LIQUID METAL BEARINGS TECHNOLOGY FOR LARGE, HIGH-TEMPERATURE, SODIUM ROTATING MACHINERY

third topical report
DESIGN / / /
LX ERNALLV PRESSURIZED / RNAL EIRIN
INCLUDING TURBULENCE AND INERTIA EFFECTS

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ABSTRACT

Design data for a Deep Pocket Hydrostatic Journals Bearing is presented. A wide range of possible operating conditions in the turbulent regime is examined. Both pressure flow induced turbulence and Bernoulli type inertia effects are accounted for in the generation of this data. Design data is presented for two bearing configurations, one selected for good stiffness characteristics, and the other with good balance between flow and stiffness. Tables of data are presented which provide load, flow, stiffness and damping of these bearings as a function of eccentricity ratio. In addition curves providing off-design information are presented, which may be used to evaluate tolerance effects and to study the performance of non-standard designs.

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FOREWORD

This is the third Topical Report of the program on "Liquid Metal Bearings Technology for Large, High Temperature, Sodium Rotating Machinery." This program is currently in progress at Mechanical Technology Incorporated, under Contract AT(30-1)-3930 from the U.S. Atomic Energy Commission, Division of Reactor Development and Technology.

The program is directed at generating new technology in the areas of bearings and bearing instrumentation, that is needed for the successful development of high capacity, sodium circulation pumps and other auxiliaries of liquid metal cooled, fast breeder reactor systems. Specifically, the program comprises:

1. Extension of lubrication theory to the region of operation where bearing flow and pressure generation are governed by turbulence and convective fluid inertia forces.
2. Identification of self-acting and externally-pressurized bearing geometries that have the greatest likelihood of successful operation in high capacity sodium pumps and other auxiliaries of liquid metal cooled fast breeder reactor systems, and generation of the design data necessary for their rational design and optimization.
3. Development of accurate instrumentation for measurement of film thickness and film pressure directly in a high temperature sodium ambient.
4. Experimental evaluation of selected self-acting bearings in high temperature liquid sodium.
5. Screening, selection and evaluation of surface materials for high temperature sodium lubricated bearings.

The extension of lubrication theory, as called for in Item 1 above, was completed and described in the first topical report (Reference 10.) This was the basic analytical effort of the program since the sodium lubricated bearings required for high-capacity, sodium pumps will operate in the turbulent, fluid-inertial flow regime by virtue of their size, geometry, surface speed, lubricant properties and Reynolds number. This regime of operation had not, in the past, received comprehensive analytical treatment in part because of its complexity, but also because of the lack of practical bearing applications in this flow regime.

The analytical development was complemented by experiments conducted with a 12-inch diameter journal bearing lubricated with a non-corrosive fluid of low viscosity to provide an early check on the validity and accuracy of the analysis. Very satisfactory correlation was obtained between the calculated and measured data. Thus, the analysis and numerical solution methods described in the first topical report were used to generate a broad range of bearing design data applicable to large, self-acting sodium lubricated bearings and necessary for their rational design and optimization specific applications.

The second topical report (Reference 11), presented the calculated performance data for self-acting bearings operating the turbulent flow regime, in accordance with Item 2 above.

In this third topical report, the turbulent lubrication analysis is extended to cover the mode of operation of hydrostatic bearings. Calculated performance data for externally pressurized bearings operating in turbulent flow regime is also generated, based on this analysis, and presented herein for a wide range of operating conditions, as called for under Item 2 above.

In further topical reports, scheduled for later this year, the other items of the program including the development of high temperature film-thickness and film-pressure instrumentation as well as the self-acting bearing tests, and the screening of surface materials will be described.

NOMENCLATURE

A_o	Area of orifice, in ²
$\overline{B}$	Normalized damping coefficient
B_{xx}, B_{yy}	Damping components, lb.sec/in.
C, C_o	Nominal clearance, in.
C_d	Coefficient of discharge
D	Diameter of journal, in.
$dArea$	Element of area, in ²
$\overline{dl}$	Element of surface length, in.
ds	Element of pocket boundary, in.
dv	Element of volume, in ³
e	Eccentricity, in.
f_p	Pocket residual
f_{pn}	Residual for Nth pocket
$f_{I,J}$	Film residual of point I,J
f_t	Film residual
f_{to}	Steady state value of film residual
f'_t	Time dependent component of film residual
Gz, Gx	Turbulent viscosity coefficient
GRADPS	Turbulent level parameter = $PsH^3 / (L\mu v)$
H	Film height, in.
I, J	Integer mesh coordinate
$J \left\{ \begin{matrix} f_{\sim p} \\ p_{\sim r} \end{matrix} \right\}$	Jacobian of pocket residuals with respect to pocket pressures

NOMENCLATURE (Continued)

K_{xx}, K_{yy}	Stiffness component, lb/in.
$\bar{K}_{xx}, \bar{K}_{yy}$	Normalized stiffness components ($\bar{K} = KC/(PsLD)$)
L	Axial length of bearing, in.
L_P	Axial length of pocket, in.
N_r	Number of pockets (or recesses)
P_r	Recess pressure, lb/in ²
P_{rn}	Pressure of nth recess, lb/in ²
$\bar{P}_r$	Centered pressure ratio (recess/supply pressure), non-dimensional
P_f	Film pressure, lb/in ²
$P_1, P_2 \dots P_9$	9 pressures surrounding mesh point, lb/in ²
P_s	Supply pressure, lb/in ²
$\vec{Q}$	Vectorial flux $\equiv$ volumetric flow per unit width in ³ /sec.in.
Q_o	Volumetric flow through resistor, in ³ E orifice flow
Q_n	Flow through nth resistor, in ³
q	Total flow from bearing pad, in ³
$\bar{Q}$	Normalized total flow from bearing
$R_{I,J}$	Matrix of zeros and ones used in calculating recess, Jacobian
s	Median of coordinate, in.
t	Time, sec.
U	Surface velocity, in/sec.
V	Volume, in ³
W_P	Resultant pad load, lb.
$\bar{W}$	Normalized load
β	Pad angular extent, radians
β_P	Pocket angular extent, radians

NOMENCLATURE (Continued)

Δp	Pressure drop; change in pressure, lbfin ²
$\Delta \epsilon$	Change in eccentricity ratio
$\Delta \theta_J$	Jth angular mesh interval, radians
$\Delta \phi$	Change in parameter ϕ
ΔS_I	Ith meridional mesh interval
E	Eccentricity ratio
E_o	Steady state value of
E^*	Amplitude of eccentricity variation
θ	Circumferential coordinate, radians
θ_P	Angle from pad inlet to eccentricity vector, radians
ν	Kinematic viscosity, in ² /sec.
ν'	Frequency, radians/sec.
ρ	Density, lb.in ⁻⁴ -sec ²
$\bar{\psi}$	Flow vector at pocket edge, in ³ /sec.in.
ϕ	Generalized parameter
ϕ'	Angle from steady state eccentricity vector to displacement
	Generalized performance parameter
∇p	Pressure gradient, lbfin ² -in.
∇f	Gradient of residual in p-space
$\oint_{cs}$	Line integral around circumference of control volume
$\iiint_{cv}$	Volumetric integral over control volume
$\oint$	Line integral around pocket

I. INTRODUCTION

This report provides the data for calculating the steady state and dynamic characteristics of large externally pressurized journal bearings. The steady state characteristics covered in this report include eccentricity, flow and load while the dynamic ones comprise fluid film stiffness and damping. The range of operation covered by the design data spans the laminar and turbulent flow regimes in the fluid film. The bearing geometries were selected from the standpoint of their applicability for sodium lubrication and, for example, in large free-surface sodium circulation pumps.

Specifically, the bearing surfaces contain a number of deep pockets. Into each pocket, usually, at its center, lubricant is supplied under pressure through an inlet resistance. This pressurization is employed to provide load capacity and stiffness for the bearing.

The advantages of the externally-pressurized bearing are good stability characteristics; low friction requirements; and the fact that experience exists with its use in operational liquid metal pumps. The disadvantages include its parasitic flow requirements and limited ultimate load capacity. Moreover, in pump applications where the bearing is directly fed from the pump discharge, start-up characteristics may be poor because of the absence of pressurized flow at start-up and the fact that only relatively narrow land areas are present in the bearing, the larger part of the surface being devoted to the bearing pockets. It is important for this reason, to insure that start-up loads are correspondingly small.

This report begins with an analysis of the externally-pressurized bearing. As a result of the low kinematic viscosity of liquid metal lubricants, certain of the assumptions made in conventional lubrication analysis must be re-examined. In particular, turbulence and lubricant inertia effects control bearing performance. Turbulence is treated here using the full, con-linear analysis (1). The predominant fluid inertia effect, and the one considered in the present analysis, occurs as the lubricant accelerates out of the deep pocket into the film. This effect is treated as a Bernoulli loss in static pressure (2).

A computer program has been developed which will evaluate the performance of pocketed hydrostatic bearings, accounting for film turbulence and Bernoulli pressure drops. Since both of these effects introduce non-linearities into the analysis, the computer program must use iterative solution methods. In addition to accounting for these non-linear effects the program iteratively matches the bearing flow with the flow through an inlet resistance. The performance characteristics calculated by the computer program include bearing load capacity, flow, stiffness and damping.

Documentation of the analysis is followed by a section detailing the geometrical configurations studied. The basic geometry consists of four partial arc pads separated from each other by drain grooves. Into each pad surface is set a deep rectangular pocket with a lubricant source at its center,

The inlet resistance and pocket size have a marked effect on hydrostatic bearing performance, and a section of this report is devoted to studying their influence. Based on the performance trends demonstrated in Section IV, decisions are made as to the bearing configurations for which detailed data should be generated.

Detailed performance data is presented for certain combinations of inlet resistance and pocket size which are considered optimal either from considerations of flow or stiffness. In addition to this detailed performance data, "sff-design" information is provided. The latter information enables the designer to seek bearing performance characteristics which are dictated by a particular design constraint, or to evaluate the performance of an existing design which may not match the optimal geometry conditions. All performance data is contained in the appendices to the handbook.

The final section of the handbook text is devoted to description of the design data and instructions for its use. A number of examples are given which demonstrate various possible applications of the data. In particular it is shown how the data for bearings with one pocket in each pad may readily be applied to bearings with two circumferentially adjacent pockets in each pad,

11. HYDROSTATIC BEARING PERFORMANCE ANALYSIS

The deep pocket hydrostatic journal bearing consists of a number of pads, surrounding the journal, whose surfaces contain one or more recesses or pockets. The pockets are usually rectangular in shape, and their depth exceeds, by one order of magnitude or more, the nominal clearance between the pads and the journal. The nominal clearance areas surrounding the pockets are referred to as lands, and their width can be as little as 10 percent of the pad's width or length.

Into each pocket, usually at its center, lubricant is delivered at some pressure, p_r , between ambient and the upstream lubricant supply pressure, p_s . An inlet resistance in the form of a sharp-edged orifice causes the drop in pressure between supply and inlet, and this inlet resistance is an essential feature of the bearing.

Because of its depth the recess may be assumed to have a constant pressure over its area, equal to the pressure at inlet. This pressure will subsequently be referred to as the recess pressure. The difference between the recess and ambient pressures induces flow through the lands. The lands offer resistance, 'firstly because of a Bernoulli pressure drop as the fluid accelerates into the lands, and secondly because of viscous friction in the lands. The combination of these two resistances will be referred to as the land film resistance.

Thus each pad of the hydrostatic bearing may be considered as possessing two resistances in series: the inlet resistance, and the land film resistance. The recess pressure is the interface pressure, and is, therefore determined by the ratio of the two resistances. As the journal displaces from a concentric position this resistance ratio takes on different values for the different pockets and the recess pressures correspondingly differ. It is this change in each recess pressure which provides the bearings stiffness in response to radial displacement.

The calculation procedure for pocketed pressurized bearings has two identifiable steps: the solution of the film pressures for given recess pressures, and adjustment of the recess pressures to satisfy the balance of flow through restrictor and film. It will be shown below that these two steps have a strong interdependence.

and the corresponding solution algorithms have been optimized by pursuing the two steps in parallel.

Solution of Film Pressures

The land film pressures are governed by the Reynolds equation, which may be considered as a surface based continuity equation:

$$\oint_{cs} \rho \vec{Q} \cdot d\vec{l} + \frac{\partial}{\partial t} \iiint_{cv} \rho dv = 0 \quad (1)$$

where $\oint_{cs} d\vec{l}$ is a line integral around a given control volume when projected onto a plane parallel to the bearing film; $\iiint_{cv} dv$ is a volumetric integral over the control volume. $\vec{Q}$ is the vectorial flux, or volumetric flow per unit width.

The solution procedure seeks to substitute for the components of equation 1 in terms of local pressure and its derivatives. The bearing surface is covered with a rectangular grid, and the components of equation 1 are related to this grid. To systematize the implementation of this procedure, the nodes and rectangles surrounding a typical point on the mesh are numbered as shown in Figure 1.

Fig. 1 Point and Rectangle Numbering for the Neighbors of Point I, J

The integer coordinate J coincides with the circumferential direction θ .
The integer coordinate I coincides with the meridional direction S .

The control volume of equation 1 is located relative to the rectangular mesh as shown in Figure 2.

Fig. 2 Location of the Control Volume Relative to the Rectangular Mesh, for point (I,J)

The first term of the continuity equation may now be written

$$\oint_{cs} \rho \vec{Q} \cdot \vec{d\ell} = \rho [Q_{S1} - Q_{S4}] R \Delta \theta_{J-1} + \rho [Q_{S2} - Q_{S5}] R \Delta \theta_J + \rho [Q_{\theta 1} - Q_{\theta 2}] \Delta S_{I-1} + \rho [Q_{\theta 4} - Q_{\theta 5}] \Delta S_I \quad (2)$$

where subscripts 1, 2, 4, 5 refer to the rectangles as numbered in Figure 1.

The flux terms Q_S , Q_θ are evaluated as follows:

$$Q_S = - \frac{H^3 G_z}{\mu} \frac{\partial p}{\partial S} \quad (3)$$

$$Q_\theta = - \frac{H^3 G_x}{\mu R} \frac{\partial p}{\partial \theta} \left(+ \frac{UH}{2} \right) \quad (4)$$

The term $\frac{UH}{2}$ would account for flow induced by surface rotation. However, in generating data for this report, the effects of surface rotation will be neglected, in comparison with hydrostatic effects, and this term will, therefore not be considered. G_x and G_z are viscosity correction factors to account for turbulence induced by pressure flow. The basis for evaluating G_x and G_z is the turbulent lubrication theory of Elrod and Ng (1), which provides $G_z (= G_x$ for pressure turbulence) as a function of the quantity $GRADPS (= \rho |\nabla p| H^3 / \mu^2$, where $|\nabla p|$ is the absolute value of the pressure gradient, H is the local film height, μ is the absolute viscosity of the lubricant, and ρ is the density of the lubricant).

The pressure gradients of equations (3) and (4) are approximated, typically, as follows:

$$\left(\frac{\partial p}{\partial S} \right)_4 = (p_4 + p_5 - p_1 - p_2) / (2\Delta S_{I-1}) \quad (5)$$

$$\left(\frac{\partial p}{\partial \theta} \right)_4 = (p_2 + p_5 - p_1 - p_4) / (2\Delta \theta_{J-1}) \quad (6)$$

The location of the journal relative to a typical pad is shown in Figure 3.

Fig. 3 Journal-Pad Location

And the land film height H is given by

$$H = \frac{1 + \epsilon C_o \cos \theta}{1 + \epsilon C_o \cos(\pi - \theta_p + \theta')} \quad (7)$$

where C_o is the nominal centered clearance, and ϵ is the eccentricity ratio. θ_p is the pad inlet angle (angle between inlet and eccentricity vector).

The developed pad surface is shown in Figure 4 for a one pocket pad:

Fig. 4 Developed Pad Surface

The Reynolds equation must be solved in the land region (shaded in Fig. 4). Within the recess the pressure is equated to the recess pressure. On the outer edges of the pad the pressure is set equal to ambient. The remaining conditions to be considered are those describing the interface between the recess and the lands.

It is assumed that flow from the recess is normal to the edge of the recess. Thus a simple Bernoulli loss in static pressure may be imposed.

$$\Delta p = p_r - p_f = \frac{\rho}{2} U_l^2 \quad (8)$$

where U_l is the land velocity, normal to the recess, evaluated as

$$U_l = -H^3 \left| \frac{\partial p}{\partial n} \right|_{G_z} / \mu \quad (9)$$

where $\frac{\partial p}{\partial n}$ is the outwards normal pressure gradient at the edge of the pocket.

and p_f is the pressure at inlet to the film,

Equation 9 is imposed along all boundaries of the recess to yield p_f . At recess corners, rather than seek to identify a normal velocity, the pressure is simply set equal to the average of the two nearest film inlet pressures. For example, at the top left hand corner of a recess.

$$p_f = (p_{I,J+1} + p_{I+1,J})/2 \quad (10)$$

and similarly for the other corners,

Thus for every point on the mesh, one of the following equations would be imposed:

On the outer boundaries of the pad

$$p = 0 \quad (\text{ambient}) \quad (11)$$

In the lands

$$\oint_{cs} \rho \vec{Q} \cdot d\vec{l} + \frac{\partial}{\partial t} \iiint \rho dV = 0 \quad (12)$$

At the recess boundaries

$$p_r - p = \frac{\rho}{2} (U_\ell)^2 \quad (13)$$

At the recess corners

$$p = (p_{I,J+1} + p_{I+1,J})/2. \quad \text{etc.} \quad (14)$$

In the recess

$$P = p_r \quad (15)$$

These equations, 11 through 15, will be referred to, collectively, as the film equations.

