.479	.492	.513	.537	.562	.586	.610
.17	.816	.595	.513	.494	.511	.535	.562	.589	.615	.641
.18	.821	.603	.524	.510	.530	.557	.586	.615	.644	.672
.19	.826	.610	.535	.525	.549	.579	.611	.642	.673	.703
.20	.831	.618	.546	.541	.568	.601	.635	.669	.702	.734

a = 150 (ft./sec.) 10^4 n/B = 2.50 (ft.$^{-2}$)

P/L	0.283	0.113	0.057	0.028	0.019	0.014	0.011	0.009	0.008	0.007
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.778	0.516	0.393	0.317	0.291	0.280	0.276	0.275	0.276	0.277
.10	.803	.555	.449	.397	.389	.393	.401	.412	.424	.436
.15	.828	.595	.505	.476	.486	.505	.527	.550	.572	.595
.16	.833	.603	.516	.492	.505	.527	.552	.577	.602	.627
.17	.838	.611	.527	.508	.525	.550	.577	.604	.631	.658
.18	.843	.619	.538	.523	.544	.572	.602	.632	.661	.690
.19	.848	.627	.550	.539	.563	.594	.627	.659	.691	.722
.20	.853	.634	.561	.555	.583	.617	.652	.687	.721	.754

a = 150 (ft./sec.) 10^4 n/B = 2.75 (ft.$^{-2}$)

P/L	0.297	0.119	0.059	0.030	0.020	0.015	0.012	0.010	0.008	0.007
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.796	0.528	0.402	0.325	0.298	0.287	0.283	0.281	0.282	0.284
.10	.822	.569	.460	.406	.398	.402	.411	.422	.434	.447
.15	.848	.609	.517	.487	.497	.517	.539	.563	.586	.609
.16	.853	.617	.528	.504	.517	.540	.565	.591	.617	.642
.17	.858	.625	.540	.520	.537	.563	.591	.619	.647	.674
.18	.863	.634	.551	.536	.557	.586	.616	.647	.677	.706
.19	.868	.642	.563	.552	.577	.609	.642	.675	.708	.739
.20	.873	.650	.574	.569	.597	.632	.668	.703	.738	.772

a = 150 (ft./sec.) 10^4 n/B = 3.00 (ft.$^{-2}$)

P/L	0.310	0.124	0.062	0.031	0.021	0.015	0.012	0.010	0.009	0.008
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.814	0.540	0.411	0.332	0.305	0.294	0.289	0.288	0.289	0.291
.10	.840	.581	.470	.415	.407	.411	.420	.431	.444	.457
.15	.866	.622	.528	.498	.508	.528	.551	.575	.599	.623
.16	.872	.631	.540	.515	.529	.552	.578	.604	.630	.656
.17	.877	.639	.552	.531	.549	.575	.604	.633	.661	.689
.18	.882	.648	.564	.548	.570	.599	.630	.661	.692	.722
.19	.887	.656	.575	.564	.590	.622	.656	.690	.723	.756
.20	.893	.664	.587	.581	.610	.646	.683	.719	.754	.789

$$x_b = v_b / \sqrt{bL}$$

a = 200 (ft./sec.) $10^4 n/B$ = 0.25 ($ft.^{-2}$)

P/L	0.159	0.064	0.042	0.016	0.011	[illegible]	[illegible]	[illegible]	0.005	[illegible]
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.578	0.379	0.284	0.223	[illegible]	0.169	0.163	0.160	0.170	[illegible]
.10	.592	.401	.316	.268	.265	.252	.254	[illegible]	[illegible]	[illegible]
.15	.606	.423	.347	.312	.310	.315	.324	.335	.346	.357
.16	.609	.428	.353	.321	.320	.328	.338	.350	.362	.375
.17	.612	.433	.360	.330	.331	.341	.353	.366	.379	.392
.18	.615	.437	.366	.339	.342	.354	.367	.381	.396	.410
.19	.618	.442	.372	.348	.353	.366	.381	.397	.412	.428
.20	.621	.446	.378	.357	.364	.378	.395	.412	.429	.446

a = 200 (ft./sec.) $10^4 n/B$ = 0.50 ($ft.^{-2}$)

P/L	0.225	0.090	0.045	0.023	0.015	0.011	0.009	0.008	0.006	0.006
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.688	0.451	0.337	0.265	0.238	0.225	0.218	0.214	0.213	0.212
.10	.705	.478	.375	.318	.303	.300	.302	.306	.312	.318
.15	.721	.504	.413	.371	.368	.375	.386	.398	.411	.424
.16	.725	.509	.420	.382	.381	.390	.403	.416	.431	.446
.17	.728	.514	.427	.392	.394	.405	.419	.435	.451	.467
.18	.732	.520	.435	.403	.407	.420	.436	.453	.471	.488
.19	.735	.525	.443	.414	.420	.435	.453	.472	.490	.509
.20	.738	.530	.450	.424	.433	.450	.470	.490	.510	.530

a = 200 (ft./sec.) $10^4 n/B$ = 0.75 ($ft.^{-2}$)

P/L	0.276	0.110	0.055	0.028	0.018	0.014	0.011	0.009	0.008	0.007
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.761	0.499	0.373	0.293	0.264	0.249	0.241	0.237	0.235	0.235
.10	.780	.529	.415	.352	.336	.332	.334	.339	.345	.352
.15	.798	.558	.457	.411	.407	.415	.427	.441	.455	.470
.16	.802	.564	.465	.423	.422	.432	.446	.461	.477	.493
.17	.806	.569	.473	.434	.436	.448	.464	.481	.499	.517
.18	.809	.575	.482	.446	.450	.465	.483	.502	.521	.540
.19	.813	.581	.490	.458	.465	.482	.502	.522	.543	.564
.20	.817	.587	.498	.470	.479	.498	.520	.542	.565	.587

a = 200 (ft./sec.) $10^4 n/B$ = 1.00 ($ft.^{-2}$)

P/L	0.318	0.127	0.064	0.032	0.021	0.016	0.013	0.011	0.009	0.008
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.818	0.536	0.401	0.315	0.283	0.268	0.259	0.255	0.253	0.252
.10	.838	.568	.446	.379	.361	.357	.359	.364	.371	.378
.15	.858	.599	.491	.442	.438	.446	.459	.473	.489	.505
.16	.862	.606	.500	.454	.453	.464	.479	.495	.512	.530
.17	.866	.612	.508	.467	.469	.482	.499	.517	.536	.555
.18	.870	.618	.517	.479	.484	.500	.519	.539	.559	.580
.19	.874	.624	.526	.492	.500	.518	.539	.561	.583	.606
.20	.878	.631	.535	.505	.515	.535	.559	.583	.607	.631

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

$$x_b = v_b \sqrt{EL}$$

a = 200 (ft./sec.) $10^4 n/B$ = 1.[illegible] (ft.$^{-2}$)

P/L	0.350	0.142	[illegible]	[illegible]	0.024	[illegible]	[illegible]	[illegible]	0.010	[illegible]
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.865	0.567	[illegible]	[illegible]	0.299	[illegible]	[illegible]	[illegible]	0.267	[illegible]
.10	.896	.601	.472	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
.15	.907	.634	.519	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
.16	.911	.640	.528	[illegible]	.479	[illegible]	[illegible]	[illegible]	.542	[illegible]
.17	.915	.647	.538	[illegible]	.496	.509	.527	.547	.567	[illegible]
.18	.920	.654	.547	.507	.512	.528	.548	.570	.592	[illegible]
.19	.924	.660	.556	.520	.528	.547	.570	.593	.617	.640
.20	.928	.667	.566	.534	.545	.566	.591	.616	.642	[illegible]

a = 200 (ft./sec.) $10^4 n/B$ = 1.50 (ft.$^{-2}$)