Iterative Solution of the Film Equations

All the film equations may be considered as having the form

$$f_{I,J}(\underline{p})_{I,J} = 0 \quad (16)$$

where $(\underline{p})_{I,J}$ is the 9-vector of **unknown** pressure values surrounding the point I,J. Using the generalized Newton-Raphson method (3), if $(\underline{p})_{I,J}^k$ is the value of $(\underline{p})_{I,J}$ at the kth iteration, then an improved value at the (k+1)th iteration is given by:

$$\{\nabla f^k\}_{I,J} \{\underline{p}^{k+1}\}_{I,J} = \{\nabla f^k\}_{I,J} \{\underline{p}^k\}_{I,J} - f_{I,J}^k \quad (17)$$

$$\text{where } \{\nabla f\}_{I,J} = \left\{ \frac{\partial f}{\partial p_1} \quad \frac{\partial f}{\partial p_2} \quad \frac{\partial f}{\partial p_3} \quad \dots \quad \frac{\partial f}{\partial p_9} \right\} \quad (18)$$

Solution of the film equations for constant recess pressure would be achieved by successively imposing equation 16 until the pressure distribution suffered fractional changes which were less than a specified convergence limit. Each pass of the iteration may be solved by the banded matrix inversion method of reference (4).

Adjustment of the Recess Pressures

To achieve a satisfactory solution for the entire hydrostatically fed pad, the film pressures must satisfy the appropriate one of equations 11, 12, 13, 14 or 15, and each recess pressure must satisfy the following equation:

$$\Delta p = p_s - p_r = \left(\frac{Q_0}{A_o} \right)^2 \frac{\rho}{2} \frac{1}{C_d^2} \quad (19)$$

where Q_0 is the volumetric flow through the restrictor

A_o is the cross-sectional area of the inlet resistance

ρ is the density of the lubricant in $\text{lb} \cdot \text{sec}^2 / \text{in}^4$

p_s is the supply pressure

C_d is the coefficient of discharge

Now, for one recess,

$$Q_0 = \oint_{\text{pocket}} \vec{v} \cdot d\vec{s} + \int \frac{dH}{dt} \cdot d\text{Area} \quad (20)$$

where $\oint \vec{ds}$ is a line integral around the pocket in the plane of the film:
 $\vec{\psi}$ is the flux vector (in³/sec-in.); $\frac{dH}{dt}$ is the local rate of change in film height.
 (in/sec); dArea is an elemental area (in²) within the area defined by the line integral
 $\oint \vec{ds}$. Thus, for steady state solution, the function which must be equated
 to zero by the flow through each restrictor, and the pressure in each recess
 is

$$f_p = p_s - p_r - \left[\oint \vec{\psi} \cdot \vec{ds} \right]^2 \frac{\rho}{2A_o^2 C_d^2} \quad (21)$$

For a bearing with a single pocket, the iterative solution of this equation,
 with p_r as subject, proceeds as follows.

$$p_r^{k+1} = p_r^k - f_p^k / (df_p / dp_r) \quad (22)$$

where k is the iteration level

$\frac{df_p}{dp_r}$ may be calculated by parts:

$$\frac{df_p}{dp_r} = \frac{\partial f_p}{\partial p_r} + \frac{\partial f_p}{\partial Q} \cdot \frac{dQ_o}{dp_r} \quad (23)$$

If the pad contains more than one separate recess, equation (22) must be
 rewritten vectorially:

$$\vec{p}_r^{k+1} = \vec{p}_r^k - \left[J \begin{Bmatrix} \vec{f}_p \\ \vec{p}_r \end{Bmatrix} \right]^{-1} \vec{f}_p^k \quad (24)$$

and the Jacobian, J is evaluated as follows:

$$\begin{aligned}
 J \begin{Bmatrix} \tilde{f}_p \\ \tilde{p}_r \end{Bmatrix} &= \begin{vmatrix} \frac{\partial f_{p1}}{\partial p_{r1}} & 0 & 0 & \dots & 0 \\ 0 & \frac{\partial f_{p2}}{\partial p_{r2}} & 0 & \dots & 0 \\ 0 & 0 & 0 & 0 & \dots & \frac{\partial f_{pn}}{\partial p_{rn}} \end{vmatrix} \\
 &+ \begin{vmatrix} \frac{\partial f_{p1}}{\partial Q_1} & 0 & 0 & \dots & 0 \\ 0 & \frac{\partial f_{p2}}{\partial Q_2} & 0 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & 0 & \dots & \frac{\partial f_{pn}}{\partial Q_n} \end{vmatrix} \begin{bmatrix} \frac{\partial Q_1}{\partial p_{r1}} & \frac{\partial Q_2}{\partial p_{r2}} & \frac{\partial Q_3}{\partial p_{r3}} & \dots \\ \frac{\partial Q_1}{\partial p_{r1}} & \frac{\partial Q_2}{\partial p_{r2}} & \frac{\partial Q_3}{\partial p_{r3}} & \dots \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \frac{\partial Q_n}{\partial p_{rn}} \end{bmatrix}
 \end{aligned}
 \tag{25}$$

The Rth column of the flow Jacobian $J \begin{Bmatrix} Q \\ \tilde{p}_r \end{Bmatrix}$ is established by solving, at each point in the film for

$$\begin{aligned}
 \left\{ \frac{\partial \tilde{p}}{\partial p_{r\ell}} \right\}_{I,J} &\text{ as follows:} \\
 \{ \nabla f_p^k \}_{I,J} \left\{ \frac{\partial \tilde{p}}{\partial p_{r\ell}} \right\}_{I,J} &= R_{I,J}
 \end{aligned}
 \tag{26}$$

where $R_{I,J} = 0$ at all points but in the Rth recess where $R_{I,J} = 1$. Equation (26) is solved by the banded matrix inversion method of reference(3), and then by calculating,

for $m = 1, 2 \dots N_r$, the elements of $J \begin{Bmatrix} Q_0 \\ \tilde{p}_r \end{Bmatrix}$ as follows:

$$\frac{\partial Q_0}{\partial p_{r\ell}} = \oint_m \frac{d\tilde{\psi}}{d\tilde{p}} \cdot \frac{\partial \tilde{p}}{\partial p_{r\ell}} \cdot d\tilde{s} \quad (27)$$

where $\oint_m d\tilde{s}$ is the cyclic integral around the m th pocket and N_r is the number of recesses.

To solve both film and restrictor equations by parallel iteration, the following sequence must be imposed.

Equation 17 for each point I, J
 Equation 25 } times the number of recesses
 Equation 26 }
 Equation 27 }
 Equation 24

Finally equation 17 is imposed, modified to account for the change in recess pressure.

$$\{\nabla f^k\}_{I,J} \{\tilde{p}^{k+1}\}_{I,J} = \{\nabla f^k\}_{I,J} \{\tilde{p}^k\} + \sum_{\ell=1}^{N_r} \frac{\partial f_{I,J}}{\partial p_{r\ell}} (p_{r\ell}^{k+1} - p_{r\ell}^k) - f_{I,J}^k \quad (28)$$

where $\frac{\partial f_{I,J}}{\partial p_{r\ell}}$ has been calculated concurrently with the calculation of the R th column of $J \begin{Bmatrix} Q_0 \\ \tilde{p}_r \end{Bmatrix}$

(Note that, with regard to computational economy, the matrix inversions involved in solving equations 28 and 26 are the same in all cases, and, therefore, need only be evaluated once and then stored for successive use.)

When the above sequence of evaluations yields a pressure distribution which differs, for successive iterations by less than a specified fractional convergence limit, the solution is accepted.

Integration for Load (single pad)

With reference to Figure 3, the force components exerted parallel and perpendicular to the line of centers by the pad film are given by, respectively:

$$w_P \cos \phi_P = - \int_0^B \int_{-L/2}^{+L/2} p \cos \theta R d\theta dS \quad (29)$$

$$w_P \sin \phi_P = \int_0^B \int_{-L/2}^{+L/2} p \sin \theta R d\theta dS \quad (30)$$

The total flow from the pad is the sum of the flows out of each recess.

$$Q_p = \sum_{I=1}^{N_r} Q_{0I} \quad \text{where } N_r \text{ is the no. of recesses in the pad} \quad (31)$$

Perturbation for Stiffness and Damping

The film and restrictor equations under time dependent conditions may be written

$$(f_f)_{I,J} = (f_{f0})_{I,J} + \frac{d}{dt} (f_f')_{I,J} \quad (32)$$

$$(\tilde{f}_p) = \tilde{f}_{p0} + \frac{d}{dt} (\tilde{f}_p') \quad (33)$$

The influence on these equations of a small, time-dependent, displacement about the steady condition, of normalized amplitude $\Delta \epsilon$ is considered as follows:

$$\begin{aligned} \epsilon &= \epsilon_0 + \Delta \epsilon \\ &= \epsilon_0 + \operatorname{Re} \{ \epsilon^* e^{i\nu' t} \} \quad (\text{where } \nu' \text{ is the frequency of oscillation}) \quad (34) \end{aligned}$$

The corresponding linear pressure responses are:

$$\tilde{p} = p_0 + \Delta \tilde{p} \quad (35)$$

$$= p_0 + \frac{dp}{d\epsilon} \Delta \epsilon$$

$$\tilde{p}_r = p_{r0} + \Delta \tilde{p}_r \quad (36)$$

$$= p_{r0} + \frac{dp_r}{d\epsilon} \Delta \epsilon$$

where subscript o implies the steady state component,

Treating ϵ and the elements of the vector $\tilde{p}_r$ as parameters of equation (32) and, imposing that, under a change in one of these parameters, the change in $(f_f)_{I,J}$ must be zero, the following relationship is obtained

$$\left\{ \left(\nabla f_{f0} \right) + i\nu \left(\nabla f_f' \right) \right\} \left\{ \frac{\partial (\tilde{p})_{I,J}}{\partial \phi} \right\} \Delta \phi = \left(- \frac{\partial f_{f0}}{\partial \phi} - i\nu \frac{\partial f_f'}{\partial \phi} \right)_{I,J} \Delta \phi \quad (37)$$

where ϕ may be ϵ , or one of the elements of $\tilde{p}_r$. Treating ϵ as a parameter of equation 33 and imposing that, under a change in ϵ , the change in f_p must be zero, the following relationship is obtained (for an incompressible lubricant)

$$\left[J \begin{Bmatrix} \tilde{f}_p \\ \tilde{p}_r \end{Bmatrix} \right] \left\{ \frac{\partial \tilde{p}_r}{\partial \epsilon} \right\} \Delta \epsilon = \left(- \frac{\partial f_{p0}}{\partial \epsilon} - i\nu \frac{\partial f_p'}{\partial \epsilon} \right) \Delta \epsilon \quad (38)$$

The evaluation of J is described in equation 25 and, in the solution algorithms, the required value of J will be available at convergence of the steady state iterations. Equation 38 is solved to yield

$$\left\{ \frac{\partial \tilde{p}_r}{\partial \epsilon} \right\} = \left[J \begin{Bmatrix} \tilde{f}_p \\ \tilde{p}_r \end{Bmatrix} \right]^{-1} \left(- \frac{\partial f_{p0}}{\partial \epsilon} - i\nu \frac{\partial f_p'}{\partial \epsilon} \right) \quad (39)$$

Now the total derivative of film pressure with respect to ϵ is the sum of the following partial derivatives

$$\frac{d(p)_{I,J}}{d\epsilon} = \left. \frac{\partial(p)_{I,J}}{\partial\epsilon} \right|_{p_r} + \left. \frac{\partial(p)_{I,J}}{\partial p_r} \right|_{\epsilon} \frac{dp_r}{d\epsilon} \quad (40)$$

and combination of equations (37), (39) and (40) yields

$$\left\{ \nabla f_{f0} + i\nu \nabla f_f' \right\}_{I,J} \left\{ \frac{d(p)_{I,J}}{d\epsilon} \right\} = \left\{ \left\{ - \frac{\partial f_{f0}}{\partial\epsilon} - i\nu \frac{\partial f_f'}{\partial\epsilon} \right\}_{I,J} + \left\{ \frac{\partial p_r}{\partial\epsilon} \right\} \left\{ - \frac{\partial f_{f0}}{\partial p_r} \right\} \right\} \quad (41)$$

(NOTE: $\frac{\partial f_f'}{\partial p_r} = 0$ for an incompressible lubricant)

The imposing of equation (41) at each point in the mesh yields $\frac{dp}{d\epsilon} = p_{\epsilon}$ for all I,J.

Integration for Stiffness

Motion of the journal, in any radial direction, in general, gives rise to two force components, in-line and perpendicular. As the motion of the journal may have two components **also**, there will be four stiffness components. Designating the direction x to be in line with the eccentricity vector, and the y direction to be rotated 90° from the x direction, the four stiffness and damping components are:

$$\begin{bmatrix} K_{xx} + i\nu B_{xx} & K_{xy} + i\nu B_{xy} \\ K_{yx} + i\nu B_{yx} & K_{yy} + i\nu B_{yy} \end{bmatrix}_P \quad \text{where the subscript p implies quantities for a single pad.}$$

Typical evaluations of these components are:

$$(Z_{xx})_p = (K_{xx} + i\nu B_{xx})_p = \frac{1}{C_o} \int_0^{\beta} \int_{-L/2}^{L/2} -p_{ex} \cos\theta R d\theta ds \quad (42)$$

$$(Z_{yy})_p = (K_{yy} + i\nu B_{yy})_p = \frac{1}{C_o} \int_0^{\beta} \int_{-L/2}^{L/2} \sin\theta R d\theta ds \quad (43)$$

where e_x, e_y are normalized displacements in the x and y directions, respectively.

Combination of Single Pad Components

The performance parameters for a multi-pad hydrostatic journal bearing are calculated by appropriate assembly of single pad components. In the present analysis, two symmetrical loading conditions will be considered, as illustrated in Figure 5.

Fig. 5 Symmetrical Loading Conditions ($\theta_p' = 0$ or 45°)

Jeglecting self-acting effects of journal rotation, these symmetrical loading conditions must give rise to symmetrical journal displacements, in line with the load. Thus the x-y coordinate system corresponds to the coordinate system defined by the load direction. Assembly of the single pad component performance parameters proceeds as follows :

Load over pad center

$$\begin{aligned}
 (\phi)_\epsilon &= (\phi)_{\epsilon, \theta_p' = \beta/2} + (\phi)_{\epsilon, \theta_p' = (\pi + \beta)/2} \\
 &+ (\phi)_{\epsilon, \theta_p' = (-\pi + \beta)/2} + (\phi)_{\epsilon, \theta_p' = (\pi + \beta)/2}
 \end{aligned}
 \tag{44}$$

Load between pads

$$\begin{aligned}
 (\phi)_\epsilon &= (\phi)_{\epsilon, \theta_p' = 0} + (\phi)_{\epsilon, \theta_p' = \pi} \\
 &+ (\phi)_{\epsilon, \theta_p' = -\pi/2} + (\phi)_{\epsilon, \theta_p' = \pi/2}
 \end{aligned}
 \tag{45}$$

where ϕ is a particular performance parameter such as vertical load, or flow, and ϕ is a single pad component of this parameter. The above procedures are implemented for load and flow, and for the stiffness components, z_{xx} and z_{yy} .

Normalization

The following conventional normalizations are employed:

$$\left. \begin{aligned}
 \bar{W} &= W / (p_s LD) \\
 \bar{Q} &= Q \mu / (p_s C^3) \\
 \bar{K} &= KC / (p_s LD) \\
 \bar{B} &= \pi B / \mu L (R/C)^3
 \end{aligned} \right\}
 \tag{46}$$

For fixed pocket and restrictor geometry these normalized parameters are functions of:

Eccentricity ratio, $e = e/C$

Length to diameter ratio, L/D

Supply pressure modified Reynolds number, $GRADPS = p_s C^3 \rho / (\mu^2)^{1/2}$

Clearance ratio, C/R

The additional influential parameters introduced by the pocket and restrictor are

Pocket circumferential length ratio, β_p / β

Pocket axial length ratio, L_p / L

Orifice diameter ratio, d_o / C

The values of these parameters will be discussed in a report section IV entitled "Optimization."

III. SELECTION OF GEOMETRICAL CONFIGURATIONS

The basic geometry considered in this handbook is a 4-pad journal bearing with a single deep pocket in the center of each pad. This geometry is illustrated in Figure 6. The potential advantage of this bearing is good stiffness and load capacity resulting from complete independence of each pocket. A possible disadvantage of this bearing will be its relatively high flow rate.

As discussed in the analysis, Section 11, of this report, performance of a hydrostatic bearing is a function of the following geometry and turbulence parameters.

- Eccentricity Ratio, $\epsilon = e/C$
- Length to Diameter Ratio, L/D
- Supply Pressure Turbulence Parameter, $GRADPS = \rho p_s C^3 / (L \mu^2)$
- Clearance Ratio, C/R

In addition the following pocket and restrictor parameters govern performance.

- Pocket Circumferential Length Ratio, β_p / β
- Pocket Axial Length Ratio, L_p / L
- Orifice Ratio, d_o / C

Ranges of the geometry and turbulence parameters can be covered adequately in the generation of performance data. However, to combine these ranges with representative ranges of all pocket and restrictor parameters would call for prohibitive quantities of data.

As a first move towards limiting the range of pocket parameters, it has been imposed that the pocket axial length and circumferential length should

Fig. 6 Four Pad, Deep Pocket Hydrostatic Bearing, with One Pocket Per Pad.

be related. The relationship imposed for this 4-pad bearing with one pocket per pad has been that the ratio of pocket axial length to total axial length should equal the ratio of pocket circumferential length to total circumferential pad length ($L_p/L = \beta_p/\beta$). Thus, by imposing only the axial pocket length ratio, L_p/L , the complete shape of the pocket relative to the pad is defined. In subsequent discussion only the pocket axial length ratio will be defined - it is implicit that the above relationship holds.

Secondly, values of orifice ratio and pocket length ratio have been selected for which the performance characteristics will be optimal from certain considerations. The particular Considerations and the means of achieving the desired characteristics will be discussed in the following section (Section IV, OPTIMIZATION).

In addition supplementary performance data relating to off-design conditions will be provided. This data will allow the design of bearings to alternate requirements from those defined as optimal. It will also allow the evaluation of existing bearings of specific geometry which may not correspond to the optimal geometries selected in this handbook.

IV. OPTIMIZATION

This section examines the influence on bearing performance of pocket size and inlet resistance. Inlet resistance is controlled, for the purposes of this study, by the centered pressure ratio, that is the ratio of pocket gauge pressure to supply gauge pressure. Since the flow through the inlet resistance is the same as the flow through the bearing film, the centered pressure ratio is equal to the ratio of film resistance to the total resistance.

The pocket size is represented by the ratio of axial pocket length to total bearing length. As discussed in the previous section, the pocket circumferential length ratio is maintained equal to the axial pocket length ratio.