P/L	0.390	0.156	0.078	0.039	0.026	0.019	0.016	0.013	0.011	0.010
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.905	0.593	0.444	0.349	0.314	0.296	0.287	0.282	0.280	0.279
.10	.927	.628	.494	.419	.399	.395	.397	.403	.411	.419
.15	.949	.663	.543	.489	.484	.494	.508	.524	.541	.558
.16	.954	.670	.553	.503	.502	.513	.530	.548	.567	.586
.17	.958	.677	.563	.517	.519	.533	.552	.572	.593	.614
.18	.962	.684	.573	.531	.536	.553	.574	.596	.619	.642
.19	.967	.691	.583	.545	.553	.573	.596	.620	.645	.670
.20	.971	.698	.593	.559	.570	.593	.618	.644	.671	.698

a = 200 (ft./sec.) $10^4 n/B$ = 1.75 (ft.$^{-2}$)

P/L	0.421	0.168	0.084	0.042	0.028	0.021	0.017	0.014	0.012	0.011
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.941	0.617	0.462	0.362	0.326	0.307	0.298	0.293	0.291	0.290
.10	.964	.653	.513	.435	.415	.410	.413	.419	.427	.435
.15	.986	.689	.564	.508	.504	.513	.528	.545	.563	.580
.16	.991	.696	.575	.522	.521	.534	.551	.570	.590	.609
.17	.996	.704	.585	.537	.539	.554	.574	.595	.617	.638
.18	1.000	.711	.595	.551	.557	.574	.596	.620	.644	.667
.19	1.005	.718	.605	.566	.575	.595	.619	.645	.671	.696
.20	1.010	.726	.616	.580	.592	.616	.642	.670	.698	.725

a = 200 (ft./sec.) $10^4 n/B$ = 2.00 (ft.$^{-2}$)

P/L	0.450	0.180	0.090	0.045	0.030	0.022	0.018	0.015	0.013	0.011
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.972	0.637	0.477	0.375	0.337	0.318	0.308	0.303	0.301	0.300
.10	.996	.675	.531	.450	.429	.424	.427	.433	.441	.450
.15	1.020	.713	.584	.525	.521	.530	.546	.563	.581	.600
.16	1.025	.720	.594	.540	.539	.552	.569	.589	.610	.630
.17	1.030	.728	.605	.555	.557	.573	.593	.615	.638	.660
.18	1.034	.735	.615	.570	.576	.594	.617	.641	.666	.690
.19	1.039	.743	.626	.585	.594	.615	.641	.667	.694	.720
.20	1.044	.750	.636	.600	.612	.636	.664	.693	.722	.750

$x_b = v_b / \sqrt{gL}$

a = 200 (ft./sec.) $10^4 n/B = 2.25$ (ft.$^{-2}$)

P/L	0.477	0.191	0.095	0.048	0.032	0.024	0.019	0.016	0.014	0.012
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.002	0.656	0.491	0.386	0.347	0.328	0.313	0.312	0.309	.309
.10	1.026	.695	.546	.464	.442	.437	.440	.446	.454	.464
.15	1.050	.734	.601	.541	.536	[illegible]	.562	.580	.599	.613
.16	1.055	.742	.612	.556	.555	[illegible]	.595	.607	.628	.619
.17	1.060	.749	.623	.572	.574	[illegible]	.611	.633	.657	[illegible]
.18	1.065	.757	.634	.587	.593	[illegible]	.635	[illegible]	[illegible]	.711
.19	1.070	.765	.645	.603	.612	.634	.660	.687	.715	.742
.20	1.075	.772	.656	.618	.631	.656	.684	.712	.743	.773

a = 200 (ft./sec.) $10^4 n/B = 2.50$ (ft.$^{-2}$)

P/L	0.504	0.201	0.101	0.050	0.034	0.025	0.020	0.017	0.014	0.013
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.028	0.674	0.505	0.397	0.356	0.336	0.326	0.321	0.318	0.317
.10	1.053	.714	.561	.476	.453	.449	.452	.458	.466	.476
.15	1.078	.754	.617	.555	.550	.561	.577	.595	.614	.634
.16	1.084	.761	.628	.571	.570	.583	.602	.623	.644	.666
.17	1.089	.769	.639	.587	.589	.605	.627	.650	.674	.698
.18	1.094	.777	.651	.603	.609	.628	.652	.678	.704	.730
.19	1.099	.785	.662	.619	.628	.651	.677	.705	.733	.761
.20	1.104	.793	.673	.634	.648	.673	.702	.733	.763	.793

a = 200 (ft./sec/) $10^4 n/B = 2.75$ (ft.$^{-2}$)

P/L	0.528	0.211	0.106	0.053	0.035	0.026	0.021	0.018	0.015	0.014
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.053	0.690	0.517	0.406	0.365	0.345	0.334	0.328	0.326	0.325
.10	1.079	.731	.575	.488	.465	.460	.463	.469	.478	.488
.15	1.104	.772	.632	.569	.564	.574	.591	.610	.630	.650
.16	1.110	.780	.643	.585	.584	.597	.616	.638	.660	.682
.17	1.115	.788	.655	.601	.604	.620	.642	.666	.690	.714
.18	1.120	.796	.666	.617	.623	.643	.668	.694	.721	.747
.19	1.125	.804	.678	.634	.643	.666	.694	.722	.751	.780
.20	1.130	.812	.689	.650	.663	.689	.719	.750	.781	.812

a = 200 (ft./sec.) $10^4 n/B = 3.00$ (ft.$^{-2}$)

P/L	0.551	0.221	0.110	0.055	0.037	0.028	0.022	0.018	0.016	0.014
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.076	0.705	0.528	0.415	0.373	0.352	0.341	0.335	0.333	0.332
.10	1.103	.747	.587	.498	.475	.470	.473	.479	.488	.498
.15	1.129	.789	.646	.581	.576	.587	.604	.623	.643	.664
.16	1.134	.797	.658	.598	.596	.610	.630	.652	.674	.697
.17	1.139	.805	.669	.614	.617	.634	.656	.681	.706	.731
.18	1.145	.814	.681	.631	.637	.658	.683	.710	.737	.764
.19	1.150	.822	.693	.648	.658	.681	.709	.738	.768	.797
.20	1.155	.830	.704	.664	.678	.704	.735	.767	.799	.830

$$x_b = v_b \sqrt{bL}$$

a = 250 (ft./sec.) $10^4 n/B$ = 0.25 (ft.$^{-2}$)

P/L	0.243	[illegible]	0.050	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
t_b \ b	100	250	500	1000	1500	2000	2500	[illegible]	3500	4000
0.05	0.719	[illegible]	0.347	[illegible]	0.2[illegible]	0.401	[illegible]	[illegible]	[illegible]	[illegible]
.10	.733	.491	.379	[illegible]	.2[illegible]	[illegible]	[illegible]	[illegible]	.356	[illegible]
.15	.747	.513	.410	[illegible]	.34[illegible]	[illegible]	[illegible]	[illegible]	.369	[illegible]
.16	.750	.517	.416	[illegible]	.3[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
.17	.753	.522	.423	.375	.3[illegible]	.372	[illegible]	[illegible]	.403	[illegible]
.18	.756	.526	.429	.384	.379	.385	[illegible]	.407	[illegible]	[illegible]
.19	.759	.530	.435	.392	.390	.397	.409	.422	.436	[illegible]
.20	.762	.535	.442	.401	.401	.410	.423	.438	.453	[illegible]

a = 250 (ft./sec.) $10^4 n/B$ = 0.50 (ft.$^{-2}$)

P/L	0.351	0.141	0.070	0.035	0.023	0.018	0.014	0.011	0.010	0.009
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.855	0.557	0.412	0.318	0.281	0.262	0.252	0.245	0.241	0.239
.10	.872	.584	.450	.371	.346	.338	.336	.337	.340	.345
.15	.889	.610	.488	.424	.411	.413	.419	.429	.439	.451
.16	.892	.615	.495	.435	.424	.428	.436	.447	.459	.472
.17	.896	.621	.503	.446	.437	.443	.453	.466	.479	.493
.18	.899	.626	.510	.456	.450	.458	.470	.484	.499	.514
.19	.902	.631	.518	.467	.463	.473	.486	.502	.519	.536
.20	.906	.636	.525	.477	.476	.488	.503	.521	.539	.557

a = 250 (ft./sec.) $10^4 n/B$ = 0.75 (ft.$^{-2}$)

P/L	0.431	0.172	0.086	0.043	0.029	0.022	0.017	0.014	0.012	0.011
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.947	0.616	0.456	0.352	0.311	0.291	0.278	0.271	0.266	0.264
.10	.965	.646	.498	.411	.383	.374	.371	.373	.376	.382
.15	.983	.675	.540	.470	.455	.457	.464	.474	.486	.499
.16	.988	.681	.548	.481	.470	.473	.483	.495	.508	.522
.17	.991	.687	.556	.493	.484	.490	.501	.515	.530	.546
.18	.995	.693	.564	.505	.498	.506	.520	536	.552	.569
.19	.999	.698	.573	.517	.513	.523	.538	.556	.574	.593
.20	1.002	.704	.581	.528	.527	.540	.557	.576	.596	.616

a = 250 (ft./sec.) $10^4 n/B$ = 1.00 (ft.$^{-2}$)

P/L	0.497	0.199	0.099	0.050	0.033	0.025	0.020	0.017	0.014	0.012
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.017	0.662	0.490	0.378	0.335	0.312	0.299	0.291	0.287	0.284
.10	1.037	.694	.535	.442	.412	.401	.399	.401	.405	.410
.15	1.057	.725	.580	.505	.489	.490	.499	.510	.523	.536
.16	1.061	.732	.589	.517	.505	.508	.519	.532	.546	.561
.17	1.065	.738	.598	.530	.520	.526	.539	.554	.570	.587
.18	1.069	.744	.607	.542	.536	.544	.559	.575	.593	.612
.19	1.073	.751	.616	.555	.551	.562	.579	.597	.617	.637
.20	1.077	.757	.624	.568	.566	.580	.599	.619	.641	.662

$$x_b = v_b\sqrt{bL}$$

a = 250 (ft./sec.) $10^4 n/B$ = 1.25 (ft.$^{-2}$)

P/L	0.556	0.223	0.111	0.056	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.076	0.700	0.519	0.400	[illegible]	0.330	0.326	[illegible]	[illegible]	0.300
.10	1.097	.734	.566	.467	.436	.423	.422	[illegible]	[illegible]	.434
.15	1.118	.767	.613	.534	.517	[illegible]	.527	[illegible]	[illegible]	.567
.16	1.122	.774	.622	.547	[illegible]	[illegible]	.548	[illegible]	[illegible]	.594
.17	1.126	.780	.632	.560	.550	.556	.570	[illegible]	[illegible]	.620
.18	1.130	.787	.641	.574	.566	.575	.591	.608	.627	.647
.19	1.135	.794	.651	.587	.583	.594	.612	.631	.652	.674
.20	1.139	.800	.660	.600	.599	.613	.633	.654	.677	.701

a = 250 (ft./sec.) $10^4 n/B$ = 1.50 (ft.$^{-2}$)

P/L	0.609	0.244	0.122	0.061	0.041	0.030	0.024	0.020	0.017	0.015
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.126	0.733	0.543	0.419	0.370	0.345	0.331	0.322	0.317	0.314
.10	1.148	.768	.592	.489	.456	.444	.442	.443	.448	.454
.15	1.170	.803	.641	.558	.542	.543	.552	.564	.578	.593
.16	1.174	.810	.651	.572	.559	.563	.574	.588	.604	.621
.17	1.179	.817	.661	.586	.576	.582	.596	.613	.631	.649
.18	1.183	.824	.671	.600	.593	.602	.618	.637	.657	.677
.19	1.188	.831	.681	.614	.610	.622	.640	.661	.683	.705
.20	1.192	.838	.691	.628	.627	.642	.662	.685	.709	.733

a = 250 (ft./sec.) $10^4 n/B$ = 1.75 (ft.$^{-2}$)

P/L	0.658	0.263	0.132	0.066	0.044	0.033	0.026	0.022	0.019	0.016
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.170	0.762	0.564	0.435	0.385	0.359	0.344	0.335	0.329	0.326
.10	1.193	.798	.616	.508	.474	.462	.459	.461	.465	.472
.15	1.216	.834	.667	.580	.563	.564	.574	.586	.601	.617
.16	1.220	.842	.677	.595	.580	.585	.597	.612	.628	.646
.17	1.225	.849	.687	.609	.598	.605	.620	.637	.655	.675
.18	1.230	.856	.698	.624	.616	.626	.642	.662	.682	.704
.19	1.234	.863	.708	.638	.634	.646	.665	.687	.710	.733
.20	1.239	.871	.718	.653	.652	.667	.688	.712	.737	.762

a = 250 (ft./sec.) $10^4 n/B$ = 2.00 (ft.$^{-2}$)

P/L	0.703	0.281	0.141	0.070	0.047	0.035	0.028	0.023	0.020	0.018
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.210	0.787	0.584	0.450	0.398	0.371	0.356	0.346	0.340	0.336
.10	1.234	.825	.637	.525	.490	.477	.474	.476	.481	.488
.15	1.257	.863	.690	.600	.582	.584	.593	.606	.622	.638
.16	1.262	.870	.700	.615	.600	.605	.617	.632	.650	.668
.17	1.267	.878	.711	.630	.619	.626	.641	.658	.678	.698
.18	1.272	.885	.721	.645	.637	.647	.664	.684	.706	.728
.19	1.276	.893	.732	.660	.655	.668	.688	.710	.734	.758
.20	1.281	.900	.743	.675	.674	.690	.712	.736	.762	.788

$$x_b = v_b / \sqrt{bL}$$

a = 250 (ft./sec.) $10^4 n/B$ = 2.25 (ft.$^{-2}$)