A wide range of operating conditions has been examined, as summarized in Table 1. Each of the influential parameters, L/D , GRADPS, and C/R , is varied in turn about a standard case value, (1., 10^5 , 0.002) while the other parameters maintain their standard case value. In addition three values of pocket length ratio are investigated under otherwise standard conditions. Thus nine cases are examined in all. At each condition the pressure ratio is varied from 0.1 to 0.9 and corresponding performance parameters are evaluated.

TABLE 1

Range of Conditions for Optimization

Influential Parameter	Standard Case Value	Variations
L/D	1.	0.75, 0.5
GRADPS	10^5	10^3 , 10^7
C/R	0.002	0.001, 0.004
L_p/L	0.8	0.5, 0.2

9

The bearing performance parameters examined are stiffness, flow, and damping. Two further quantities are extracted, the ratio of stiffness to flow, and the ratio of orifice diameter to clearance which corresponds to the imposed pressure ratio and the calculated flow. Only a single bearing pad is examined for this study. It may be assumed that trends demonstrated by a single pad will correspond closely to the trends for a complete four-pad journal bearing.

It has been shown by other workers (5,6,7) that optimum bearing stiffness for a particular geometry occurs when the inlet resistance is very similar to the bearing film resistance, that is when the pressure ratio approximately equals 0.5. This will be confirmed below. It will further be shown that peak values of certain other performance parameters correspond to consistent values of the pressure ratio.

In a series of Figures (7 through 22) each performance parameter is plotted against pressure ratio for each of the values of L/D ratio, GRADPS, clearance ratio and pocket length ratio of Table 2. The influence of performance of pressure ratio and pocket size (L_p/L) is initially discussed below.

1. Maximum values of stiffness, damping and stiffness to flow ratio occur at consistent values of centered pressure ratio, as given in Table 2 .

TABLE 2

Values of Centered Pressure Ratios for Optimum Performance

Centered Pressure Ratio	Optimum Quantity
0.5	Stiffness
0.35	Damping
0.33	Stiffness to Flow Ratio

OPTIMIZATION. STIFFNESS AND ORIFICE RATIO VS
 CENTERED PRESSURE FOR A RANGE OF
 L/D VALUES
 C/R □ .002 LP/L = 0.8
 GRRDPS □ 10***5

Fig. 7 Optimization. Stiffness, $\bar{K}$ and Orifice Ratio, do/C vs.
 Centered Pressure Ratio, P_r . Influence of L/D ratio.

OPTIMIZATION. STIFFNESS AND ORIFICE RATIO VS
CENTERED PRESSURE FOR A RANGE OF
GRRDPS VALUES

$C/R = .002$

$LP/L = 0.8$

$L/D = 1.0$

Fig. 8 Optimization. Stiffness, $\bar{K}$ and Orifice Ratio, d_0/C vs.
Centered Pressure Ratio, $\bar{P}_r$. Influence of GRADPS.

OPTIMIZRTION. STIFFNESS RNO ORIFICE RRTIO VS
 CENTEREO PRESSURE FOR R RANGE OF
 C/R VRLUES
 LP/L = .8 L/D = 1.0
 GRROPS = 10**5

Fig. 9 Optimization. Stiffness, $\bar{K}$ and Orifice Ratio, d_o/C vs.
 Centered Pressure Ratio, $\bar{P}_r$. Influence of C/R.

□	STIFFNESS	LP/L □ .8
○	STIFFNESS	LP/L = .5
△	STIFFNESS	LP/L = .2
+	ORIFICE RATIO	LP/L = .8
x	ORIFICE RATIO	LP/L = .5
◇	ORIFICE RATIO	LP/L = .2

OPTIMIZATION. STIFFNESS AND ORIFICE RATIO VS
CENTERED PRESSURE FOR A RANGE OF
LP/L VALUES

C/R = .002 L/D □ 1.0
GRRDPS □ 10**5

Fig. 10 Optimization. Stiffness, $\bar{K}$ and Orifice Ratio, d_0/C vs.
Centered Pressure Ratio, $\bar{P}_r$. Influence of L/L .

□	FLOW	L/D □ .75
○	FLOW	L/D = .5
△	FLOW	L/D □ 1.

OPTIMIZATION. FLOW VS. CENTERED PRESSURE
 RATIO FOR A RANGE OF L/D VALUES
 $C/R = .002$ $LP/L = 0.8$
 $GROPS = 10^{**}5$

Fig. 11 Optimization. Flow, $\bar{Q}$ vs. Centered Pressure Ratio, $\bar{P}_r$.
 Influence of L/D Ratio.

□	FLOW	GRROPS = 10**3
○	FLOW	GRROPS = 10**7
△	FLOW	GRROPS = 10**5

OPTIMIZATION. FLOW VS. CENTERED PRESSURE
 FOR A RANGE OF GRADPS VALUES
 C/R = .002 LP/L = .8
 L/D = 1.

Fig. 12 Optimization. Flow, $\bar{Q}$ vs. Centered Pressure Ratio, P_r .
 Influence of GRADPS.

□	FLOW	C/R = .002
○	FLOW	C/R = .004
△	FLOW	C/R = .001

OPTIMIZATION. FLOW VS. CENTERED PRESSURE
 FOR A RANGE OF C/R VALUES
 $L/D = 1.$ $LP/L = .8$
 $GRRDPS = 10^{**}5$

Fig. 13 Optimization. Flow, $\bar{Q}$ vs. Centered Pressure Ratio, $\bar{Pr}$.
 Influence of C/R.

○ FLOW $L_P/L = .5$
 ▲ FLOW $L_P/L = .2$

OPTIMIZATION. FLOW VS. CENTERED PRESSURE
 FOR A RANGE OF L_P/L VALUES
 $C/R = .002$ $L/D = 1.$
 $GRADPS = 10^{*}5$

Fig. 14 Optimization. Flow, $\bar{Q}$ vs. Centered Pressure Ratio, $\bar{P}_r$.
 Influence of L_P/L .

□ DRMPING L/D = .75
 ○ DRMPING L/D = .5
 ▲ DRMPING L/D = 1.

OPTIMIZRTION. DRMPING VS. CENTERED PRESSURE
 FOR A RRNGE OF L/D VRLUES
 C/R = .002 LP/L □ .8
 GRRDPS = 10**5

Fig. 15 Optimization. Damping, $\bar{\beta}$ vs. Centered Pressure Ratio, $\bar{Pr}$.
 Influence of L/D Ratio.

□	DFIMPING	GRRDPS = 10**3
○	DFIMPING	GRRDPS = 10**7
△	DFIMPING	GRRDPS = 10**5

OPTIMIZATION. DFIMPING VS. CENTERED PRESSURE
 FOR A RANGE OF GRRDPS VALUES
 $C/R = .002$ $LP/L = .8$
 $L/D = 1.$

Fig. 16 Optimization. Damping, $\bar{\beta}$ vs. Centered Pressure Ratio, $\bar{p}_r$.
 Influence of GRRDPS.

□	DRMPING	C/R = .002
○	DRMPING	C/R = .004
▲	DAMPING	C/R = .001

OPTIMIZRTION. DRMPING VS. CENTERED PRESSURE
 FOR A RRNGE OF C/R VRLUES
 $\underline{L}/\underline{D} = 1.$ $\underline{L_P}/\underline{L} = .8$
 $\text{GRADPS} = 10^{**}5$

Fig. 17 Optimization. Damping, $\bar{\beta}$ vs. Centered Pressure Ratio, $\bar{P}_r$.
 Influence of C/R.

□	DRMPING	LP/L = .8
○	DRMPING	LP/L = .5
△	DRMPING	LP/L = .2

OPTIMIZATION. DRMPING VS. CENTERED PRESSURE
FOR A RANGE OF LP/L VALUES
C/R = .002 L/D = 1.
GRRDPS = 10**5

Fig. 18 Optimization. Damping, $\bar{P}$ vs. Centered Pressure Ratio, $\bar{P}_r$.
Influence of L_p/L .

- STIFFNESS/FLOW $L/D = .75$
- STIFFNESS/FLOW $L/D = .5$
- △ STIFFNESS/FLOW $L/D = 1.$

OPTIMIZATION. STIFFNESS/FLOW VS. CENTERED
PRESSURE FOR A RANGE OF
L/D VALUES
C/R = .002 LP/L = .8
GRFIDPS = 10**5

Fig. 19 Optimization. Stiffness to Flow Ratio, K/Q vs. Centered Pressure Ratio, P_r . Influence of L/D Ratio.

- STIFFNESS/FLOW GRROPS = 10**3
- STIFFNESS/FLOW GRADPS = 10**7
- △ STIFFNESS/FLOW GRRDPS = 10**5

OPTIMIZRTION. STIFFNESS/FLOW VS. CENTERED
 PRESSURE FOR A RRNGE OF
 GRROPS VRLUES
 L/D = 1. LP/L = .8
 C/R = .002

Fig. 20 Optimization. Stiffness to Flow Ratio, $\bar{K}/Q$ vs. Centered Pressure Ratio, $\bar{P}_r$. Influence of GRADPS.

- STIFFNESS/FLOW C/R = .002
- STIFFNESS/FLOW C/R = .004
- △ STIFFNESS/FLOW C/R = .001

OPTIMIZATION. STIFFNESS/FLOW VS. CENTERED
PRESSURE FOR A RANGE OF
C/R VALUES. LP/L = .8
GRADPS = 10**5

Fig. 21 Optimization. Stiffness to Flow Ratio, K/Q vs. Centered Pressure Ratio, P_r . Influence of C/R.

- STIFFNESS/FLOW $LP/L = .5$
- STIFFNESS/FLOW $LP/L = .2$
- △ STIFFNESS/FLOW $LP/L = .8$

OPTIMIZATION. STIFFNESS/FLOW VS. CENTERED
PRESSURE FOR A RANGE OF
LP/L VALUES
 $L/D = 1.$ $C/R = .002$
GRRDPS = 10**5

Fig. 22 Optimization. Stiffness to Flow Ratio, $\bar{K}/\bar{Q}$ vs. Centered Pressure Ratio, $\bar{P}_r$. Influence of L_p/L .

There are two exceptions to these patterns. Firstly, at a value of GRADPS equal to 10^3 , which is the lowest value considered in this study, the stiffness to flow ratio does not show a peak in the range of pressure ratios considered (see Figure 20). A probable reason is that $\text{GRADPS} = 10^3$ is close to laminar conditions, and at the lower pressure ratios turbulence effects may disappear. Due to this transition the rate of change of flow with pressure ratio will be greatest at low pressure ratios, and the peak in the stiffness to flow curve will be shifted to a lower pressure ratio. Under fully laminar conditions the curve may be expected to peak out at a pressure ratio near 0.33 again. Secondly, (see Figure 18) at the smallest pocket size, $L_p/L = 0.2$, the peak damping occurs at a pressure ratio of 0.8, which is markedly different for the value of 0.35 tabulated above. Even at $L_p/L = 0.5$, peak damping has shifted from a pressure ratio of 0.35 to 0.4. This effect results because, for the small pocket, the influence of the pocket on damping almost disappears. Apart from these exceptions, the trends of Table 2 are consistent.

2. Flow, as would be expected, is a monotonically increasing function of pressure ratio. At low values of pressure ratio the rate of increase from zero is sharpest, since at sufficiently low pressure ratios the flow must become laminar, and the resistance to flow a minimum.
3. The orifice diameter corresponding to the specified pressure ratio also increases monotonically with pressure ratio (see Figures 7, 8, 9, and 10). The rate of increase is sharp at low pressure ratios, flattens off in the middle of the range, and rises again in the high pressure range. Clearly, as the pressure ratio tends towards one, the orifice diameter will tend towards infinity. The direct influence of orifice diameter may be observed in Appendix C, which provides off-design data.
4. Pocket size strongly affects stiffness and flow, both of which increase with pocket size. Thus, selection of the pocket size can be reduced to a trade-off between flow on one hand, and stiffness on the other hand.
5. The ratio of stiffness to flow may be used to give some indication of the combined performance of the bearing. Figure 22 shows a sharp increase in this parameter as the pocket axial length ratio is decreased

from 0.8 to 0.5 and there is a suggestion of a peak in this parameter for a pocket length ratio between 0.5 and 0.2. However, because stiffness falls off so sharply below a length ratio of 0.5 (Figure 10), a pocket length ratio below 0.5 could not be recommended.

In addition the following effects of turbulence, inertia and L/D ratio, within the studied ranges of these parameters may be observed:

1. The onset of turbulence tends to reduce the normalized stiffness. As indicated in Figure 8, the normalized stiffness becomes smaller, as GRADPS is increased. In terms of actual stiffness, this means that, in turbulent flow regime, the actual stiffness, (K, lbs/in) achievable does not increase linearly in proportion with increase in applied pressure difference between supply and drain (P_s , psi). This is unlike the case with laminar flow, where stiffness can be kept proportional to pressure difference. It should be noted, however, that once turbulence is developed, further increase in turbulence has a less marked effect on normalized stiffness. A greater loss in the peak normalized stiffness occurs between the GRADPS values of 10^3 and 10^5 (23%) than between the values of 10^5 and 10^7 (13%).
2. Inertia effects governed by the clearance ratio also tend to reduce normalized stiffness. Increasing the clearance ratio from 0.001 to 0.004 decreased the normalized stiffness by approximately 15%, as indicated by Figure 9. This means that, in turbulent flow, the reduction in actual stiffness (K, lbs/inch) resulting from an increase in actual clearance (C, inches) will be somewhat greater than that predicted by the inverse relationship between stiffness and clearance that prevails under laminar flow. It is expected that this increase influence of clearance ratio will be greater at high values of GRADPS than at lower ones, although specific examples of this are not shown here. The final performance results, i.e. the tabular data of Appendices A and B, however, appear to confirm this trend.
3. L/D ratio has a negligible effect on normalized stiffness or flow. However, normalized damping is almost directly proportional to L/D ratio over the entire range of pressure ratios considered. As damping is normalized with respect to bearing length amongst other parameters, the actual damping is proportional to the square of the bearing Length.

By considering all the above observations in the light of the objectives of this report, the following was concluded regarding the performance data to be generated and presented.

1. The majority of the bearing data should be generated for a high stiffness bearing. This bearing should have a pocket axial length ratio of 0.8 and a centered pressure ratio of 0.5.
2. Secondary data should be run for a bearing with high stiffness to flow ratio. This bearing will have a pocket axial length ratio of 0.5 and a centered pressure ratio of 0.33.
3. The orifice ratio which will provide the desired pressure ratio and corresponding flow will be calculated and provided as an item of data, The value calculated will be based on a discharge coefficient of 0.6. This is a standard value often used in the absence of specific data (8). If a different value of Cd were to be favored by a designer the corresponding modification to orifice diameter is given by:

$$\frac{d_o'}{d_o} = \left(\frac{0.6}{Cd'} \right)^{1/2} \quad (47)$$

where d_o' is the modified orifice diameter, d_o is given by the performance data, and Cd' is the preferred coefficient of discharge.

4. In addition to the performance of the optimum bearing, the designer will require a basis for evaluating off-design performance. To provide this basis, the optimization data has been reordered and replotted. The ratio of performance under non-standard conditions to performance under standard Conditions has been related to the corresponding ratio of non-standard orifice diameter to standard orifice diameter. Thus for the high stiffness bearing ($L_p/L = 0.8$)

$$\left\{ \begin{array}{l} K/K_{Pr} = 0.5 \\ B/B_{Pr} = 0.5 \\ Q/Q_{Pr} = 0.5 \end{array} \right\}$$

have been plotted against
 $(d_o)/(d_o)_{Pr} = 0.5$

where $\bar{P}_r$ is the centered pressure ratio, and for the bearing with high stiffness to flow ratio ($L_p/L = 0.5$)

$$\left\{ \begin{array}{l} K/K_{\bar{P}_r} = 0.33 \\ B/B_{\bar{P}_r} = 0.33 \\ C/Q_{\bar{P}_r} = 0.33 \end{array} \right\} \quad \text{have been plotted against} \quad (do)/(do)_{\bar{P}_r} = 0.33$$

It is found that near universal curves of these performance ratios are obtained. The consistency of the curve for stiffness is demonstrated in Figure 23, which includes data points corresponding to all values of L/D , C/R and GRADPS considered for optimization.

A set of these curves is presented in Appendix C, which is entitled "Off-Design Data". With the detailed performance data as a base, and with these curves for correction, the performance of bearing with a wide range of orifice sizes can be obtained. The use of these off-design performance curves will be discussed and demonstrated in the following section.

5. To fully define bearing performance the range of the parameters GRADPS, C/R and L/D ratio should be covered as follows:

GRADPS: 10^3 ; 10^4 ; 10^5 ; 10^6 ; 10^7 .

C/R : 0.001; 0.002; 0.004

L/D : 0.5; 0.75; 1.0

For the large pocket bearing performance data was generated for a full combination of these values. For the small pocket bearing, however data was generated only for a full combination of the underlined values.

□ STRNDRRD
 ○ L/D=.5 RND .75
 ▲ C/R □ .004
 + C/R = .001
 X GRFIDPS = 10**3
 ◇ GRROPS = 10**7

OFF-DESIGN PERFORMRNC
 (STIFFNESS/STIFFNESS FIT PR=.5) VS.
 (ORIFICE DIA./ORIFICE DIA. PR=.5)

Fig. 23 Off-Design Curve for Stiffness.

V. DESIGN DATA - DESCRIPTION AND USE, WITH EXAMPLES

Description

The design data is presented in Appendices A and B. Appendix A contains the extensive data generated for a 4-pad bearing, with one pocket per pad. The pocket axial length ratio, L_p/L for Appendix A is 0.8 (Figure 24a). Appendix B contains less extensive, though representative data for a similar bearing with a 0.5 pocket axial length ratio (Figure 24b). Each page of these appendices contains a set of data for a particular operating condition. The following details of geometry and operating conditions are defined in the heading to the page:

Pad Extent, β , in degrees

No. of Pads

No. of Pockets per Pad

Pocket Axial Length Ratio, L_p/L

Pocket Circumferential Length Ratio, β_p/β

GRADPS, $p_s C^3 \rho / (L \mu^2)$

Clearance Ratio, C/R

L/D Ratio

Orifice Ratio, d_o/C

The last item, orifice ratio, is in fact a calculated quantity and is the ratio of orifice diameter to clearance required to produce the specified pressure ratio, and the corresponding performance given below on the page. For Appendix A the orifice ratio and performance correspond in all cases to a centered pressure ratio of 0.5. For Appendix B the orifice ratio and performance correspond to a centered pressure ratio of 0.33.