P/L	0.746	0.298	0.149	0.075	0.050	0.037	0.030	0.025	0.021	0.019
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.246	0.811	0.601	0.464	0.410	0.382	0.366	0.357	0.351	0.347
.10	1.271	.850	.656	.541	.505	.492	.489	.491	.496	.502
.15	1.295	.888	.710	.618	.599	.601	.611	.624	.640	.657
.16	1.300	.896	.721	.634	.618	.623	.635	.651	.669	.688
.17	1.305	.904	.732	.649	.637	.645	.660	.678	.698	.718
.18	1.310	.912	.743	.664	.656	.666	.684	.705	.727	.749
.19	1.314	.919	.754	.680	.675	.688	.708	.732	.756	.780
.20	1.319	.927	.765	.695	.694	.710	.733	.759	.785	.811

a = 250 (ft./sec.) $10^4 n/B$ = 2.50 (ft.$^{-2}$)

P/L	0.786	0.315	0.157	0.079	0.052	0.039	0.031	0.026	0.022	0.020
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.279	0.833	0.617	0.476	0.421	0.393	0.376	0.366	0.360	0.357
.10	1.304	.873	.673	.555	.518	.505	.502	.504	.509	.516
.15	1.329	.912	.729	.634	.615	.617	.627	.641	.657	.674
.16	1.334	.920	.740	.650	.635	.639	.652	.669	.687	.706
.17	1.339	.928	.752	.666	.654	.662	.677	.696	.717	.738
.18	1.344	.936	.763	.682	.674	.684	.702	.724	.746	.769
.19	1.349	.944	.774	.698	.693	.707	.727	.751	.776	.801
.20	1.354	.952	.785	.714	.712	.729	.752	.779	.806	.833

a = 250 (ft./sec.) $10^4 n/B$ = 2.75 (ft.$^{-2}$)

P/L	0.825	0.330	0.165	0.082	0.055	0.041	0.033	0.027	0.024	0.021
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.310	0.853	0.632	0.487	0.431	0.402	0.385	0.375	0.369	0.366
.10	1.336	.894	.690	.569	.531	.517	.514	.516	.521	.528
.15	1.361	.934	.747	.650	.630	.632	.642	.657	.673	.690
.16	1.366	.942	.758	.666	.650	.655	.668	.685	.703	.723
.17	1.372	.950	.770	.682	.670	.678	.694	.713	.734	.756
.18	1.377	.958	.781	.699	.690	.701	.719	.741	.764	.788
.19	1.382	.967	.793	.715	.710	.724	.745	.769	.795	.821
.20	1.387	.975	.804	.731	.730	.747	.771	.797	.825	.853

a = 250 (ft./sec.) $10^4 n/B$ = 3.00 (ft.$^{-2}$)

P/L	0.861	0.345	0.172	0.086	0.057	0.043	0.034	0.029	0.025	0.022
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.339	0.871	0.645	0.498	0.440	0.411	0.394	0.383	0.377	0.374
.10	1.365	.913	.704	.581	.542	.528	.525	.527	.533	.540
.15	1.391	.955	.763	.664	.644	.645	.656	.671	.688	.706
.16	1.397	.963	.775	.681	.664	.669	.683	.700	.719	.739
.17	1.402	.971	.787	.697	.685	.693	.709	.728	.750	.772
.18	1.407	.980	.798	.714	.705	.716	.735	.757	.781	.805
.19	1.412	.988	.810	.730	.725	.740	.761	.786	.812	.838
.20	1.418	.996	.822	.747	.745	.763	.787	.815	.843	.871

$x_b = v_b/\sqrt{bL}$

a = 300 (ft./sec.) 10^4 n/B = 0.25 (ft.$^{-2}$)

P/L	0.358	0.143	0.072	0.036	0.024	0.018	0.014	0.012	0.01[illegible]	0.010
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	0.860	0.553	0.410	0.312	0.273	0.252	0.240	0.232	0.226	0.223
.10	.874	.580	.442	.357	.321	.315	.311	.309	.310	.312
.15	.888	.602	.473	.401	.372	.378	.381	.388	.393	.401
.16	.891	.607	.479	.410	.382	.391	.396	.402	.410	.419
.17	.894	.611	.486	.419	.404	.404	.411	.417	.427	.437
.18	.897	.616	.492	.428	.415	.416	.423	.433	.444	.455
.19	.900	.620	.498	.437	.426	.429	.437	.448	.460	.473
.20	.903	.624	.505	.446	.437	.442	.451	.464	.477	.491

a = 300 (ft./sec.) 10^4 n/B = 0.50 (ft.$^{-2}$)

P/L	0.506	0.202	0.101	0.051	0.034	0.025	0.020	0.017	0.014	0.013
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.023	0.663	0.487	0.371	0.325	0.300	0.285	0.276	0.269	0.265
.10	1.040	.690	.525	.424	.390	.375	.369	.368	.369	.371
.15	1.057	.716	.563	.477	.455	.450	.452	.459	.468	.477
.16	1.060	.721	.570	.488	.468	.465	.469	.478	.488	.499
.17	1.063	.727	.578	.499	.481	.480	.486	.496	.508	.520
.18	1.067	.732	.585	.509	.494	.495	.503	.514	.527	.541
.19	1.070	.737	.593	.520	.507	.510	.520	.533	.547	.562
.20	1.074	.743	.600	.530	.520	.525	.537	.551	.567	.584

a = 300 (ft./sec.) 10^4 n/B = 0.75 (ft.$^{-2}$)

P/L	0.620	0.248	0.124	0.062	0.041	0.031	0.025	0.021	0.018	0.015
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.132	0.734	0.539	0.411	0.359	0.332	0.315	0.305	0.298	0.294
.10	1.151	.763	.581	.470	.431	.415	.408	.407	.408	.411
.15	1.170	.792	.623	.528	.503	.498	.501	.508	.518	.528
.16	1.173	.798	.631	.540	.518	.515	.520	.529	.540	.552
.17	1.177	.804	.639	.552	.532	.531	.538	.549	.562	.575
.18	1.181	.810	.648	.564	.546	.548	.557	.569	.584	.599
.19	1.184	.816	.656	.575	.560	.564	.576	.590	.606	.622
.20	1.188	.822	.664	.587	.575	.581	.594	.610	.628	.646

a = 300 (ft./sec.) 10^4 n/B = 1.00 (ft.$^{-2}$)

P/L	0.716	0.286	0.143	0.072	0.048	0.036	0.029	0.024	0.020	0.018
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.217	0.788	0.580	0.442	0.386	0.357	0.339	0.328	0.320	0.315
.10	1.237	.820	.625	.505	.464	.446	.439	.437	.438	.442
.15	1.257	.852	.669	.568	.541	.535	.539	.546	.556	.568
.16	1.261	.858	.678	.580	.556	.553	.558	.568	.580	.593
.17	1.265	.864	.687	.593	.572	.571	.578	.590	.604	.618
.18	1.269	.870	.696	.606	.587	.589	.598	.612	.627	.643
.19	1.273	.877	.705	.618	.603	.607	.618	.634	.651	.669
.20	1.277	.883	.714	.631	.618	.624	.638	.656	.674	.694

$$x_b = v_b/\sqrt{bL}$$

a = 300 (ft./sec.) 10^4 n/B = 1.25 (ft.$^{-2}$)

P/L	0.801	0.320	0.160	0.080	0.053	0.040	0.032	0.027	0.023	0.020
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.287	0.834	0.613	0.467	0.405	0.377	0.359	0.346	0.339	0.334
.10	1.308	.867	.660	.534	.490	.472	.464	.462	.464	.467
.15	1.329	.900	.707	.600	.572	.566	.570	.578	.588	.600
.16	1.333	.907	.717	.614	.589	.585	.591	.601	.613	.627
.17	1.337	.914	.726	.627	.604	.604	.612	.624	.638	.654
.18	1.341	.920	.735	.640	.620	.622	.633	.647	.663	.680
.19	1.346	.927	.745	.654	.637	.641	.654	.670	.688	.707
.20	1.350	.934	.755	.667	.654	.660	.675	.693	.713	.734

a = 300 (ft./sec.) 10^4 n/B = 1.50 (ft.$^{-2}$)

P/L	0.877	0.351	0.175	0.088	0.058	0.044	0.035	0.029	0.025	0.022
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.347	0.873	0.642	0.488	0.428	0.395	0.375	0.363	0.354	0.349
.10	1.369	.908	.691	.568	.513	.494	.486	.484	.485	.489
.15	1.391	.942	.740	.628	.598	.592	.596	.605	.616	.628
.16	1.395	.949	.750	.642	.616	.612	.618	.629	.642	.656
.17	1.400	.956	.760	.656	.633	.632	.640	.653	.668	.684
.18	1.404	.963	.770	.670	.650	.652	.662	.677	.694	.712
.19	1.408	.970	.780	.684	.667	.671	.684	.701	.720	.740
.20	1.413	.977	.790	.698	.684	.691	.706	.725	.746	.768

a = 300 (ft./sec.) 10^4 n/B = 1.75 (ft.$^{-2}$)

P/L	0.947	0.379	0.189	0.095	0.063	0.047	0.038	0.032	0.027	0.024
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.399	0.907	0.667	0.508	0.444	0.410	0.390	0.377	0.368	0.363
.10	1.422	.943	.718	.581	.533	.513	.505	.503	.504	.508
.15	1.445	.979	.769	.653	.622	.616	.620	.628	.640	.653
.16	1.450	.987	.780	.668	.640	.636	.642	.653	.667	.682
.17	1.455	.994	.790	.682	.658	.657	.665	.679	.694	.711
.18	1.459	1.001	.800	.696	.675	.677	.688	.704	.721	.740
.19	1.464	1.008	.811	.711	.693	.698	.711	.729	.748	.769
.20	1.468	1.016	.821	.726	.711	.718	.734	.754	.776	.798

a = 300 (ft./sec.) 10^4 n/B = 2.00 (ft.$^{-2}$)

P/L	1.013	0.406	0.203	0.101	0.068	0.051	0.041	0.034	0.029	0.025
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.447	0.937	0.690	0.525	0.459	0.424	0.403	0.390	0.381	0.375
.10	1.471	.975	.743	.600	.551	.530	.522	.520	.521	.525
.15	1.494	1.013	.796	.675	.643	.636	.640	.650	.661	.675
.16	1.499	1.020	.806	.690	.662	.658	.664	.676	.690	.705
.17	1.504	1.028	.817	.705	.680	.679	.688	.702	.718	.735
.18	1.509	1.035	.828	.720	.698	.700	.712	.728	.746	.765
.19	1.513	1.042	.838	.735	.717	.721	.735	.754	.774	.795
.20	1.518	1.050	.849	.750	.735	.743	.759	.780	.802	.825

$$x_b = \eta_b \sqrt{bL}$$

a = 300 (ft./sec.) 10^4 n/B = 2.25 (ft.$^{-2}$)

P/L	1.074	0.430	0.215	0.107	0.072	0.054	0.043	[illegible]	0.031	[illegible]
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.490	0.985	0.710	0.541	0.473	0.437	0.415	0.401	0.392	0.386
.10	1.515	1.004	.765	.618	.568	.546	.538	.535	.537	.541
.15	1.539	1.043	.819	.695	.662	.655	.660	.669	.681	.695
.16	1.544	1.051	.830	.711	.681	.677	.684	.696	.710	.726
.17	1.549	1.059	.841	.726	.700	.699	.708	.723	.739	.757
.18	1.554	1.066	.852	.742	.719	.721	.733	.749	.768	.788
.19	1.559	1.074	.863	.757	.738	.743	.757	.776	.797	.819
.20	1.564	1.082	.874	.772	.757	.765	.782	.803	.826	.850

a = 300 (ft./sec.) 10^4 n/B = 2.50 (ft.$^{-2}$)

P/L	1.132	0.453	0.226	0.113	0.075	0.057	0.045	0.038	0.032	0.028
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.530	0.991	0.729	0.555	0.486	0.449	0.426	0.412	0.403	0.396
.10	1.555	1.031	.785	.635	.583	.561	.552	.550	.551	.555
.15	1.580	1.071	.841	.714	.680	.673	.677	.687	.699	.714
.16	1.585	1.079	.852	.730	.699	.696	.702	.714	.729	.746
.17	1.590	1.087	.864	.746	.719	.718	.727	.742	.759	.777
.18	1.595	1.095	.875	.761	.738	.740	.752	.769	.789	.809
.19	1.600	1.102	.886	.777	.758	.763	.778	.797	.818	.840
.20	1.606	1.110	.897	.793	.777	.785	.803	.824	.848	.872

a = 300 (ft./sec.) 10^4 n/B = 2.75 (ft.$^{-2}$)

P/L	1.188	0.475	0.238	0.119	0.079	0.059	0.048	0.040	0.034	0.030
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.567	1.015	0.746	0.569	0.497	0.459	0.437	0.422	0.412	0.406
.10	1.593	1.056	.804	.650	.597	.574	.565	.563	.564	.569
.15	1.618	1.097	.862	.731	.696	.689	.693	.704	.716	.731
.16	1.623	1.105	.873	.747	.716	.712	.719	.732	.747	.764
.17	1.628	1.113	.884	.764	.736	.735	.745	.760	.777	.796
.18	1.634	1.121	.896	.780	.756	.758	.771	.788	.808	.829
.19	1.639	1.129	.908	.796	.776	.781	.796	.816	.838	.861
.20	1.644	1.137	.919	.812	.796	.804	.822	.844	.868	.893

a = 300 (ft./sec.) 10^4 n/B = 3.00 (ft.$^{-2}$)

P/L	1.241	0.496	0.248	0.124	0.083	0.062	0.050	0.041	0.035	0.031
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.601	1.037	0.763	0.581	0.508	0.470	0.446	0.431	0.422	0.415
.10	1.628	1.079	.822	.664	.610	.587	.578	.575	.577	.581
.15	1.654	1.121	.880	.747	.712	.704	.709	.719	.732	.747
.16	1.659	1.129	.892	.764	.732	.728	.735	.748	.763	.780
.17	1.664	1.137	.904	.780	.752	.751	.761	.776	.794	.814
.18	1.670	1.146	.916	.797	.773	.775	.788	.805	.825	.847
.19	1.675	1.154	.928	.814	.793	.798	.814	.834	.856	.880
.20	1.680	1.162	.939	.830	.813	.822	.840	.863	.887	.913

$x_b = v_b / \sqrt{bL}$

a = 350 (ft./sec.) 10^4 n/B = 0.25 (ft.$^{-2}$)