Below the headings of geometry and operating conditions, the following steady state and dynamic performance quantities are tabulated as a function of eccentricity ratio and loading direction.

Load Parameter, $W/(P_s L D)$

Flow Parameter, $Q \mu / (p_s C^3)$

Fig. 24 Four Pad Hydrostatic Bearing, Large and Small Pockets, One Pocket Per Pad.

$$\text{Normalized Stiffness } [\bar{K}_{xx}, \bar{K}_{yy}] = [K_{xx}, K_{yy}]C/(PsLD)$$

$$\text{Normalized Stiffness } [\bar{B}_{xx}, \bar{B}_{yy}] = [B_{xx}, B_{yy}]2\pi C/(\mu DL(R/C)^2)$$

Two symmetrical loading conditions are considered: load over pad center; and load between pads (see Figure 5, section II). A representative range of eccentricity ratios between zero and 0.9 is covered.

Due to the symmetrical loading conditions considered the cross-coupling stiffness and damping coefficients are zero. For non-symmetrical loading the cross-coupling stiffnesses would be non-zero but small.

Usage

The combinations of conditions available, in terms of the influential parameters: L/D ratio, GRADPS and C/R; are summarized at the beginning of each of Appendices A and B. In applying the data to real design problems the actual influential parameters will not in general assume the discrete values available. It is necessary, therefore, to extract information relating to non-standard values of the influential parameters from the discrete information. In order of increasing sophistication, one of the following methods may be used:

1. Selection of nearest condition
2. Linear interpolation
3. Plotting

In many cases the range of parameters is sufficiently well covered that the selection of the nearest condition can be used with tolerable error. To determine in any specific case what error will be involved, the sharpness with which the performance parameter of interest varies with the relevant influential parameter must be known. For this purpose, typical variations for all combinations of parameters have been plotted in Figures 25 through 34, from the data of Appendix A.

FLOW

Fig. 25 Centered Flow vs. GRADPS. $L/D = 1.0$; $C/R = 0.002$; $L_p/L = 0.8$.

STIFFNESS

STIFFNESS VS. GRADPS AT
ECCENTRICITY = 0.

Fig. 26 Centered Stiffness vs. GRADPS. $L/D = 1.0$; $C/R = 0.002$; $L_p/L = 0.2$

Fig. 27 Centered Damping vs DPS. $L/D = 1.0$; $C/R = 0.002$; $L_0/L = 0.8$.

□ LOAD
○ FLOW

LOAD PARAMETER AND FLOW VS.
ECCENTRICITY RATIO
GRFIOPS = 1.0E5 L/D = 1.0
C/R = .002

Fig. 28 Load Parameter and Flow vs. Eccentricity Ratio.
L/D = 1.0; C/R = 0.002; L/L = 0.8; GRADPS = 105.

STIFFNESS

DAMPING

STIFFNESS RNO ORMPING VS.
ECCENTRICITY RATIO
GROPS $\square 1.0E5$ $L/D = 1.0$
 $C/R = .002$

Fig. 29 Centered Stiffness and Damping vs. Eccentricity Ratio.
 $L/D = 1.0$; $C/R = 0.002$; $L_p/L = 0.8$; $GRADPS = 10^5$.

□ FLOW
○ STIFFNESS
△ DAMPING

FLOW VS. CLERRRNC E RFIIO
STIFFNESS VS. CLEFIRFINCE RFIIO
DRMPING VS. CLERRFINCE RFIIO

Fig. 30 Centered Stiffness and Damping vs. Clearance Ratio, C/R.
L/D = 1.0; GRADPS = 10^5 ; C/R = 0.002.

□ FLOW
 ○ STIFFNESS
 ▲ DRMPING

FLOW VS. L/D
 STIFFNESS VS. L/D
 DRMPING VS. L/D

Fig. 31 Flow, Stiffness and Damping vs. L/D Ratio.
 GRADPS = 10^5 ; C/R = 0.002; $L_p/L = 0.8$.

ORIFICE RATIO

ORIFICE RATIO VS. GRADPS AT
ECCENTRICITY = 0.

Fig. 32 Orifice Ratio, d_o/C vs. GRADPS, L/D Ratio; $C/R = 0.002$; $L_p/L = 0.8$.

ORIFICE RATIO

ORIFICE RATIO VS.
CLEARANCE RATIO

Fig. 33 Orifice Ratio vs. Clearance Ratio, C/R.
L/D = 1.0, GRADPS = 10^5 ; LP/L = 0.8.

ORIFICE RRTIO

ORIFICE RRTIO VS.
L/D

Fig. 34 Orifice Ratio vs. L/D Ratio. GRADPS = 10^5 ; C/R = 0.004; $L_*/L = 0.8$.

The sharpest variation is shown by flow and damping as a function of GRADPS (see Figures 25 and 27). For each decade increase in GRADPS the normalized flow decreases, and the normalized damping increases, by a factor of about 3. Thus, to determine flow and damping at a specific value of GRADPS, the nearest value approach may often be inadequate. To improve accuracy the following approximate relationships may be used:

$$\bar{B} \propto \sqrt{\text{GRADPS}} \quad (48)$$

$$\bar{Q}_{cy} \propto 1./\sqrt{\text{GRADPS}} \quad (49)$$

The agreement with these relationships is best at high values of GRADPS and deteriorates at low values. However, in application above $\text{GRADPS} = 10^3$, when used as a correction on the flow or damping given by the nearest value of GRADPS, these relationships will not give errors in excess of 30 percent. For GRADPS above 10^5 , discrepancies will be less than 10 percent. If better accuracy than this is required a curve may be plotted on log-log graph paper (see example 1).

Stiffness does not exhibit sharp variation with GRADPS (see Figure 26) and typically, errors of 10 percent or less may be expected by selection of stiffness predictions at the nearest value of GRADPS. These errors will again be smallest at high values of GRADPS. If better accuracy is required, a curve may be plotted on semi-log graph paper, as in Figure 26.

The influence of eccentricity ratio on load parameter is obviously significant (see Figure 28). The rate of increase of load parameter from zero is linear at low eccentricities, but falls off at high eccentricity ratios. Normally interpolation or plotting is necessary to achieve good accuracy in load parameter.

Flow falls slightly with eccentricity ratio, and the predicted value at the nearest eccentricity ratio will be sufficiently accurate.

Stiffness and damping tend to fall with eccentricity ratio except at very high eccentricity where the increased squeeze film action of the side lands begins to dominate (Figure 29). The need for plotting or interpolation in a particular instance can be judged from this figure in terms of the accuracy desired.

Some variation of performance with clearance ratio may be observed (Figure 30). The use of performance parameters at the nearest value of C/R will lead to an error of 20 percent at worst. In this case a linear plot can be used to improve accuracy in any performance parameter, if required.

For all normalized performance parameters but damping the influence of L/D ratio is small (see Figure 31) and may be neglected. Performance predictions at the nearest value of L/D may be satisfactorily applied. For normalized damping the following law of variation may be accurately applied:

$$\bar{B} \propto L/D \quad (50)$$

Corrections on this basis to the value of $\bar{B}$ obtained at the nearest available value of L/D will not lead to errors greater than 5 percent,

Figures 32, 33, and 34 show the variation of orifice ratio with GRADPS, C/R, and L/D ratio respectively. While this is, in some cases, gradual, selection of the value at the nearest condition will not always be satisfactory. The off-design data of Appendix C may be used as described below to estimate the likely performance penalty for a particular error in orifice diameter. If too high a penalty is anticipated, linear interpolation may be used to improve the accuracy in orifice ratio.

Influence of Pocket Size and Load Direction

In addition to the above trends as a function of eccentricity ratio, GRADPS, C/R, and L/D ratio, the following effects as a function of pocket size and load direction may be observed.

1. The stiffness and load capacity are lower for the small pocket bearing than for the large pocket bearing by as much as 30 percent.
2. The small pocket bearing of Appendix B shows the benefit of substantially reduced flow (by a factor between 2 and 2.5) in comparison with the large pocket bearing of Appendix A.

3. Lower ultimate load capacity is exhibited by the small pocket bearing.
4. For loading over the pad center, the small pocket bearing also starts to show negative stiffness at eccentricity ratios of 0.8 and above. Care must be exercised to avoid operation of this bearing at high eccentricity ratio.
5. Loading between pads generally improves load capacity, particularly for the small pocket bearing. Since negative stiffness can set in with the small pocket bearing for loading over the pad center it is to be recommended that this bearing be loaded between the pads whenever a fixed load direction can be assured.

Use of Off-Design Data

Appendix C contains off-design data for the two pocket sizes. Correction factors for stiffness, damping and flow are plotted as a function of normalized orifice diameter. Orifice diameter is normalized with respect to the standard value as given by the design curves of Appendices A and B. The correction factors relate the value to be expected with a non-standard orifice diameter to the value predicted in Appendices A and B. The curves of Appendix C are universal curves applicable to a wide range of conditions.

To use the off-design data, standard performance for the required value of **GRADPS**, **C/R** and **L/D** ratio should be read from the appropriate table in Appendix A or B. In particular the ratio of standard orifice diameter to clearance should be read. The non-standard value of this ratio should be calculated, followed by the ratio of actual orifice diameter to standard orifice diameter. The appropriate correction factors for stiffness, flow and damping may then be read from Appendix C as a function of the latter ratio. Finally the standard performance should be corrected accordingly, to give performance corresponding to the actual orifice diameter.

Application to Alternate Bearing Geometries

Although specifically developed for the two geometries illustrated in Figures 24a and 24b, it is possible to apply the performance data to a number of other

configurations with little error. Two specific examples are given. The first of these configurations is shown in Figure 35a. It consists, as for the bearings already discussed, of four 80° pads, but in this case there are two circumferentially adjacent pockets in each pad. The two pockets are separated by an axial land, whose purpose is to provide an additional surface area over which pressures may be generated by surface motion at start-up. Since the hydrostatic supply pressure is provided by the pump itself, there can be no hydrostatic action at start-up. The data of Appendices A, B and C would be most applicable to a bearing of the configuration of Figure 35a in which the pockets had the same axial width, and in which the circumferential extent of the two pockets plus the central land was the same as the pocket circumferential extent provided in these appendices.

Table 3 shows a typical set of performance data for the bearing with two pockets per pad of Figure 35a. The conditions for this set of data correspond in all respects but pocket geometry to the data, in Table A-42 of Appendix A, for a bearing with one pocket per pad. Figures 36, 37, 38 and 39 are plots comparing the two sets of data for load capacity, flow, stiffness and damping. It is observed that the data of Appendix A is in all cases similar to data for the bearing with two pockets per pad and may, therefore, be validly applied to this configuration. On the basis of equal flow the orifice ratio for the bearing with two pockets per pad should be smaller than that for one pocket per pad, by a factor of $\sqrt{2}$. In the comparative example given this factor is calculated to be 1.405, so that use of the factor 1.4141 is in error by less than 1 percent, and may be imposed whenever the single pocket data is to be applied to a two pocket bearing.

The second configuration to which the data of Appendices A, B and C may be applied consists of two axially adjacent sets of 80° pads with a single pocket in each pad. The two rows of pads are separated by a circumferential drain groove. The configuration is shown in Figure 35b. As the lubricant films in the two rows of pads are entirely independent, each row of pads may be treated as a single bearing and, provided the pockets are centrally located in their pads, the data of Appendices A, B and C is directly applicable without compromise. The objective in designing a bearing of the configuration shown in

TABLE 3 Typical Data for Bearing With
Two Pockets Per Pad

DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GHAOPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	2	.800	.350	1.000E+04	.0040	1.000	31.652

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1.6891
.200	.1293	1.6714
.400	.2576	1.6170
.600	.3720	1.5319
.700	.4176	1.4836
.800	.4535	1.4359
.900	.4786	1.3957

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1.6891
.200	.1297	1.6712
.400	.2634	1.6150
.600	.3920	1.5243
.700	.4459	1.4710
.800	.4865	1.4221
.900	.5137	1.3890

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	H(XX)	H(YY)
0.000	6.445E-01	6.445E-01	1.233E+01	1.233E+01
.200	6.542E-01	6.534E-01	1.225E+01	1.233E+01
.400	6.216E-01	6.745E-01	1.155E+01	1.247E+01
.600	5.033E-01	6.902E-01	9.892E+00	1.266E+01
.700	4.214E-01	6.911E-01	8.876E+00	1.267E+01
.800	3.805E-01	6.779E-01	8.992E+00	1.270E+01
.900	2.002E-01	6.737E-01	2.091E+01	1.298E+01

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	H(XX)	H(YY)
6.445E-01	6.445E-01	1.233E+01	1.233E+01
6.649E-01	6.485E-01	1.235E+01	1.220E+01
6.719E-01	6.335E-01	1.223E+01	1.200E+01
6.014E-01	5.805E-01	1.116E+01	1.120E+01
4.720E-01	5.369E-01	1.028E+01	1.071E+01
3.297E-01	4.921E-01	1.019E+01	1.033E+01
2.365E-01	4.094E-01	1.921E+01	1.051E+01

Fig. 35 Alternate Bearing Configurations.

□ SINGLE POCKET PERFORMRNC
○ DOUBLE POCKET PERFORMRNC

Fig. 36 Comparison of One and Two Pocket Data. Load Parameter vs. Eccentricity Ratio.

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□ SINGLE POCKET PERFORMRNC
 ○ DOUBLE POCKET PERFORMRNC

COMPRRISON OF SINGLE POCKET WITH DOUBLE
 POCKET PERFORMANCE. FLOW VS ECCENTRICITY RATIO
 GRADPS = 1.0E+4 L/D = 1.0
 C/R = .004

Fig. 37 Comparison of One and Two Pocket Data. Flow vs. Eccentricity Ratio.

□ SINGLE POCKET PERFORMRNC
 ○ DOUBLE POCKET PERFORMRNC

COMPARISON OF SINGLE POCKET WITH DOUBLE
 POCKET PERFORMRNC. KXX VS ECCENTRICITY RFITIO
 GRFIDPS = 1.0E+4 L/D = 1.0
 C/R □ .004

Fig. 38 Comparison of One and Two Pocket Data. Stiffness vs. Eccentricity Ratio.

□ SINGLE POCKET PERFORMRNC
 ○ DOUBLE POCKET PERFORMANCE

COMPARISON OF SINGLE POCKET WITH DOUBLE
 POCKET PERFORMRNC. BXX VS ECCENTRICITY RRTIO
 GRRDPS = 1.0E+4 L/D = 1.0
 C/R = -004

Fig. 39 Comparison of One and Two Pocket Data. Damping vs. Eccentricity Ratio.

Figure 35b is to provide good resistance to misalignment and the misalignment stiffness is therefore of interest. Although misalignment stiffness is not provided directly in this report it may be approximately calculated from the available data as demonstrated in example 3 below.

Use of Laminar Performance Data

At the end of Appendix A is provided data applicable, for the large pocket bearing ($L_p/L = 0.8$), to laminar operation with negligible inertia pressure drop at exit from the pocket. The conditions at which the data was generated were arbitrarily selected as $C/R = .001$, $GRADPS = 1.0$. However, apart from orifice ratio, do/C the data is directly applicable to any value of $GRADPS$ or C/R at which laminar operation with negligible inertia effect may be assumed. To calculate the orifice ratio, do/C to give this performance, the following relationship is used:

$$(do/C) \propto \left[\frac{GRADPS}{Cd^2 (C/R)} \right]^{1/4} \quad \text{or}$$

$$(do/C) = 1.6515 \left[\frac{GRADPS}{Cd^2 (C/R)} \right]^{1/4}$$

Performance Examples

Use of the performance data and off-design curves is best illustrated by example. A series of examples follow which demonstrate use of the data for a number of different applications.

Example 1

It is required to design an externally pressurized .-Pad Journal Bearing, of diameter 12", and of length 12". 1200°F liquid sodium at a supply pressure of 150 psig is the lubricant. High stiffness is to be achieved by setting the axial and circumferential pocket length ratios each equal to 0.8, and by designing the orifice for optimum stiffness. The clearance is to be 0.012".

What will be the journal eccentricity ratio and lubricant flow under a radial load of 6000 lb.? What should be the orifice diameter to achieve this performance?

The governing conditions are summarized in Table 4 .

Table 4 Example 1. Governing Conditions

Length	12"
Diameter	12"
Clearance	0.012"
Supply Pressure	150 psig
Viscosity	$2.76 \times 10^{-8} \text{ lb. sec. in}^{-2}$
Density	$7.65 \times 10^{-5} \text{ lb. sec}^2 \text{ in}^{-4}$
Load	6000 lb.

From these governing conditions the influential parameters may be calculated as in Table 5 .

Table 5 Example 1. Influential Parameters

L/D Ratio	1.
C/R Ratio	0.002
GRADPS	2.17×10^6
W/psLD	0,278

The data of Appendix A applies to an optimum stiffness bearing with pocket axial and circumferential length ratios = 0.8, and is therefore directly applicable to this example. Tables A-39 and A-40 apply to the above set of conditions except that the discrete values of GRADPS are 10^6 and 10^7 for these two. To obtain data precisely applicable to the actual GRADPS value of 2.17×10^6 , linear interpolation may be used. A study of the influence of GRADPS shows that the precise definition in GRADPS is not really necessary as far as load capacity or eccentricity is concerned, but that it is necessary for flow. However, for this first example interpolation will be used to determine all performance parameters.

For both GRADPS = 10^6 and 10^7 a load parameter of 0.278 will cause an eccentricity ratio between 0.4 and 0.6. Load direction makes little difference to performance in this eccentricity range, and load over pad center will be arbitrarily selected. Linear interpolation gives the eccentricity ratio under the required load parameter:

At GRADPS = 10^6 :

$$[\epsilon]_{10^6} = \frac{[0.4 \times (0.3201 - 0.278) + 0.6 \times (0.278 - 0.2203)]}{[0.3201 - 0.2203]}$$

$$= 9.516$$

similarly at GRADPS = 10^7 :

$$[\epsilon]_{10^7} = \frac{[0.4 \times (0.3074 - 0.278) + 0.6 \times (0.278 - 0.2103)]}{[0.3074 - 0.2103]}$$

$$= 0.538$$

In Figure 40 eccentricity ratio is plotted against GRADPS. A linear variation of eccentricity ratio with the log of GRADPS is assumed, and since small changes in eccentricity ratio are involved this must be a satisfactory assumption. At a GRADPS value of 2.17×10^6 , the interpolated value of eccentricity is 0.523

Fig. 40 Example 1. Eccentricity Ratio vs GRADPS

$$\text{therefore } \epsilon = 0.523$$

The flow parameter at each value of GRADPS is obtained by linear interpolation on a similar basis:

$$\text{At GRADPS} = 10^6 :$$

$$\frac{Q_{\mu}}{P_{SC}^3} = \frac{[0.2486 \times (0.3201 - 0.278) + 0.2384 \times (0.278 - 0.2203)]}{[0.3201 - 0.2203]}$$

$$= 0.243$$

$$\text{At GRADPS} = 10^7 :$$

$$\frac{Q_{\mu}}{P_{SC}^3} = \frac{[0.0841 \times (0.3074 - 0.278) + 0.0808 \times (0.278 - 0.2103)]}{[0.3074 - 0.2103]}$$

$$= 0.0818$$

On Figure 41 flow parameter is plotted against GRADPS on log-log paper. At $\text{GRADPS} = 2.17 \times 10^6$, The interpolated value of flow parameter is

$$\frac{Q_{\mu}}{P_{SC}^3} = 0.169$$

$$\text{therefore } Q = \frac{0.169 \times 150 \times 1.73 \times 10^{-6}}{2.76 \times 10^{-8}}$$

$$\text{therefore flow} = 1590 \text{ in}^3/\text{sec} = 415 \text{ GPM}$$

The orifice diameter ratios for $\text{GRADPS} = 10^6$ and 10^7 are 65.688 and 67.909 respectively. The orifice ratios are plotted against GRADPS in figure 42 and the interpolated value at $\text{GRADPS} = 2.17 \times 10^6$ is 66.4.

Fig. 41 Example 1: Flow vs. GRADPS. Load Parameter = 0.278; $C/R = 0.002$; $L/D = 1.0$

Fig. 42 Example 1. Orifice Ratio vs GRADPS for Interpolation.

Therefore orifice diameter is given by:

$$d_o = 66.4 \times 0.012 \text{ inches}$$

$$\text{therefore orifice diameter} = 0.797 \text{ inch}$$

It is of interest to examine the discrepancy in flow obtained by applying the relationship of equation 49:

$$\bar{Q} \propto \text{GRADPS}^{-\frac{1}{2}}$$

to correct the value obtained for $\bar{Q}$ at $\text{GRADPS} = 10^6$. On this basis, the approximate value for flow:

$$\begin{aligned} \bar{Q}' &= \frac{0.243}{\sqrt{2.17}} \\ &= 0.165 \end{aligned}$$

Interpolation provided the value 0.169, so that the discrepancy involved in this case is 2.4 percent, which clearly would be acceptable.

Example 2

It is necessary to reduce the flow to roughly 40 percent of the level of the Example 1. It is proposed to achieve the reduction by cutting the pocket-size and designing for optimum stiffness to flow ratio. What will be the performance of the new design?

Appendix B contains data for pads with smaller pockets, whose width and length are 50 percent of the pad width and length, and whose orifice diameter is sized for optimum stiffness to flow ratio. However the data of this appendix is slightly limited and, although an L/D ratio of 1.0 and clearance ratio of 0.002 are included, the nearest values of GRADPS are 10^5 or 10^7 . Flow varies by a factor of 8 over this range, but it is anticipated that application of the correction formula (equation 49) provided in this report section, and tested in the previous example, will again be satisfactory. At $\text{GRADPS} = 10^5$ the flow value is 0.2753 for an eccentricity ratio of 0.4. Applying the correction formula, at $\text{GRADPS} = 2.17 \times 10^6$, the corrected flow parameter is

$$\begin{aligned} \bar{Q} &= \frac{0.2753}{\sqrt{21.7}} \\ &= 0.0589 \end{aligned}$$

This is 35 percent of the flow in Example 1, so that the design objective for flow has been achieved.

Examining the values of load parameter as a function of eccentricity ratio at $\text{GRADPS} = 10^7$ it is seen that a value of 0.278 is greater than the ultimate load capacity for load over pad center (0.274), but that it is comfortably short of the ultimate load capacity for loading between the pads (0.351). For this reason it is necessary to design for loading between the pads, and it should be noted that this design can only be satisfactory if a consistent loading direction can be assured. Considering loading between the pads, the eccentricity ratio at $\text{GRADPS} = 10^5$ is given by

$$\begin{aligned} (\epsilon)_1 &= [0.6 \times (0.2935 - 0.2780) + 0.7 \times (0.2780 - 0.2485)] / (0.2935 - 0.2485) \\ &= 0.665 \end{aligned}$$

and at $\text{GRADPS} = 10^7$ by

$$\begin{aligned} (\epsilon)_2 &= [0.7 \times (0.3015 - 0.2780) + 0.8 \times (0.2780 - 0.2564)] / (0.3015 - 0.2564) \\ &= 0.749 \end{aligned}$$

Linear interpolation between these points on a semi-log plot, for the eccentricity ratio at $\text{GRADPS} = 2.17 \times 10^6$ gives a value of eccentricity ratio as follows

$$\boxed{\epsilon = 0.721}$$

The necessary orifice ratios for $\text{GRADPS} = 10^5$ and 10^7 are 36.38 and 41.8 respectively. Applying the mean of these values to GRADPS , based on the clearance of 0.012 inch, the necessary orifice diameter is given by

$$\boxed{d_o = 39.0 \times 0.0012 = 0.468 \text{ inch}}$$

Example 3

What radial and misalignment stiffness can be obtained from an externally pressurized bearing employing two rows of 80 degree pads, separated by a central drain groove (geometry of Figure 35b). What is the required orifice diameter for each pocket? The geometry and operating conditions are given in Table 6.

Table 6 Example 3. Geometry and Operating Conditions

Length, L	19"
Diameter, D	12"
Width of Central Groove	1"
Clearance	0.012"
Supply Pressure	100 psig
Lubricant	1200°F sodium
Viscosity	$2.76 \times 10^{-8} \text{ lb. sec. in}^{-2}$
Density	$7.65 \times 10^{-5} \text{ lb. sec}^2 \text{ in}^{-4}$
Pocket Width	$0.8 \times L$
Pocket Circumferential Length	64°

Performance for this bearing may be obtained from the data of Appendix A if each row of pads is considered as a single bearing. The central drain groove makes the two rows of pads independent. Thus single pad data is required for the following conditions:

$$L/D = (19 - 1)/(12 \times 2) = 0.75$$

$$C/R = 0.002$$

$$\begin{aligned} \text{GRADPS} &= \frac{100 \times 1.2^3 \times 10^{-6} \times 7.65 \times 10^{-5}}{9 \times (2.76 \times 10^{-8})^2} \\ &= 1.93 \times 10^6 \end{aligned}$$

Table A-25 provides data for $L/D = 0.75$

$$C/R = 0.002$$

$$\text{GRADPS} = 10^7$$

Comparison of Table A-25 with Table A-24 for $\text{GRADPS} = 10^6$ shows the stiffness values for $\text{GRADPS} = 10^7$ to be slightly conservative, which validates their use for this example.

Under centered conditions the normalized stiffness is extracted from Table A-25 as

$$\frac{KC}{psLD} = 0.5298$$

Therefore the actual radial stiffness for one half of the double bearing

$$\begin{aligned} K_{1/2} &= \frac{0.5298 \times 100 \times 9 \times 12}{1.2 \times 10^{-2}} \\ &= 4.77 \times 10^5 \text{ lb/in.} \end{aligned}$$

Therefore the total radial stiffness

$$2K_{1/2} = 9.54 \times 10^5 \text{ lb/in.}$$

To evaluate the misalignment stiffness the approximation is made that the two rows of pads act as independent springs located at the center-line of each row. See figure 43 .

Figure 43 Double Row Bearing. Equivalent Spring System for Misalignment Stiffness Calculation.

Effective misalignment stiffness

$$K_M = \frac{1}{2} K_{1/2} (L')^2$$

where L' = distance between pad center-lines
 = 10" for this case

therefore $K_M = \frac{1}{2} \times 4.77 \times 10^5 \times 10^2$ lb.in/radian

$$K_M = 2.385 \times 10^7 \text{ lb.in/radian}$$

Example 4

A bearing in operation has the following dimensions:

Length	= 6"
Diameter	= 12"
Clearance	= 0.012"
Supply Pressure	= 125 psig
Lubricant	= 1200°F liquid sodium
Viscosity	= 2.76×10^{-8} lb.sec.in ⁻²
Density	= 7.65×10^{-5} lb.sec.in ⁻⁴
Orifice Diameter	= 0.5"
Pad Extent	= 80°
Pocket Width, Length	= 0.8 x pad width, length

What performance may be expected in terms of stiffness, flow and damping?

The following quantities may be calculated:

$$L/D = 0.5$$

$$C/R = 0.002$$

$$\begin{aligned} \text{GEUDPS} &= \frac{12.5 \times (1.2)^3 \times 10^{-6} \times 7.65 \times 10^{-5}}{6 \times (2.76 \times 10^{-8})^2} \\ &= 3.62 \times 10^6 \end{aligned}$$

Tables A-9 and A-10 provide performance data for this bearing at GRADPS = 10^6 and 10^7 respectively. The standard orifice ratios for these two conditions may be seen to be 56.810 and 58.455 respectively, giving a mean value of 57.5. Now the actual orifice ratio, $d_o = 0.5/0.012 = 41.67$. Since the actual orifice diameter is non-standard the "off-design" data of Appendix C must be used. To apply the data of this appendix, the ratio of actual orifice diameter to the standard orifice diameter must be calculated:

$$\begin{aligned} (do)/(do)_{Pr=0.5} &= \frac{41.67}{57.5} \\ &= 0.737 \end{aligned}$$

Figures C-1, C-2, and C-3 of Appendix C provide the ratios of actual performance to standard performance values for stiffness, damping and flow. These ratios are read as follows:

$$(stiffness)/(stiffness)_{Pr=0.5} = 0.72$$

$$(flow)/(flow)_{Pr=0.5} = 0.65$$

$$(damping)/(damping)_{Pr=0.5} = 1.05$$

The following table gives the standard values of stiffness, flow and damping from Tables A-9 and A-10 for GRADPS = 10^6 and 10^7 , together with interpolated values for GRADPS = 3.62×10^6 obtained from the plots of figures 44 and 45, the corrected values for actual orifice size, and the actual performance values.

Table 7 Example 4. Stiffness, Flow and Damping. Standard and Off-design Data.

	GRADPS= 10^6	GRADPS= 10^7	GRADPS= 3.62×10^6	Corrected Values	Dimensional Values
Stiffness	0.5501	0.5215	0.534	0.385	2.89×10^5 lbfin.
Flow	0.2721	0.0911	0.145	0.095	744 in ³ fsec.
Damping	40.55	119.7	73.5	77.2	424 lb.sec/in.

Fig. 44 Example 4. Centered Stiffness vs GRADPS.
 $L/D = 0.5$; $C/R = 0.002$

Fig. 45 Example 4. Flow and Damping Parameters vs. GRADPS

Example 5

An externally pressurized four pad journal bearing is to be designed. The bearing is to have two pockets in each pad, circumferentially adjacent to each other. The pocket axial length ratio is to be 0.8. The total pocket circumferential length ratio for the two pockets and separating land is to be 0.8, and the separating land is to be 10 percent of the pad circumferential length. Estimate the centered stiffness, damping, flow and the eccentricity ratio corresponding to a load of 400 lbs. The governing conditions are given in Table 8 .

Table 8 Example 5. Governing Conditions

Length	6"
Diameter	4.5"
Clearance	0.012"
Supply Pressure	40 psig
Lubricant	1200°F liquid sodium
Viscosity	$2.76 \times 10^{-8} \text{ lb. sec. in}^{-2}$
Density	$7.65 \times 10^{-5} \text{ lb. sec}^2 \text{ in}^{-4}$
Load	200 lbs.

The following influential parameters may be calculated,

Table 9 Example 5. Influential Parameters

L/D Ratio	0.75
C/R Ratio	0.004
GRADPS	1.15×10^6
$W/p_s LD$	0.185

The calculated value of GRADPS is so close to 10^6 that data for GRADPS = 10^6 may be accurately used. The relevant table for a single pocket per pad is therefore A-29 of Appendix A. The following non-dimensional information may be extracted from Table A-29.

Centered flow parameter $\bar{Q} = 0.2057$

Centered stiffness $\bar{K} = 0.503$

Centered damping $\bar{B} = 78.83$

Eccentricity ratio, for a load parameter of 0.185, ≈ 0.37 (for both load directions)

Thus the dimensional performance for the bearing is given as follows:

Centered flow, $Q = \bar{Q} \rho s C / \mu^3$

$$Q = 517 \text{ in}^3/\text{sec.}$$

Centered stiffness, $K = \bar{K} LD \rho s / C$

$$K = 4.54 \times 10^4 \text{ lb/in.}$$

Centered damping, $B = \bar{B} \mu DL (R/C)^2 / (2\pi C)$

$$B = 48.7 \text{ lb.sec/in.}$$

e

a

P

APPENDIX A

Performance Data for a 4 Pad Hydrostatic Bearing
with one pocket per pad, designed for a
centered pressure ratio of 0.5. Pocket axial length ratio = 0.8.

Table of Contents for Appendix A

<u>L/D.</u>	<u>GRADPs</u>	<u>C/R</u>	<u>Table No.</u>
0.5	10^3	0.001	A-1
0.5	10^4	0.001	A-2
0.5	10^5	0.001	A-3
0.5	10^6	0.001	A-4
0.5	10^7	0.001	A-5
0.5	10^3	0.002	A-6
0.5		0.002	A-7
0.5	10^5	0.002	A-8
0.5	10^6	0.002	A-9
0.5	10^7	0.002	A-10
0.5	10^3	0.004	A-11
0.5	10^4	0.004	A-12
0.5	10^5	0.004	A-13
0.5	10^6	0.004	A-14
0.5	10^7	0.004	A-15
0.75	10^3	0.001	A-16
0.75	10^4	0.001	A-17
0.75	10^5	0.001	A-18
0.75	10^6	0.001	A-19
0.75	10^7	0.001	A-20
0.75	10^3	0.002	A-21
0.75	10^4	0.002	A-22
0.75	10^5	0.002	A-23
0.75	10^6	0.002	A-24
0.75	10^7	0.002	A-25

Table of Contents for Appendix A
(cont.)

<u>L/D</u>	<u>GRADPS</u>	<u>C/R</u>	<u>Table No.</u>
0.75	10^3	0.004	A-26
0.75	10^4	0.004	A-27
0.75	10^5	0.004	A-28
0.75	10^6	0.004	A-29
0.75	10^7	0.004	A-30
1.0	10^3	0.001	A-31
1.0	10^4	0.001	A-32
1.0	10^5	0.001	A-33
1.0	10^6	0.001	A-34
1.0	10^7	0.001	A-35
1.0	10^3	0.002	A-36
1.0	10^4	0.002	A-37
1.0	10^5	0.002	A-38
1.0	10^6	0.002	A-39
1.0	10^7	0.002	A-40
1.0	10^3	0.004	A-41
1.0	10^4	0.004	A-42
1.0	10^5	0.004	A-43
1.0	10^6	0.004	A-44
1.0	10^7	0.004	A-45
0.5	Laminar	Non-Inertial	A-46
0.75	Laminar	Non-Inertial	A-47
1.0	Laminar	Non-Inertial	A-48

NOMENCLATURE AND DEFINITION OF TERMS FOR APPENDIX A

Pad Extent	The circumferential extent of each bearing pad, in degrees (B)
No. of Pads	The number of bearing pads which comprise the complete journal bearing
No. of Pockets	The number of rectangular hydrostatic pockets in each bearing pad
Pocket Width Ratio	The ratio of pocket width in the axial direction to bearing length (L_p/L)
Pocket Length Ratio	The ratio of pocket circumferential length to pad circumferential length (β_p/β)
GRADPS	Supply turbulence parameter = $psC_p^3/(L\mu^2)$ (non-dimensional)
ps	Supply pressure, lb/in^2
C	Clearance, inches
ρ	Lubricant density, $lb.in^{-4}sec^2$
L	Bearing length, inches
μ	Viscosity in reyns ($lb.in^{-2}sec.$)
Clearance Ratio	The ratio of machined radial clearance to bearing radius (C/R)
L/D Ratio	The ratio of bearing length to bearing diameter
Orifice Ratio (d_o/C)	The ratio of orifice diameter to clearance which will provide the performance of the particular table (based on a discharged coefficient of 0.6)
Eccentricity Ratio	The ratio of bearing eccentricity to radial clearance
Load Parameter	Normalized bearing load, $W/(psLD)$
W	Bearing load, lb.
D	Bearing diameter
Total Flow Parameter	Normalized leakage flow from bearing, $Q\mu/(PsC^3)$

K_{xx}	Normalized stiffness for motion parallel to the load vector, $\bar{K}_{xx} = CK_{xx}/(PsLD)$
K_{yy}	Normalized stiffness for motion perpendicular to the load vector, $K_{yy} = CK_{yy}/(PsLD)$
B_{xx}	Normalized damping for motion parallel to the load vector, $\bar{B}_{xx} = 2\pi B_{xx}C/(\mu DL(R/C)^2)$
B_{yy}	Normalized damping for motion perpendicular to the load vector, $\bar{B}_{yy} = 2\pi B_{yy}C/(\mu DL(R/C)^2)$
K_{xx}, K_{yy}	Stiffness, lb/in.
B_{xx}, B_{yy}	Damping, lb.sec/in.
Q	Total bearing flow, in ³ /sec.