P/L	0.487	0.135	0.097	0.049	0.032	0.024	0.019	0.016	0.014	0.012
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.001	0.447	0.473	0.357	0.309	0.284	0.268	0.255	0.250	0.245
.10	1.016	.669	.505	.402	.364	.347	.339	.335	.334	.335
.15	1.030	.691	.536	.446	.419	.410	.409	.412	.417	.424
.16	1.032	.696	.542	.455	.430	.423	.423	.428	.434	.442
.17	1.035	.700	.549	.464	.441	.435	.437	.443	.450	.459
.18	1.038	.705	.555	.473	.452	.448	.451	.458	.467	.477
.19	1.041	.709	.561	.482	.462	.460	.466	.474	.484	.495
.20	1.044	.714	.568	.491	.473	.473	.480	.489	.501	.513

a = 350 (ft./sec.) 10^4 n/B = 0.50 (ft.$^{-2}$)

P/L	0.689	0.276	0.138	0.069	0.046	0.034	0.028	0.023	0.020	0.017
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.191	0.769	0.562	0.424	0.368	0.338	0.319	0.306	0.298	0.292
.10	1.200	.796	.600	.477	.433	.413	.403	.398	.397	.398
.15	1.224	.822	.638	.530	.498	.488	.486	.490	.496	.504
.16	1.228	.828	.645	.541	.511	.503	.503	.508	.516	.525
.17	1.231	.833	.653	.552	.524	.518	.520	.527	.536	.546
.18	1.234	.838	.660	.562	.537	.533	.537	.545	.556	.568
.19	1.238	.844	.668	.573	.550	.548	.554	.564	.576	.589
.20	1.241	.849	.675	.584	.563	.563	.571	.582	.595	.610

a = 350 (ft./sec.) 10^4 n/B = 0.75 (ft.$^{-2}$)

P/L	0.844	0.338	0.169	0.084	0.056	0.042	0.034	0.028	0.024	0.021
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.318	0.851	0.622	0.469	0.407	0.374	0.353	0.339	0.329	0.323
.10	1.337	.881	.664	.528	.479	.457	.446	.441	.439	.440
.15	1.355	.910	.706	.587	.551	.540	.538	.542	.549	.558
.16	1.359	.916	.714	.599	.566	.556	.557	.563	.571	.581
.17	1.362	.922	.722	.610	.580	.573	.576	.583	.593	.605
.18	1.366	.928	.730	.622	.594	.589	.594	.603	.615	.628
.19	1.370	.934	.739	.634	.609	.606	.613	.624	.637	.652
.20	1.374	.939	.747	.646	.623	.622	.631	.644	.659	.675

a = 350 (ft./sec.) 10^4 n/B = 1.00 (ft.$^{-2}$)

P/L	0.975	0.390	0.195	0.097	0.065	0.049	0.039	0.032	0.028	0.024
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.416	0.914	0.669	0.505	0.438	0.401	0.379	0.364	0.354	0.347
.10	1.436	.946	.714	.568	.515	.491	.479	.474	.472	.473
.15	1.456	.978	.758	.631	.592	.580	.578	.583	.590	.599
.16	1.460	.984	.767	.644	.608	.598	.598	.605	.614	.624
.17	1.464	.990	.776	.656	.623	.616	.618	.626	.637	.649
.18	1.468	.997	.785	.669	.639	.634	.638	.648	.661	.675
.19	1.472	1.003	.794	.681	.654	.651	.658	.670	.684	.700
.20	1.476	1.009	.803	.694	.670	.669	.678	.692	.708	.725

$$x_b = v_b / \sqrt{gL}$$

a = 350 (ft./sec.) 10^4 n/B = 1.25 (ft.$^{-2}$)

P/L	1.090	0.436	0.218	0.109	0.073	0.054	0.044	0.036	0.031	0.027
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.498	0.967	0.707	0.533	0.483	0.424	0.400	0.385	0.374	0.367
.10	1.519	1.001	.755	.600	.545	.519	.506	.501	.499	.500
.15	1.540	1.034	.802	.667	.626	.613	.612	.616	.624	.633
.16	1.544	1.040	.811	.680	.643	.632	.633	.636	.649	.660
.17	1.548	1.047	.821	.694	.659	.651	.654	.662	.674	.687
.18	1.552	1.054	.830	.707	.675	.670	.675	.686	.699	.714
.19	1.556	1.060	.840	.720	.692	.689	.696	.708	.724	.740
.20	1.561	1.067	.849	.733	.708	.707	.717	.732	.749	.767

a = 350 (ft./sec.) 10^4 n/B = 1.50 (ft.$^{-2}$)

P/L	1.194	0.478	0.239	0.119	0.080	0.060	0.048	0.040	0.034	0.030
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.567	1.012	0.740	0.558	0.484	0.444	0.419	0.403	0.392	0.384
.10	1.589	1.047	.790	.628	.570	.543	.530	.524	.523	.524
.15	1.611	1.082	.839	.698	.656	.642	.640	.645	.653	.663
.16	1.616	1.089	.849	.712	.673	.661	.662	.669	.679	.691
.17	1.620	1.096	.859	.726	.690	.681	.684	.693	.705	.719
.18	1.625	1.103	.869	.740	.707	.701	.706	.717	.731	.747
.19	1.629	1.110	.879	.754	.724	.721	.728	.742	.758	.775
.20	1.634	1.117	.889	.768	.741	.741	.750	.766	.784	.803

a = 350 (ft./sec.) 10^4 n/B = 1.75 (ft.$^{-2}$)

P/L	1.290	0.502	0.258	0.129	0.086	0.064	0.052	0.043	0.037	0.032
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.629	1.052	0.770	0.580	0.503	0.461	0.436	0.419	0.407	0.399
.10	1.652	1.088	.821	.653	.592	.564	.551	.545	.543	.544
.15	1.675	1.124	.872	.726	.681	.667	.665	.670	.679	.689
.16	1.680	1.132	.882	.740	.699	.687	.688	.695	.706	.718
.17	1.684	1.139	.893	.754	.717	.708	.711	.720	.733	.747
.18	1.688	1.146	.903	.769	.734	.728	.734	.746	.760	.776
.19	1.693	1.154	.913	.784	.752	.749	.757	.771	.787	.805
.20	1.698	1.161	.923	.798	.770	.770	.780	.796	.814	.834

a = 350 (ft./sec.) 10^4 n/B = 2.00 (ft.$^{-2}$)

P/L	1.379	0.551	0.276	0.138	0.092	0.069	0.055	0.046	0.039	0.034
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.684	1.087	0.796	0.600	0.521	0.477	0.450	0.433	0.421	0.413
.10	1.708	1.125	.849	.675	.613	.584	.569	.563	.562	.563
.15	1.732	1.163	.902	.750	.704	.690	.688	.693	.702	.713
.16	1.736	1.170	.912	.765	.723	.711	.712	.719	.730	.743
.17	1.741	1.177	.923	.780	.741	.732	.735	.745	.758	.773
.18	1.746	1.185	.934	.795	.760	.753	.759	.771	.786	.803
.19	1.751	1.193	.944	.810	.778	.774	.783	.797	.814	.833
.20	1.755	1.200	.955	.825	.796	.795	.807	.823	.842	.863

$$x_b = v_b / \sqrt{bL}$$

a = 350 (ft./sec.) 10^4 n/B = 2.25 (ft.$^{-2}$)