TABLE A-1

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-6

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEC)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
30.00	2	1	.800	.800	1.000E+03	.0010	.500	50.322

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	4.7732
.200	.1650	4.6995
.400	.3152	4.4875
.600	.4107	4.2464
.700	.4353	4.1839
.800	.4501	4.1245
.900	.4595	4.1722

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	4.7732
.200	.1658	4.6995
.400	.3210	4.4941
.600	.4471	4.2299
.700	.4948	4.1086
.800	.5328	4.0090
.900	.5637	3.9331

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	8.335E-01	8.335E-01	2.082E+00	2.082E+00
.200	8.070E-01	8.334E-01	2.019E+00	2.057E+00
.400	6.456E-01	8.079E-01	1.749E+00	2.055E+00
.600	3.170E-01	7.688E-01	1.220E+00	2.044E+00
.700	1.878E-01	7.375E-01	1.028E+00	2.063E+00
.800	1.160E-01	7.012E-01	1.155E+00	2.131E+00
.900	7.576E-02	6.655E-01	3.227E+00	2.329E+00

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
8.335E-01	8.335E-01	2.082E+00	2.082E+00
8.135E-01	8.280E-01	2.048E+00	2.039E+00
7.236E-01	7.862E-01	1.979E+00	1.936E+00
5.300E-01	6.567E-01	1.925E+00	1.751E+00
4.283E-01	5.810E-01	2.061E+00	1.633E+00
3.391E-01	4.957E-01	2.939E+00	1.553E+00
2.943E-01	4.224E-01	1.075E+01	1.710E+00

TABLE A-2

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRAPPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/D
80.00	4	1	.800	.800	1.000E+04	.0010	.500	62.700

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	2.3434
.200	.1430	2.3145
.400	.2770	2.2333
.600	.3813	2.1190
.700	.4162	2.0612
.800	.4387	2.0163
.900	.4520	1.9905

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	7.3434
.200	.1432	2.3147
.400	.2811	2.2342
.600	.4051	2.1144
.700	.4576	2.0499
.800	.5009	1.9921
.900	.5358	1.9467

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	B(YY)
0.000	7.224E+01	7.225E+01	4.678E+00	4.678E+00
.200	7.110E+01	7.199E+01	4.561E+00	4.690E+00
.400	6.135E+01	7.114E+01	4.142E+00	4.695E+00
.600	4.205E+01	7.014E+01	3.166E+00	4.687E+00
.700	2.833E+01	6.859E+01	2.629E+00	4.725E+00
.800	1.789E+01	6.732E+01	2.348E+00	4.780E+00
.900	1.004E+01	6.490E+01	4.062E+00	4.975E+00

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *				
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.224E+01	7.225E+01	4.678E+00	4.678E+00
.200	7.135E+01	7.163E+01	4.642E+00	4.627E+00
.400	6.630E+01	6.880E+01	4.513E+00	4.439E+00
.600	5.612E+01	6.162E+01	4.289E+00	4.052E+00
.700	4.834E+01	5.605E+01	4.276E+00	3.802E+00
.800	3.920E+01	4.992E+01	4.943E+00	3.561E+00
.900	3.251E+01	4.324E+01	1.258E+01	3.570E+00

TABLE A-3

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

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***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800	1.000E+05	.0010	.500	69.647

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.9143
.1200	.1307	.9048
.400	.2550	.8772
.600	.3588	.8363
.700	.3973	.8144
.800	.4252	.7946
.900	.4437	.7792

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.9143
.200	.1309	.9048
.400	.2583	.8772
.600	.3766	.8350
.700	.4293	.8110
.800	.4762	.7873
.900	.5163	.7664

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.601E-01	6.602E-01	1.226E+01	1.226E+01
.200	6.488E-01	6.588E-01	1.203E+01	1.227E+01
.400	5.862E-01	6.538E-01	1.108E+01	1.230E+01
.600	4.397E-01	6.465E-01	8.980E+00	1.235E+01
.700	3.323E-01	6.391E-01	7.707E+00	1.243E+01
.800	2.332E-01	6.294E-01	6.644E+00	1.256E+01
.900	1.450E-01	6.175E-01	7.514E+00	1.284E+01

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
6.601E-01	6.602E-01	1.226E+01	1.226E+01
6.525E-01	6.566E-01	1.218E+01	1.214E+01
6.256E-01	6.372E-01	1.188E+01	1.170E+01
5.553E-01	5.875E-01	1.140E+01	1.084E+01
5.002E-01	5.452E-01	1.128E+01	1.026E+01
4.396E-01	4.960E-01	1.180E+01	9.629E+00
3.740E-01	4.392E-01	1.847E+01	9.210E+00

TABLE A-4

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DES)	Q. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/D
80.00	4	1	.804	.200	1.000E+06	.0010	.500	74.318

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.3292
.200	.1207	.3261
.400	.2375	.3170
.500	.3409	.3027
.700	.3617	.2946
.800	.4123	.2870
.900	.4646	.2667

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.3292
.200	.1209	.3261
.400	.2403	.3169
.600	.3549	.3024
.700	.4075	.2940
.800	.4555	.2854
.900	.4983	.2775

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	C(XX)	C(YY)
0.000	6.057E-01	6.058E-01	3.445E+01	3.445E+01
.200	6.023E-01	6.086E-01	3.365E+01	3.447E+01
.400	5.610E-01	6.074E-01	3.150E+01	3.459E+01
.500	4.502E-01	6.066E-01	2.619E+01	3.473E+01
.700	3.620E-01	6.067E-01	2.287E+01	3.500E+01
.800	2.641E-01	6.096E-01	1.993E+01	3.538E+01
.900	1.702E-01	6.011E-01	2.037E+01	3.613E+01

*****--LOAD BETWEEN PADS--*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	C(XX)	C(YY)
6.057E-01	6.057E-01	3.445E+01	3.445E+01
6.054E-01	6.067E-01	3.424E+01	3.412E+01
5.936E-01	5.941E-01	3.347E+01	3.299E+01
5.497E-01	5.591E-01	3.229E+01	3.079E+01
5.048E-01	5.250E-01	3.201E+01	2.931E+01
4.547E-01	4.859E-01	3.307E+01	2.764E+01
4.196E-01	4.372E-01	4.226E+01	2.624E+01

TABLE A-5

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-10

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DES)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO L/D
60.00	4	1	.800	.200	1.000E+07	.0010	.500	77.049

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.00	-.0000	.1130
.200	.1151	.1120
.400	.2273	.1090
.600	.3280	.1043
.700	.3692	.1016
.800	.4022	.0990
.900	.4266	.0966

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.1130
.200	.1151	.1120
.400	.2294	.1090
.600	.3398	.1042
.700	.3917	.1014
.800	.4405	.0985
.900	.4850	.0957

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENT *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.791E-01	5.791E-01	9.931E+01	9.930E+01
.200	5.798E-01	5.798E-01	9.776E+01	9.842E+01
.400	5.463E-01	5.798E-01	9.159E+01	9.982E+01
.600	4.511E-01	5.798E-01	7.798E+01	1.106E+02
.700	3.736E-01	5.783E-01	6.888E+01	1.014E+02
.800	2.897E-01	5.756E-01	6.023E+01	1.024E+02
.900	2.030E-01	5.715E-01	5.938E+01	1.044E+02

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *				
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.791E-01	5.791E-01	9.930E+01	9.930E+01
.200	5.779E-01	5.764E-01	9.880E+01	9.847E+01
.400	5.691E-01	5.700E-01	9.706E+01	9.558E+01
.600	5.366E-01	5.411E-01	9.419E+01	8.984E+01
.700	5.063E-01	5.147E-01	9.328E+01	8.550E+01
.800	4.694E-01	4.795E-01	9.558E+01	8.121E+01
.900	4.332E-01	4.355E-01	1.106E+02	7.768E+01

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

PAD EXTENT (DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800	1.000E+03	.0020	8500	40.938

★-★-★-★-★-★-★-LOAD OVER PAD CENTER-★-★-★-★-★-★-★

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0,000	.0000	4,4676
.200	.1595	4,3987
.400	.3083	4,2002
.600	.4070	3,9640
.700	.4333	3,8772
.800	.4489	3,8317
.900	.4587	3,8228

*****LOAD BETWEEN PADS*****

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0.000	.0000	4,4676
.200	.1599	4,3992
.400	.3121	4,2086
.600	.4380	3,9597
.700	.4862	3,8435
.800	.5245	3,7483
.900	.5551	3,6759

*****-*-*-LOAD OVER PAD CENTER-**-**--*-**

ECCENTRICITY		★ DYNAMIC COEFFICIENTS ★		
RATIO	K(XX)	K(YY)	B(XX)	B(YY)
0.000	8.027E-01	8.027E-01	2.234E+00	2.234E+00
.200	7.857E-01	8.035E-01	2.173E+00	2.215E+00
.400	6.519E-01	7.887E-01	1.908E+00	2.210E+00
.600	3.369E-01	7.507E-01	1.356E+00	2.227E+00
.700	2.001E-01	7.222E-01	1.137E+00	2.256E+00
.800	1.215E-01	6.912E-01	1.239E+00	2.320E+00
.900	7.831E-02	6.636E-01	3.293E+00	2.511E+00

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
8.027E-01	8.027E-01	2.234E+00	2.234E+00
7.968E-01	8.022E-01	2.194E+00	2.185E+00
7.151E-01	7.713E-01	2.140E+00	2.094E+00
5.385E-01	6.670E-01	2.081E+00	1.900E+00
4.336E-01	5.888E-01	2.218E+00	1.786E+00
3.429E-01	5.078E-01	3.088E+00	1.699E+00
2.973E-01	4.385E-01	1.089E+01	1.850E+00

 DEEP POCKET HYDROSTATIC BEARING PERFOHANCE DATA

PAD EXTENT(DEG)	YO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RAT IO?	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIF ICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+04	.0020	.500	49.657

***** STEADY STATE PERFORMANCE DATA *****

★-★-★-★-★-★-LOAD OVER PAD CENTER-★-★-★-★-★-★

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0,000	,0000	2,0786
,200	,1344	2,0542
,400	,2631	1,9848
,600	,3706	1,8806
,700	,4088	1,8253
,800	,4344	1,7798
,900	,4495	1,7512

*****LOAD BETWEEN PADS*****

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0.000	.0000	210786
.200	.1343	2,0544
.400	.2656	1,9859
.600	.3887	1,8804
.700	.4425	1,8219
.800	.4876	1,7683
.909	.5236	1,7263

***** DYNAMIC PERFORMANCE DATA *****

--LOAD OVER PAD CENTER-***-***-***

ECCENTRICITY		* DYNAMIC COEFFICIENTS *			
RATIO	K(XX)	K(YY)	B(XX)	B(YY)	
0.000	6.750E-01	6.751E-01	5.209E+00	5.209E+00	
.200	6.713E-01	6.753E-01	5.098E+00	5.216E+00	
.400	6.066E-01	6.717E-01	4.708E+00	5.245E+00	
.600	4.524E-01	6.687E-01	3.701E+00	5.264E+00	
.700	3.181E-01	6.597E-01	3.104E+00	5.313E+00	
.800	2.043E-01	6.478E-01	2.711E+00	5.393E+00	
.900	1.117E-01	6.266E-01	4.346E+00	5.617E+00	

*****-LOAD BETWEEN PADS-*****

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      * DYNAMIC COEFFICIENTS *
      K(XX)      K(YY)      B(XX)      B(YY)
6,750E-01  6.751E+01  5,209E+00  5.209E+00
6,713E-01  6.774E+01  5,174E+00  5.150E+00
6,527E-01  6.607E+01  5,048E+00  4,966E+00
5,694E-01  6.062E+01  4,870E+00  4,601E+00
4,993E-01  5.610E+01  4,856E+00  4,341E+00
4,074E-01  5.071E+01  5,506E+00  4,084E+00
3,337E-01  4.470E+01  1,311E+01  4,067E+00

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TABLE A-8

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

* * * * * GEOMETRY AND OPERATING CONDITIONS * * * * *

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80.00	4	1	.600	.800	1.000E+05	.0020	.500	54.048

* * * * * STEADY STATE PERFORMANCE DATA * * * * *

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	1.0000	.7787
.200	.1196	.7712
.400	.2364	.7490
.600	.3412	.7140
.700	.3828	.6944
.800	.4150	.6755
.900	.4373	.6600

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	1.0000	.7787
.200	.1197	.7712
.400	.2387	.7490
.600	.3541	.7140
.700	.4078	.6934
.800	.4573	.6723
.900	.5001	.6535

* * * * * DYNAMIC PERFORMANCE DATA * * * * *

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.027E-01	6.027E-01	1.413E+01	1.413E+01
.200	5.997E-01	6.032E-01	1.391E+01	1.414E+01
.400	5.666E-01	6.031E-01	1.300E+01	1.421E+01
.600	4.635E-01	6.050E-01	1.085E+01	1.430E+01
.700	3.749E-01	6.026E-01	9.423E+00	1.442E+01
.800	2.761E-01	5.990E-01	8.124E+00	1.460E+01
.900	1.759E-01	5.920E-01	8.678E+00	1.493E+01

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
6.027E-01	6.027E-01	1.413E+01	1.413E+01
6.017E-01	6.024E-01	1.406E+01	1.401E+01
5.953E-01	5.940E-01	1.380E+01	1.358E+01
5.570E-01	5.634E-01	1.338E+01	1.272E+01
5.191E-01	5.345E-01	1.327E+01	1.210E+01
4.677E-01	4.935E-01	1.378E+01	1.142E+01
3.974E-01	4.443E-01	2.040E+01	1.093E+01

TABLE A-9

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-14

.....* * GEOMETRY AND OPEGATING CONDITIONS*

PAD EXTENT (DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80.00	4	1	0800	.800	1.000E+06	.0020	.500	56.810

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.2721
.1200	.1093	.2697
.400	.2178	.2626
.600	.3197	.2510
.700	.3628	.2442
.800	.3980	.2374
.900	.4245	.2314

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.2121
.200	.1094	.2697
.400	.2198	.2626
.600	.3298	.2511
.700	.3827	.2441
.800	.4329	.2369
.900	.4793	.2300

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.501E-01	5.502E-01	4.055E+01	4.055E+01
.200	5.499E-01	5.514E-01	3.997E+01	4.059E+01
.9400	5.420E-01	5.570E-01	3.740E+01	4.064E+01
.600	4.679E-01	5.622E-01	3.218E+01	4.102E+01
.700	3.960E-01	5.638E-01	2.851E+01	4.137E+01
.800	3.107E-01	5.641E-01	2.493E+01	4.189E+01
.900	2.197E-01	5.634E-01	2.451E+01	4.270E+01

*****--LOAD BETWEEN PADS--*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
5.501E-01	5.502E-01	4.055E+01	4.055E+01
5.516E-01	5.507E-01	4.036E+01	4.022E+01
5.582E-01	5.471E-01	3.963E+01	3.906E+01
5.431E-01	5.289E-01	3.863E+01	3.684E+01
5.195E-01	5.068E-01	3.840E+01	3.527E+01
4.845E-01	4.754E-01	3.955E+01	3.346E+01
4.597E-01	4.373E-01	4.878E+01	3.179E+01

TABLE A-10

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTEN(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80 00	4	1	.800	.800	1.000E+07	.0020	.500	58.455

***** STEADY STATE PERFORMANCE DATA *****

***** LOAD OVER PAD CENTER *****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0911
.200	.1037	.0903
.400	.2070	.0881
.600	.3043	.0844
.700	.3470	.0823
.800	.3836	.0800
.900	.4133	.0778

***** LOAD BETWEEN PADS *****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0911
.200	.1037	.0903
.400	.2083	.0881
.600	.3129	.0845
.700	.3644	.0822
.800	.4151	.0798
.900	.4635	.0774

***** DYNAMIC PERFORMANCE DATA *****

***** LOAD OVER PAD CENTER *****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.215E-01	5.216E-01	1.197E+02	1.197E+02
.200	5.227E-01	5.228E-01	1.181E+02	1.198E+02
.400	5.131E-01	5.263E-01	1.118E+02	1.203E+02
.600	4.554E-01	5.317E-01	9.753E+01	1.215E+02
.700	4.003E-01	5.351E-01	8.734E+01	1.224E+02
.800	3.393E-01	5.387E-01	7.662E+01	1.237E+02
.900	2.554E-01	5.413E-01	7.339E+01	1.260E+02

***** LOAD BETWEEN PADS *****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.215E-01	5.216E-01	1.197E+02	1.197E+02
.200	5.239E-01	5.225E-01	1.192E+02	1.188E+02
.400	5.278E-01	5.206E-01	1.176E+02	1.159E+02
.600	5.225E-01	5.053E-01	1.149E+02	1.099E+02
.700	5.121E-01	4.883E-01	1.142E+02	1.055E+02
.800	5.010E-01	4.640E-01	1.167E+02	1.003E+02
.900	4.801E-01	4.302E-01	1.403E+02	9.540E+01

TABLE A-11

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+03	.0040	.500	32.643

***** STEADY STATE PERFORMANCE DATA *****

--***-LOAD OVER PAD CENTER-***-***-***

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	4.0170
.200	.1523	3.9558
.400	.2973	3.7814
.600	.4008	3.5586
.700	.4297	3.4687
.800	.4468	3.4159
.900	.4572	3.3985

--***-LOAD BETWEEN PADS-***-***-***

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	4.0170
.200	.1517	3.9571
.400	.2988	3.7906
.600	.4249	3.5653
.700	.4740	3.4582
.800	.5131	3.3698
.900	.5448	3.3020

***** DYNAMIC PERFORMANCE DATA *****

--***-LOAD OVER PAD CENTER-***-***-***

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.661E-01	7.661E-01	2.452E+00	2.452E+00
.200	7.687E-01	7.624E-01	2.401E+00	2.478E+00
.400	6.568E-01	7.520E-01	2.177E+00	2.491E+00
.600	3.688E-01	7.244E-01	1.594E+00	2.526E+00
.700	2.215E-01	7.050E-01	1.330E+00	2.550E+00
.800	1.314E-01	6.778E-01	1.385E+00	2.627E+00
.900	8.232E-02	6.479E-01	3.405E+00	2.846E+00

--***-LOAD BETWEEN PADS-***-***-***

* DYNAMIC COEFFICIENTS *				
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.661E-01	7.661E-01	2.452E+00	2.452E+00
.200	7.630E-01	7.650E-01	2.450E+00	2.439E+00
.400	7.018E-01	7.442E-01	2.414E+00	2.360E+00
.600	5.471E-01	6.616E-01	2.356E+00	2.163E+00
.700	4.436E-01	5.933E-01	2.485E+00	2.041E+00
.800	3.509E-01	5.221E-01	3.341E+00	1.942E+00
.900	3.013E-01	4.542E-01	1.113E+01	2.082E+00

TABLE A-12

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+04	.0040	.500	38,290

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1,7478
.200	.1233	1,7296
.400	.2445	1,6755
.600	.3548	1,5869
.700	.3971	1,9376
.800	.4274	1,4935
.900	.4455	1,4635

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1,7478
.200	.1233	1,7297
.400	.2468	1,6757
.600	.3679	1,5889
.700	.4234	1,5389
.800	.4713	1,4913
.900	.5092	1,4538

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.215E-01	6.216E-01	6.071E+00	6.071E+00
.200	6.212E-01	6.221E-01	5.986E+00	6.081E+00
.400	5.895E-01	6.211E-01	5.608E+00	6.149E+00
.600	4.849E-01	6.298E-01	4.551E+00	6.191E+00
.700	3.670E-01	6.256E-01	3.870E+00	6.262E+00
.800	2.438E-01	6.205E-01	3.328E+00	6.359E+00
.900	1.315E-01	6.033E-01	4.806E+00	6.607E+00

*****--LOAD BETWEEN PADS--*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
6.215E-01	6.216E-01	6.071E+00	6.071E+00
6.225E-01	6.228E-01	6.047E+00	6.023E+00
6.250E-01	6.176E-01	5.952E+00	5.851E+00
5.818E-01	5.897E-01	5.794E+00	5.470E+00
5.248E-01	5.542E-01	5.786E+00	5.199E+00
4.316E-01	5.097E-01	6.415E+00	4.909E+00
3.481E-01	4.536E-01	1.398E+01	4.860E+00

TABLE A-13

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-18

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+05	.0040	.500	40.861

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.6294
.200	.1079	.6239
.400	.2160	.6072
.600	.3187	.5798
.700	.3630	.5635
.800	.4002	.5469
.900	.4279	.5322

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.6294
.200	.1080	.6239
.400	.2176	.6073
.600	.3282	.5803
.700	.3825	.5637
.800	.4350	.5461
.900	.4820	.5298

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.432E-01	5.433E-01	1.710E+01	1.710E+01
.200	5.452E-01	5.447E-01	1.689E+01	1.713E+01
.400	5.423E-01	5.514E-01	1.587E+01	1.717E+01
.600	4.761E-01	5.585E-01	1.369E+01	1.736E+01
.700	4.133E-01	5.620E-01	1.208E+01	1.752E+01
.800	3.312E-01	5.665E-01	1.044E+01	1.772E+01
.900	2.225E-01	5.682E-01	1.054E+01	1.809E+01

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.432E-01	5.433E-01	1.710E+01	1.710E+01
.200	5.466E-01	5.446E-01	1.704E+01	1.698E+01
.400	5.567E-01	5.439E-01	1.679E+01	1.653E+01
.600	5.557E-01	5.296E-01	1.638E+01	1.561E+01
.700	5.377E-01	5.103E-01	1.632E+01	1.495E+01
.800	5.038E-01	4.805E-01	1.686E+01	1.418E+01
.900	4.331E-01	4.421E-01	2.342E+01	1.355E+01

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

PAD EXTENT(DEG)	NO.OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800	1.000E+06	.0040	.500	42.339

--**-LOAD OVER PAD CENTER-***-***-***

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0,000	.0000	.2137
,200	.0989	.2120
,400	.1991	.2067
,600	.2959	.1981
,700	.3395	.1928
,800	.3785	.1873
,900	.4104	.1819

--*-*-*-LOAD BETWEEN PADS*-*-*.--.-.-*-*

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
.0.000	-.0000	,2137
.200	.0990	,2120
.400	.2002	.2068
.600	.3036	,1983
.700	.3557	.1930
.800	.4077	.1872
.900	.4587	.1814

-*-*-*-LOAD OVER PAD CENTER-**--*-*

ECCENTRICITY		* DYNAMIC COEFFICIENTS *			
RATIO	K(XX)	K(YY)	B(XX)	B(YY)	
0,000	4.964E-01	4.965E-01	5.021E+01	5.021E+01	
,200	5.031E-01	4.999E-01	4.933E+01	5.013E+01	
,400	5.032E-01	5.061E-01	4.685E+01	5.032E+01	
,600	4.630E-01	5.154E-01	4.115E+01	5.082E+01	
,700	4.173E-01	5.216E-01	3.696E+01	5.124E+01	
,800	3.606E-01	5.284E-01	3.247E+01	5.185E+01	
,900	2.806E-01	5.348E-01	3.092E+01	5.287E+01	

*****-LOAD BETWEEN PADS-*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
4.964E-01	4.965E-01	5.021E+01	5.021E+01
5.031E-01	4.982E-01	4.988E+01	4.976E+01
5.149E-01	5.001E-01	4.923E+01	4.856E+01
5.258E-01	4.918E-01	4.822E+01	4.611E+01
5.225E-01	4.788E-01	4.803E+01	4.435E+01
5.174E-01	4.580E-01	4.929E+01	4.225E+01
5.148E-01	4.287E-01	5.882E+01	4.020E+01

TABLE A-15

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

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***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	YO.OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+07	.0040	.500	43.126

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER-----*

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0701
.200	.0941	.0696
.400	.1886	.0680
.600	.2803	.0654
.700	.3226	.0637
.800	.3614	.0619
.900	.3959	.0601

*****--LOAD BETWEEN PADS-----*

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0701
.200	.0941	.0696
.400	.1895	.0680
.600	.2871	.0654
.700	.3369	.0637
.800	.3884	.0618
.900	.4409	.0599

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER-----*

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	4.733E-01	4.734E-01	1.514E+02	1.514E+02
.200	4.758E-01	4.744E-01	1.496E+02	1.516E+02
.400	4.740E-01	4.784E-01	1.425E+02	1.522E+02
.600	4.423E-01	4.864E-01	1.263E+02	1.534E+02
.700	4.081E-01	4.925E-01	1.143E+02	1.545E+02
.800	3.715E-01	5.005E-01	1.009E+02	1.560E+02
.900	3.235E-01	5.122E-01	9.374E+01	1.586E+02

*****--LOAD BETWEEN PADS-----*

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	4.733E-01	4.734E-01	1.514E+02	1.514E+02
.200	4.760E-01	4.746E-01	1.508E+02	1.504E+02
.400	4.848E-01	4.751E-01	1.489E+02	1.471E+02
.600	4.965E-01	4.672E-01	1.458E+02	1.403E+02
.700	5.064E-01	4.568E-01	1.448E+02	1.352E+02
.800	5.218E-01	4.405E-01	1.477E+02	1.290E+02
.900	5.374E-01	4.162E-01	1.728E+02	1.228E+02

TABLE A-16

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800	1.000E+03	.0010	.750	53.794

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	4.4538
.200	.1614	4.3942
.400	.31179	4.2173
.600	.4061	3.9985
.700	.4323	3.9195
.800	.4483	3.8756
.900	.4581	3.8674

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	4.4538
.200	.1615	4.3946
.400	.3140	4.2186
.600	.4369	3.9987
.700	.4833	3.9015
.800	.5201	3.8250
.900	.5502	3.7683

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	B(YY)
0.000	8.192E-01	8.192E-01	3.342E+00	3.342E+00
.200	7.846E-01	8.099E-01	3.278E+00	3.330E+00
.400	6.503E-01	7.901E-01	2.845E+00	3.266E+00
.600	3.308E-01	7.347E-01	2.055E+00	3.358E+00
.700	2.043E-01	7.059E-01	1.764E+00	3.368E+00
.800	1.232E-01	6.692E-01	2.061E+00	3.440E+00
.900	7.705E-02	6.287E-01	6.448E+00	3.750E+00

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	B(YY)
8.192E-01	8.192E-01	3.342E+00	3.342E+00
7.893E-01	8.094E-01	3.317E+00	3.306E+00
7.078E-01	7.706E-01	3.183E+00	3.131E+00
5.166E-01	6.597E-01	3.080E+00	2.866E+00
4.155E-01	5.935E-01	3.229E+00	2.709E+00
3.270E-01	5.268E-01	4.279E+00	2.620E+00
2.886E-01	4.645E-01	1.327E+01	2.858E+00

TABLE A-17

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

C-22

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D0/C
80.00	4	1	.800	.800	1.000E+04	.0010	.750	66.695

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	2.1649
.200	.1415	2.1408
.400	.2742	2.0697
.600	.3776	1.89710
.700	.4128	1.9213
.800	.4365	1.8789
.900	.4507	1.8530

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	2.1649
.200	.1419	2.1407
.400	.2786	2.0701
.600	.4001	1.9678
.700	.4513	1.9138
.800	.4937	1.8657
.900	.5275	1.8307

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	7.151E-01	7.151E-01	7.663E+00	7.663E+00
.200	6.995E-01	7.120E-01	7.468E+00	7.652E+00
.400	6.104E-01	7.056E-01	6.750E+00	7.599E+00
.600	4.110E-01	6.823E-01	5.294E+00	7.632E+00
.700	2.968E-01	6.759E-01	4.458E+00	7.637E+00
.800	1.837E-01	6.552E-01	4.103E+00	7.758E+00
.900	1.066E-01	6.314E-01	7.883E+00	8.136E+00

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
7.151E-01	7.151E-01	7.663E+00	7.663E+00
7.076E-01	7.082E-01	7.562E+00	7.546E+00
6.526E-01	6.809E-01	7.340E+00	7.238E+00
5.520E-01	6.124E-01	6.950E+00	6.638E+00
4.794E-01	5.616E-01	6.867E+00	6.261E+00
3.804E-01	5.016E-01	7.588E+00	5.918E+00
3.135E-01	4.446E-01	1.629E+01	5.921E+00

TABLE A-18

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

* * * * * GEOMETRY AND OPERATING CONDITIONS * * * * *

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80.00	4	1	.800	.800	1.000E+05	.0010	.750	74.305

* * * * * STEADY STATE PERFORMANCE DATA * * * * *

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW, PARAMETER
0.000	.0000	.8498
.200	.1313	.00411
.400	.2554	.00164
.600	.3578	.7805
.700	.3960	.7612
.800	.4240	.7435
.900	.4427	.7295

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.8498
.200	.1315	.8411
.400	.2586	.8165
.600	.3752	.7795
.700	.4266	.7588
.800	.4722	.7389
.900	.5112	.7217

* * * * * DYNAMIC PERFORMANCE DATA * * * * *

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.629E-01	6.629E-01	1.984E+01	1.984E+01
.200	6.494E-01	6.608E-01	1.947E+01	1.986E+01
.400	5.822E-01	6.537E-01	1.794E+01	1.989E+01
.600	4.304E-01	6.405E-01	1.471E+01	1.997E+01
.700	3.325E-01	6.346E-01	1.273E+01	1.999E+01
.800	2.313E-01	6.219E-01	1.126E+01	2.019E+01
.900	1.468E-01	6.062E-01	1.365E+01	2.072E+01

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
6.629E-01	6.629E-01	1.984E+01	1.984E+01
6.532E-01	6.584E-01	1.971E+01	1.964E+01
6.162E-01	6.369E-01	1.923E+01	1.896E+01
5.431E-01	5.846E-01	1.839E+01	1.760E+01
4.896E-01	5.447E-01	1.812E+01	1.672E+01
4.332E-01	4.981E-01	1.865E+01	1.579E+01
3.618E-01	4.443E-01	2.671E+01	1.520E+01

TABLE A-19

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-24

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRAPDS 1.000E+06	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800		.0010	.750	79.451

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.3672
.200	.1220	.3044
.400	.2392	.2961
.600	.3410	.2834
.700	.3816	.2762
.800	.4125	.2694
.900	.4341	.2636

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.3072
.200	.1222	.3044
.400	.2419	.2961
.600	.3557	.2831
.700	.4075	.2757
.800	.4542	.2683
.900	.4955	.2617

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	6.150E-01	6.151E-01	5.573E+01	5.573E+01
.200	6.064E-01	6.143E-01	5.475E+01	5.576E+01
.400	5.596E-01	6.114E-01	5.093E+01	5.590E+01
.600	4.457E-01	6.061E-01	4.273E+01	5.620E+01
.700	3.597E-01	6.064E-01	3.750E+01	5.628E+01
.800	2.623E-01	5.993E-01	3.327E+01	5.682E+01
.900	1.734E-01	5.884E-01	3.592E+01	5.792E+01

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
6.150E-01	6.151E-01	5.573E+01	5.573E+01
6.099E-01	6.120E-01	5.536E+01	5.520E+01
5.882E-01	5.968E-01	5.415E+01	5.342E+01
5.438E-01	5.590E-01	5.196E+01	4.987E+01
4.942E-01	5.251E-01	5.134E+01	4.759E+01
4.427E-01	4.856E-01	5.250E+01	4.508E+01
3.942E-01	4.376E-01	6.601E+01	4.314E+01

TABLE A-20

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+07	.0010	.750	83.092

***** STEADY STATE PERFORMANCE DATA *****

▲-----▲--▲--▲--LOAD OVER PAD CENTER-----▲--▲--▲--▲--

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.1063
.200	.1166	.1053
.400	.2299	.1025
.600	.3301	.0983
.700	.3708	.0958
.800	.4031	.0935
.900	.4271	.0913

●-----●--▲--▲--LOAD BETWEEN PADS-----●--▲--▲--▲--▲--

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.1063
.200	.1168	.1053
.400	.2321	.1025
.600	.3424	.0982
.700	.3936	.0957
.800	.4410	.0931
.900	.4841	.0907

▲-----▲--▲--▲--DYNAMIC PERFORMANCE DATA-----▲--▲--▲--▲--

*****-LOAD OVER PAD CENTER-----▲--▲--▲--▲--

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.871E-01	5.872E-01	1.596E+02	1.596E+02
.200	5.819E-01	5.871E-01	1.570E+02	1.597E+02
.400	5.469E-01	5.861E-01	1.471E+02	1.602E+02
.600	4.461E-01	5.838E-01	1.256E+02	1.613E+02
.700	3.674E-01	5.813E-01	1.117E+02	1.623E+02
.800	2.827E-01	5.771E-01	9.924E+01	1.638E+02
.900	1.965E-01	5.706E-01	1.028E+02	1.667E+02

*****-LOAD BETWEEN PADS-----▲--▲--▲--▲--

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.871E-01	5.872E-01	1.596E+02	1.596E+02
.200	5.844E-01	5.855E-01	1.587E+02	1.582E+02
.400	5.704E-01	5.746E-01	1.557E+02	1.536E+02
.600	5.307E-01	5.423E-01	1.507E+02	1.444E+02
.700	4.958E-01	5.143E-01	1.488E+02	1.382E+02
.800	4.591E-01	4.791E-01	1.512E+02	1.313E+02
.900	4.117E-01	4.359E-01	1.830E+02	1.254E+02

TABLE A-21

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-26

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800	1.000E+03	.0020	.750	43.928

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	4.2000
.200	.1565	4.1441
.400	.3021	3.9734
.600	.4029	3.7588
.700	.4307	3.6782
.800	.4475	3.6287
.900	.4577	3.6143

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	4.2000
.200	.1566	4.1444
.400	.3069	3.9769
.600	.4299	3.7650
.700	.4747	3.6702
.800	.5137	3.5958
.900	.5439	3.5418

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.926E-01	7.926E-01	3.563E+00	3.563E+00
.200	7.662E-01	7.853E-01	3.501E+00	3.557E+00
.400	6.550E-01	7.760E-01	3.067E+00	3.494E+00
.600	3.483E-01	7.281E-01	2.254E+00	3.530E+00
.700	2.165E-01	6.979E-01	1.928E+00	3.622E+00
.800	1.293E-01	6.624E-01	2.188E+00	3.726E+00
.900	7.977E-02	6.274E-01	6.547E+00	4.031E+00

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.926E-01	7.926E-01	3.563E+00	3.563E+00
.200	7.704E-01	7.859E-01	3.540E+00	3.528E+00
.400	7.024E-01	7.569E-01	3.414E+00	3.356E+00
.600	5.240E-01	6.632E-01	3.303E+00	3.079E+00
.700	4.190E-01	5.949E-01	3.449E+00	2.920E+00
.800	3.307E-01	5.283E-01	4.466E+00	2.802E+00
.900	2.903E-01	4.682E-01	1.345E+01	3.033E+00

TABLE A-22

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT (DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80.00	4	1	.800	.800	1.000E+04	.0020	.750	53,206

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1,9485
.200	.1336	1,9270
.400	.2620	1.8639
.600	.3677	1,7726
.700	.4059	1,7238
.800	.4323	1.6812
.900	.4483	1.6531

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1,9485
.200	.1340	1,9269
.400	.2651	1,8649
.600	.3862	1,7717
.700	.4386	1,7212
.800	.4826	1,6757
.900	.5173	1,6425

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	6.722E-01	6.722E-01	8.428E+00	8.428E+00
.200	6.668E-01	6.746E-01	8.230E+00	8.386E+00
.400	6.030E-01	6.698E-01	7.567E+00	8.412E+00
.600	4.372E-01	6.580E-01	6.076E+00	8.462E+00
.700	3.265E-01	6.571E-01	5.147E+00	8.449E+00
.800	2.063E-01	6.413E-01	4.675E+00	8.576E+00
.900	1.197E-01	6.193E-01	8.321E+00	8.905E+00

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
6.722E-01	6.722E-01	8.428E+00	8.428E+00
6.727E-01	6.706E-01	8.329E+00	8.307E+00
6.364E-01	6.536E-01	8.150E+00	8.025E+00
5.609E-01	6.016E-01	7.770E+00	7.413E+00
4.946E-01	5.578E-01	7.687E+00	7.026E+00
3.969E-01	5.064E-01	8.384E+00	6.653E+00
3.184E-01	4.482E-01	1.706E+01	6.639E+00

TABLE A-23

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

C-28

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DD/D
90.00	4	1	.800	.800	1.000E+05	.0020	.750	58.111

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.7350
.200	.1210	.7280
.400	.2384	.7074
.600	.3416	.6760
.700	.3628	.6581
.800	.4145	.6411
.900	.4366	.6269

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.7350
.200	.1211	.7280
.400	.2406	.7076
.600	.3552	.6758
.700	.4079	.6574
.800	.4559	.6391
.900	.4974	.6232