P/L	1.462	0.585	0.292	0.146	0.097	0.073	0.058	0.049	0.042	0.037
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.754	1.120	0.819	0.618	0.536	0.492	0.464	0.446	0.433	0.425
.10	1.759	1.159	.874	.695	.631	.601	.586	.580	.578	.580
.15	1.783	1.198	.929	.772	.725	.710	.708	.714	.723	.734
.16	1.788	1.205	.940	.788	.744	.732	.733	.741	.752	.765
.17	1.793	1.213	.950	.804	.763	.754	.757	.767	.780	.796
.18	1.798	1.221	.961	.819	.782	.776	.782	.794	.809	.827
.19	1.803	1.228	.972	.834	.801	.798	.806	.821	.838	.858
.20	1.808	1.236	.983	.850	.820	.819	.831	.848	.867	.889

a = 350 (ft./sec.) 10^4 n/B = 2.50 (ft.$^{-2}$)

P/L	1.541	0.617	0.308	0.154	0.103	0.077	0.062	0.051	0.044	0.039
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.781	1.150	0.841	0.634	0.550	0.505	0.477	0.458	0.445	0.436
.10	1.806	1.190	.897	.714	.648	.617	.602	.596	.594	.595
.15	1.831	1.229	.953	.793	.745	.729	.727	.733	.742	.754
.16	1.836	1.237	.965	.809	.764	.751	.752	.760	.771	.785
.17	1.841	1.245	.976	.825	.784	.774	.778	.788	.801	.817
.18	1.846	1.253	.987	.841	.803	.796	.803	.815	.831	.849
.19	1.851	1.261	.998	.856	.822	.819	.828	.843	.861	.881
.20	1.856	1.269	1.010	.872	.842	.841	.853	.870	.890	.912

a = 350 (ft./sec.) 10^4 n/B = 2.75 (ft.$^{-2}$)

P/L	1.617	0.647	0.323	0.162	0.108	0.081	0.065	0.054	0.046	0.040
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.824	1.178	0.862	0.650	0.563	0.517	0.488	0.469	0.456	0.447
.10	1.850	1.219	.919	.731	.663	.632	.617	.610	.608	.609
.15	1.875	1.259	.976	.812	.763	.747	.745	.750	.760	.771
.16	1.880	1.267	.988	.828	.783	.770	.771	.778	.790	.804
.17	1.885	1.275	.999	.845	.802	.793	.796	.807	.821	.837
.18	1.891	1.283	1.011	.861	.822	.816	.822	.835	.851	.869
.19	1.896	1.292	1.022	.877	.842	.839	.848	.863	.881	.902
.20	1.901	1.300	1.034	.894	.862	.862	.873	.891	.911	.934

a = 350 (ft./sec.) 10^4 n/B = 3.00 (ft.$^{-2}$)

P/L	1.688	0.675	0.338	0.169	0.113	0.084	0.068	0.056	0.048	0.042
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.864	1.203	0.880	0.664	0.576	0.528	0.499	0.479	0.468	0.457
.10	1.890	1.245	.939	.747	.678	.646	.630	.623	.621	.623
.15	1.916	1.287	.998	.830	.780	.763	.761	.767	.778	.789
.16	1.922	1.295	1.010	.847	.800	.787	.788	.796	.808	.722
.17	1.927	1.303	1.021	.863	.820	.810	.814	.824	.839	.855
.18	1.932	1.312	1.033	.880	.840	.834	.840	.853	.870	.888
.19	1.937	1.320	1.045	.897	.861	.857	.866	.882	.901	.922
.20	1.943	1.328	1.057	.913	.881	.880	.892	.911	.932	.955

$$x_b = v_b \sqrt{bt}$$

a = 400 (ft./sec.) 10^4 n/B = 0.25 (ft.$^{-2}$)

P/L	0.637	0.255	0.127	0.064	0.042	0.032	0.025	0.021	0.018	0.016
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.142	0.736	0.536	0.401	0.346	0.315	0.296	0.283	0.274	0.268
.10	1.157	.758	.568	.446	.401	.379	.367	.361	.358	.357
.15	1.171	.780	.599	.491	.455	.442	.437	.438	.441	.446
.16	1.174	.785	.606	.500	.466	.454	.451	.453	.458	.464
.17	1.176	.790	.612	.509	.477	.467	.466	.469	.475	.482
.18	1.179	.794	.618	.517	.488	.479	.480	.484	.491	.500
.19	1.182	.798	.624	.526	.499	.492	.494	.500	.508	.518
.20	1.185	.803	.631	.535	.510	.505	.508	.515	.524	.535

a = 400 (ft./sec.) 10^4 n/B = 0.50 (ft.$^{-2}$)

P/L	0.900	0.360	0.180	0.090	0.060	0.045	0.036	0.030	0.026	0.022
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.359	0.875	0.637	0.477	0.411	0.375	0.352	0.337	0.326	0.318
.10	1.376	.902	.675	.530	.476	.450	.436	.429	.425	.424
.15	1.392	.928	.713	.583	.541	.525	.520	.521	.524	.530
.16	1.396	.934	.720	.594	.554	.540	.537	.539	.544	.552
.17	1.399	.939	.728	.605	.567	.555	.554	.557	.564	.573
.18	1.402	.944	.735	.615	.580	.570	.570	.576	.584	.594
.19	1.406	.950	.743	.626	.593	.585	.587	.594	.604	.615
.20	1.409	.955	.750	.636	.606	.600	.604	.612	.624	.636

a = 400 (ft./sec.) 10^4 n/B = 0.75 (ft.$^{-2}$)

P/L	1.103	0.441	0.221	0.110	0.074	0.055	0.044	0.037	0.032	0.028
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.503	0.969	0.705	0.528	0.455	0.415	0.390	0.373	0.361	0.352
.10	1.522	.998	.747	.587	.527	.498	.483	.475	.471	.470
.15	1.541	1.027	.789	.646	.599	.581	.576	.576	.580	.587
.16	1.544	1.033	.797	.658	.614	.598	.594	.596	.602	.610
.17	1.548	1.039	.805	.669	.628	.615	.613	.617	.624	.634
.18	1.552	1.045	.814	.681	.642	.631	.631	.637	.646	.658
.19	1.556	1.051	.822	.693	.657	.648	.650	.658	.668	.681
.20	1.560	1.057	.830	.704	.671	.664	.668	.678	.690	.704

a = 400 (ft./sec.) 10^4 n/B = 1.00 (ft.$^{-2}$)

P/L	1.273	0.509	0.255	0.127	0.085	0.064	0.051	0.042	0.036	0.032
t_b \ b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.616	1.040	0.758	0.568	0.489	0.446	0.419	0.401	0.388	0.378
.10	1.636	1.072	.803	.631	.567	.535	.519	.510	.506	.505
.15	1.656	1.104	.848	.694	.644	.624	.618	.619	.624	.631
.16	1.660	1.110	.856	.706	.659	.642	.638	.641	.647	.656
.17	1.664	1.116	.865	.719	.675	.660	.658	.663	.671	.681
.18	1.668	1.123	.874	.732	.690	.678	.678	.685	.695	.707
.19	1.672	1.129	.883	.744	.706	.696	.698	.706	.718	.732
.20	1.676	1.136	.892	.757	.721	.714	.718	.728	.742	.757

$$x_b = v_b/\sqrt{bL}$$

a = 400 (ft./sec.) 10^4 n/B = 1.25 (ft.$^{-2}$)

P/L	1.423	0.569	0.285	0.142	0.095	0.071	0.057	0.047	0.041	0.036
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.708	1.100	0.802	0.600	0.517	0.472	0.443	0.423	0.410	0.400
.10	1.730	1.134	.849	.667	.599	.556	.549	.539	.535	.534
.15	1.751	1.167	.896	.734	.681	.660	.654	.655	.660	.667
.16	1.755	1.174	.906	.747	.697	.679	.676	.678	.685	.694
.17	1.759	1.180	.915	.760	.713	.699	.696	.701	.709	.720
.18	1.763	1.187	.924	.774	.730	.717	.717	.724	.734	.747
.19	1.767	1.194	.934	.787	.746	.736	.738	.747	.759	.774
.20	1.771	1.200	.943	.800	.762	.756	.759	.770	.784	.800

a = 400 (ft./sec.) 10^4 n/B = 1.50 (ft.$^{-2}$)

P/L	1.559	0.624	0.312	0.156	0.104	0.078	0.062	0.052	0.045	0.039
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.788	1.152	0.839	0.628	0.542	0.493	0.464	0.443	0.429	0.419
.10	1.810	1.187	.889	.698	.627	.592	.574	.564	.560	.559
.15	1.832	1.222	.938	.768	.712	.691	.684	.685	.690	.698
.16	1.837	1.229	.948	.782	.730	.711	.706	.709	.716	.726
.17	1.841	1.236	.958	.796	.747	.730	.728	.734	.743	.754
.18	1.845	1.243	.968	.810	.764	.750	.750	.758	.769	.782
.19	1.850	1.250	.977	.824	.781	.770	.773	.782	.795	.810
.20	1.854	1.257	.987	.838	.798	.790	.795	.806	.821	.838

a = 400 (ft./sec.) 10^4 n/B = 1.75 (ft.$^{-2}$)

P/L	1.684	0.674	0.337	0.168	0.112	0.084	0.067	0.056	0.048	0.042
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.858	1.197	0.872	0.653	0.563	0.513	0.482	0.461	0.446	0.435
.10	1.881	1.233	.923	.726	.652	.616	.597	.587	.582	.580
.15	1.904	1.269	.974	.798	.740	.718	.711	.712	.717	.725
.16	1.909	1.277	.985	.813	.758	.739	.734	.737	.745	.755
.17	1.913	1.284	.995	.827	.776	.759	.757	.762	.772	.784
.18	1.918	1.291	1.006	.842	.794	.780	.780	.788	.799	.813
.19	1.923	1.299	1.016	.856	.812	.800	.803	.813	.826	.842
.20	1.927	1.306	1.026	.871	.829	.821	.826	.838	.853	.871

a = 400 (ft./sec.) 10^4 n/B = 2.00 (ft.$^{-2}$)

P/L	1.801	0.720	0.360	0.180	0.120	0.090	0.072	0.060	0.051	0.045
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.921	1.237	0.902	0.675	0.582	0.530	0.498	0.476	0.461	0.450
.10	1.945	1.275	.955	.750	.674	.637	.617	.606	.602	.600
.15	1.969	1.313	1.008	.825	.766	.743	.735	.736	.742	.750
.16	1.974	1.320	1.018	.840	.784	.764	.759	.762	.770	.780
.17	1.978	1.328	1.029	.855	.802	.785	.783	.788	.798	.810
.18	1.983	1.335	1.040	.870	.821	.806	.806	.814	.826	.840
.19	1.988	1.343	1.050	.885	.839	.828	.830	.840	.854	.870
.20	1.993	1.350	1.061	.900	.858	.849	.854	.866	.882	.900

$x_b = v_b/\sqrt{bL}$

a = 400 (ft./sec.) 10^4 n/B = 2.25 (ft.$^{-2}$)

P/L	1.010	0.764	0.382	0.191	0.127	0.096	0.076	0.064	0.055	0.048
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	1.979	1.274	0.923	0.695	0.599	0.546	0.513	0.490	0.475	0.464
.10	2.003	1.313	.983	.773	.694	.656	.635	.624	.620	.618
.15	2.027	1.352	1.038	.850	.788	.765	.757	.758	.764	.772
.16	2.032	1.360	1.049	.865	.807	.787	.782	.785	.793	.803
.17	2.037	1.367	1.060	.881	.826	.808	.806	.812	.822	.834
.18	2.042	1.375	1.071	.896	.845	.830	.831	.838	.851	.865
.19	2.047	1.383	1.082	.912	.864	.852	.855	.865	.880	.896
.20	2.052	1.391	1.092	.927	.883	.874	.880	.892	.909	.927

a = 400 (ft./sec.) 10^4 n/B = 2.50 (ft.$^{-2}$)

P/L	2.013	0.806	0.403	0.201	0.134	0.103	0.081	0.067	0.058	0.050
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	2.032	1.309	0.953	0.714	0.615	0.561	0.527	0.504	0.488	0.476
.10	2.057	1.349	1.010	.793	.712	.673	.652	.641	.636	.635
.15	2.082	1.388	1.066	.872	.809	.785	.777	.778	.784	.793
.16	2.087	1.396	1.077	.888	.829	.808	.803	.806	.814	.825
.17	2.092	1.404	1.088	.904	.848	.830	.828	.833	.844	.857
.18	2.097	1.412	1.099	.920	.868	.852	.853	.861	.873	.888
.19	2.102	1.420	1.110	.936	.887	.875	.878	.888	.903	.920
.20	2.107	1.428	1.122	.952	.907	.897	.903	.916	.933	.952

a = 400 (ft./sec.) 10^4 n/B = 2.75 (ft.$^{-2}$)

P/L	2.111	0.845	0.422	0.211	0.141	0.106	0.084	0.070	0.060	0.053
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	2.080	1.340	0.976	0.731	0.630	0.574	0.539	0.516	0.499	0.487
.10	2.106	1.381	1.034	.812	.730	.689	.668	.657	.651	.650
.15	2.132	1.422	1.091	.893	.829	.804	.796	.797	.803	.812
.16	2.137	1.430	1.103	.910	.849	.827	.822	.825	.834	.845
.17	2.142	1.438	1.114	.926	.869	.850	.848	.854	.864	.877
.18	2.147	1.446	1.126	.942	.889	.873	.873	.882	.894	.910
.19	2.153	1.454	1.137	.958	.909	.896	.899	.910	.925	.943
.20	2.158	1.462	1.149	.975	.929	.919	.925	.938	.955	.976

a = 400 (ft./sec.) 10^4 n/B = 3.00 (ft.$^{-2}$)

P/L	2.205	0.882	0.441	0.221	0.147	0.110	0.088	0.074	0.063	0.055
t_b	100	250	500	1000	1500	2000	2500	3000	3500	4000
0.05	2.128	1.370	0.998	0.747	0.644	0.587	0.551	0.527	0.510	0.498
.10	2.153	1.412	1.057	.830	.746	.705	.683	.671	.666	.664
.15	2.179	1.453	1.115	.913	.847	.822	.814	.815	.821	.830
.16	2.184	1.461	1.127	.930	.868	.845	.840	.844	.852	.864
.17	2.189	1.469	1.139	.946	.888	.869	.866	.872	.883	.897
.18	2.195	1.478	1.151	.963	.908	.892	.893	.901	.914	.930
.19	2.200	1.486	1.162	.980	.929	.916	.919	.930	.945	.963
.20	2.205	1.494	1.174	.996	.949	.939	.945	.959	.976	.996

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.