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	6.093E-01	6.094E-01	2.255E+01	2.255E+01
.200	6.043E-01	6.092E-01	2.220E+01	2.257E+01
.400	5.654E-01	6.077E-01	2.075E+01	2.266E+01
.600	4.576E-01	6.052E-01	1.742E+01	2.282E+01
.700	3.666E-01	6.041E-01	1.529E+01	2.292E+01
.800	2.605E-01	5.981E-01	1.347E+01	2.317E+01
.900	1.751E-01	5.884E-01	1.543E+01	2.367E+01

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
6.093E-01	6.094E-01	2.255E+01	2.255E+01
6.067E-01	6.080E-01	2.243E+01	2.236E+01
5.909E-01	5.969E-01	2.203E+01	2.170E+01
5.491E-01	5.829E-01	2.127E+01	2.034E+01
5.079E-01	5.613E-01	2.103E+01	1.941E+01
4.588E-01	4.925E-01	2.153E+01	1.840E+01
3.788E-01	4.437E-01	2.950E+01	1.770E+01

TABLE A-24

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADE RATIO	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80.00	4	1	.800	.800	1.000E+06	.0020	.750	61.246

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.2582
.200	.1111	.2559
.400	.2203	.2494
.600	.3214	.2388
.700	.3641	.2325
.800	.3987	.2263
.900	.4245	.2207

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.2582
.200	.1112	.2560
.400	.2227	.2494
.600	.3326	.2387
.700	.3850	.2374
.800	.4341	.2259
.900	.4788	.2199

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.587E-01	5.588E-01	6.455E+01	6.455E+01
.200	5.568E-01	5.593E-01	6.365E+01	6.463E+01
.400	5.341E-01	5.609E-01	5.997E+01	6.485E+01
.600	4.651E-01	5.678E-01	5.143E+01	6.514E+01
.700	3.906E-01	5.693E-01	4.587E+01	6.559E+01
.800	3.034E-01	5.682E-01	4.077E+01	6.635E+01
.900	2.125E-01	5.642E-01	4.220E+01	6.767E+01

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.587E-01	5.588E-01	6.455E+01	6.455E+01
.200	5.585E-01	5.582E-01	6.426E+01	6.406E+01
.400	5.596E-01	5.516E-01	6.307E+01	6.226E+01
.600	5.400E-01	5.291E-01	6.128E+01	5.876E+01
.700	5.119E-01	5.069E-01	6.069E+01	5.630E+01
.800	4.739E-01	4.742E-01	6.199E+01	5.361E+01
.900	4.285E-01	4.331E-01	7.553E+01	5.132E+01

TABLE A-25

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

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***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D0/C
80.00	4	1	.800	.800	1.000E+07	.0020	.750	63,237

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0870
.200	.1054	.0863
.400	.2099	.0842
.600	.3075	.0808
.700	.3498	.0787
.800	.3856	.0767
.900	.4141	.0747

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0870
.200	.1055	.0863
.400	.2114	.0842
.600	.3168	.0808
.700	.3680	.0787
.800	.4177	.0765
.900	.4648	.0744

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.298E-01	5.299E-01	1.893E+02	1.893E+02
.200	5.299E-01	5.307E-01	1.869E+02	1.895E+02
.400	5.161E-01	5.334E-01	1.769E+02	1.903E+02
.600	4.529E-01	5.381E-01	1.548E+02	1.918E+02
.700	3.941E-01	5.405E-01	1.394E+02	1.931E+02
.800	3.245E-01	5.426E-01	1.242E+02	1.951E+02
.900	2.418E-01	5.435E-01	1.243E+02	1.986E+02

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.298E-01	5.299E-01	1.893E+02	1.893E+02
.200	5.312E-01	5.301E-01	1.865E+02	1.880E+02
.400	5.328E-01	5.264E-01	1.858E+02	1.833E+02
.600	5.217E-01	5.084E-01	1.813E+02	1.740E+02
.700	5.064E-01	4.896E-01	1.797E+02	1.673E+02
.800	4.924E-01	4.636E-01	1.823E+02	1.595E+02
.900	4.587E-01	4.282E-01	2.147E+02	1.525E+02

TABLE A-26

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D0/C
80.00	4	1	.800	.800	1.000E+03	.0040	.750	35.216

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	3.0173
.200	.1492	3.7671
.400	.2925	3.6098
.600	.3970	3.4053
.700	.4272	3.3218
.800	.4456	3.2677
.900	.4566	3.2466

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	3.8173
.200	.1495	3.7665
.400	.2957	3.6152
.600	.4192	3.4176
.700	.4667	3.3272
.800	.5043	3.2564
.900	.5347	3.2055

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.515E-01	7.515E-01	3.947E+00	3.947E+00
.200	7.504E-01	7.509E-01	3.836E+00	3.913E+00
.400	6.564E-01	7.465E-01	3.452E+00	3.905E+00
.600	3.759E-01	7.108E-01	2.604E+00	3.970E+00
.700	2.380E-01	6.885E-01	2.218E+00	4.007E+00
.800	1.404E-01	6.592E-01	2.412E+00	4.097E+00
.900	8.473E-02	6.252E-01	6.719E+00	4.428E+00

*****--LOAD BETWEEN PADS--*****

* DYNAMIC COEFFICIENTS *				
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.515E-01	7.515E-01	3.947E+00	3.947E+00
.200	7.569E-01	7.489E-01	3.884E+00	3.875E+00
.400	6.934E-01	7.311E-01	3.811E+00	3.741E+00
.600	5.328E-01	6.536E-01	3.699E+00	3.455E+00
.700	4.258E-01	5.962E-01	3.820E+00	3.268E+00
.800	3.350E-01	5.314E-01	4.831E+00	3.149E+00
.900	2.910E-01	4.725E-01	1.379E+01	3.366E+00

TABLE A-27

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

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***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT (DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
90.00	4	1	.800	.800	1.000E+04	.0040	.750	41.374

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1.6662
.200	.1239	1.6484
.400	.2451	1.5973
.600	.3524	1.5185
.700	.3946	1.4731
.800	.4250	1.4321
.900	.4439	1.4026

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1.6662
.200	.1239	1.6485
.400	.2470	1.5983
.600	.3670	1.5187
.700	.4214	1.4740
.800	.4681	1.4323
.900	.5045	1.4017

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.255E-01	6.256E-01	9.571E+00	9.571E+00
.200	6.214E-01	6.235E-01	9.508E+00	9.651E+00
.400	5.853E-01	6.232E-01	8.890E+00	9.735E+00
.600	4.663E-01	6.218E-01	7.346E+00	9.837E+00
.700	3.677E-01	6.286E-01	6.292E+00	9.847E+00
.800	2.416E-01	6.202E-01	5.631E+00	1.000E+01
.900	1.415E-01	6.032E-01	9.050E+00	1.038E+01

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.255E-01	6.256E-01	9.571E+00	9.571E+00
.200	6.227E-01	6.226E-01	9.600E+00	9.564E+00
.400	6.116E-01	6.136E-01	9.464E+00	9.306E+00
.600	5.757E-01	5.812E-01	9.123E+00	8.689E+00
.700	5.209E-01	5.449E-01	9.047E+00	8.285E+00
.800	4.193E-01	5.005E-01	9.713E+00	7.865E+00
.900	3.288E-01	4.473E-01	1.833E+01	7.800E+00

TABLE A-28

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
60.00	4	1	.800	.800	1.000E+05	.0040	.750	44.248

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.6027
.200	.1095	.5974
.400	.2182	.5817
.600	.3203	.5563
.700	.3640	.5412
.800	.4000	.5260
.900	.4270	.5124

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.6027
.200	.1095	.5974
.400	.2198	.5818
.600	.3306	.5564
.700	.3844	.5412
.800	.4356	.5254
.900	.4813	.5111

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.503E-01	5.504E-01	2.693E+01	2.693E+01
.200	5.511E-01	5.514E-01	2.659E+01	2.697E+01
.400	5.388E-01	5.547E-01	2.510E+01	2.708E+01
.600	4.724E-01	5.635E-01	2.166E+01	2.726E+01
.700	4.057E-01	5.664E-01	1.925E+01	2.748E+01
.800	3.172E-01	5.673E-01	1.701E+01	2.783E+01
.900	2.171E-01	5.671E-01	1.831E+01	2.839E+01

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.503E-01	5.504E-01	2.693E+01	2.693E+01
.200	5.523E-01	5.511E-01	2.683E+01	2.674E+01
.400	5.591E-01	5.478E-01	2.641E+01	2.604E+01
.600	5.468E-01	5.292E-01	2.578E+01	2.465E+01
.700	5.302E-01	5.093E-01	2.554E+01	2.363E+01
.800	4.991E-01	4.786E-01	2.609E+01	2.249E+01
.900	4.124E-01	4.366E-01	3.400E+01	2.161E+01

TABLE A-29

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-34

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEC)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/D
50.00	4	1	.300	.800	1.000E+06	.0040	.750	45.974

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER-----*

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.2057
.200	.1002	.2041
.400	.2003	.1992
.600	.2985	.1910
.700	.3420	.1860
.800	.3799	.1808
.900	.4107	.1759

*****--LOAD BETWEEN PADS-----*

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.2057
.200	.1002	.2041
.400	.2023	.1992
.600	.3067	.1911
.700	.3588	.1861
.800	.4102	.1808
.900	.4597	.1756

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER-----*

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.030E-01	5.031E-01	7.883E+01	7.883E+01
.200	5.051E-01	5.045E-01	7.783E+01	7.887E+01
.400	5.042E-01	5.111E-01	7.372E+01	7.892E+01
.600	4.628E-01	5.205E-01	6.488E+01	7.263E+01
.700	4.130E-01	5.270E-01	5.852E+01	8.014E+01
.800	3.471E-01	5.329E-01	5.233E+01	8.105E+01
.900	2.642E-01	5.373E-01	5.214E+01	8.261E+01

*****--LOAD BETWEEN PADS-----*

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
5.030E-01	5.031E-01	7.883E+01	7.883E+01
5.050E-01	5.039E-01	7.849E+01	7.828E+01
5.201E-01	5.039E-01	7.719E+01	7.628E+01
5.255E-01	4.930E-01	7.556E+01	7.259E+01
5.197E-01	4.762E-01	7.510E+01	6.993E+01
5.109E-01	4.571E-01	7.648E+01	6.674E+01
4.870E-01	4.245E-01	9.023E+01	6.390E+01

TABLE A-30

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80.00	4	1	.800	.800	1.000E+07	.0040	.750	46.949

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0678
.200	.0953	.0673
.400	.1909	.0658
.600	.2834	.0633
.700	.3257	.0617
.800	.3640	.0600
.900	.3971	.0584

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0678
.200	.0953	.0673
.400	.1919	.0658
.600	.2905	.0633
.700	.3405	.0617
.800	.3915	.0600
.900	.4431	.0582

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	4.784E-01	4.785E-01	2.365E+02	2.365E+02
.200	4.808E-01	4.796E-01	2.336E+02	2.366E+02
.400	4.733E-01	4.838E-01	2.227E+02	2.374E+02
.600	4.436E-01	4.915E-01	1.982E+02	2.392E+02
.700	4.061E-01	4.973E-01	1.804E+02	2.407E+02
.800	3.638E-01	5.047E-01	1.612E+02	2.430E+02
.900	2.952E-01	5.127E-01	1.570E+02	2.471E+02

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	4.784E-01	4.785E-01	2.365E+02	2.365E+02
.200	4.815E-01	4.794E-01	2.354E+02	2.349E+02
.400	4.898E-01	4.794E-01	2.324E+02	2.297E+02
.600	4.992E-01	4.704E-01	2.275E+02	2.193E+02
.700	5.035E-01	4.589E-01	2.258E+02	2.117E+02
.800	5.191E-01	4.415E-01	2.288E+02	2.026E+02
.900	5.175E-01	4.146E-01	2.631E+02	1.937E+02

TABLE A-31

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

A-38

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800	1.000E+03	.0010	1.000	58,350

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	4,5381
.200	.1584	4,4806
.400	.3014	4,3147
.600	.4009	4,0927
.700	.4286	4,0097
.800	.4457	3,9598
.900	.4559	3,9459

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	4,5381
.200	.1584	4,4813
.400	.3059	4,3174
.600	.4255	4,1075
.700	.4769	4,0172
.800	.5069	3,9491
.900	.5368	3,9017

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	8.030E-01	8.030E-01	4.392E+00	4.392E+00
.200	7.707E-01	7.925E-01	4.311E+00	4.374E+00
.400	6.265E-01	7.660E-01	3.839E+00	4.413E+00
.600	3.479E-01	7.176E-01	2.846E+00	4.444E+00
.700	2.156E-01	6.832E-01	2.539E+00	4.476E+00
.800	1.310E-01	6.493E-01	3.134E+00	4.557E+00
.900	7.863E-02	6.065E-01	1.068E+01	4.995E+00

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	8.030E-01	8.030E-01	4.392E+00	4.392E+00
.200	7.730E-01	7.942E-01	4.350E+00	4.345E+00
.400	6.894E-01	7.644E-01	4.242E+00	4.175E+00
.600	5.051E-01	6.680E-01	4.139E+00	3.874E+00
.700	4.051E-01	6.083E-01	4.334E+00	3.697E+00
.800	3.227E-01	5.434E-01	5.595E+00	3.611E+00
.900	2.871E-01	4.877E-01	1.595E+01	3.980E+00

TABLE A-32

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT (DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRAVPS	CLEARANCE RATIO	L/O RATIO	ORIFICE RATIO D ₀ /C
90.00	4	1	.800	.800	1.000E+04	.0010	1.000	71.490

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	2.1542
.200	.1397	2.1312
.400	.2699	2.0654
.600	.3732	1.9696
.700	.4084	1.9227
.800	.4333	1.8803
.900	.4483	1.8527

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	2.1542
.200	.1399	2.1314
.400	.2742	2.0650
.600	.3931	1.9693
.700	.4433	1.9186
.800	.4853	1.8743
.900	.5186	1.8435

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.065E-01	7.065E-01	1.029E+01	1.029E+01
.200	6.895E-01	7.021E-01	1.006E+01	1.029E+01
.400	5.986E-01	5.944E-01	9.183E+00	1.021E+01
.600	4.146E-01	5.686E-01	7.306E+00	1.034E+01
.700	2.971E-01	5.517E-01	6.334E+00	1.039E+01
.800	1.941E-01	5.438E-01	6.035E+00	1.041E+01
.900	1.143E-01	5.162E-01	1.273E+01	1.085E+01

*****--LOAD BETWEEN PADS--*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
7.065E-01	7.065E-01	1.029E+01	1.029E+01
6.909E-01	6.995E-01	1.021E+01	1.018E+01
6.424E-01	6.725E-01	9.890E+00	9.759E+00
5.460E-01	6.104E-01	9.431E+00	9.035E+00
4.606E-01	5.622E-01	9.418E+00	8.593E+00
3.717E-01	5.058E-01	1.029E+01	8.194E+00
3.062E-01	4.530E-01	2.018E+01	8.256E+00

TABLE A-33

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

* * * * * GEOMETRY AND OPEGATING CONDITIONS * *

PAD EXTENT(DEG)	NO.OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D0/C
80.00	4	1	.800	.800	1.000E+05	.0010	1.000	79.545

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0,000	,0000	,8434
,200	,1303	,8350
,400	,2533	,8113
,600	,3550	,7768
,700	,3929	,7584
,800	,4213	,7409
,900	,4404	,7269

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.8434
.200	.1305	.8351
.400	.2563	.8115
.600	.3710	.7766
.700	.4215	.7572
.800	.4660	.7387
.900	.5044	.7231

***** DYNAMIC PERFORMANCE DATA *****

-*-*-*-LOAD OVER PAD CENTER--*-*-*-*

ECCENTRICITY		* DYNAMIC COEFFICIENTS *			
RATIO	K(XX)	K(YY)	B(XX)	B(YY)	
0.000	6.576E-01	6.577E-01	2.677E+01	2.677E+01	
.200	6.437E-01	6.552E-01	2.628E+01	2.678E+01	
.400	5.768E-01	6.469E-01	2.430E+01	2.682E+01	
.600	4.281E-01	6.306E-01	2.017E+01	2.713E+01	
.700	3.357E-01	6.208E-01	1.773E+01	2.729E+01	
.800	2.358E-01	6.116E-01	1.606E+01	2.746E+01	
.900	1.637E-01	5.965E-01	2.111E+01	2.808E+01	

--*-*-LOAD BETWEEN PADS-*-*-*-*

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	B(YY)
6.576E-01	6.577E-01	2.677E+01	2.677E+01
6.473E-01	6.529E-01	2.659E+01	2.651E+01
6.008E-01	6.315E-01	2.596E+01	2.561E+01
5.351E-01	5.810E-01	2.490E+01	2.388E+01
4.760E-01	5.425E-01	2.464E+01	2.278E+01
4.162E-01	4.989E-01	2.562E+01	2.172E+01
3.536E-01	4.494E-01	3.469E+01	2.107E+01

TABLE A-34

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D0/G
80.00	4	1	.800	.800	1.000E+06	.0010	1.000	84e954

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.3042
.200	.1217	.3014
.400	.2382	.2934
.600	.3391	.2814
.700	.3790	.2746
.800	.4102	.2679
.900	.4321	.2622

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.3042
.200	.1218	.3014
.400	.2409	.2935
.600	.3531	.2812
.700	.4043	.2741
.800	.4500	.2672
.900	.4905	.2612

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.129E+01	6.130E+01	7.545E+01	7.545E+01
.200	6.035E+01	6.119E+01	7.415E+01	7.549E+01
.400	5.554E+01	6.080E+01	6.914E+01	7.567E+01
.600	4.407E+01	6.009E+01	5.859E+01	7.603E+01
.700	3.609E+01	5.963E+01	5.205E+01	7.636E+01
.800	2.649E+01	5.937E+01	4.714E+01	7.679E+01
.900	1.762E+01	5.818E+01	5.362E+01	7.831E+01

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *				
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.129E+01	6.130E+01	7.545E+01	7.545E+01
.200	6.068E+01	6.096E+01	7.497E+01	7.475E+01
.400	5.827E+01	5.936E+01	7.337E+01	7.240E+01
.600	5.376E+01	5.558E+01	7.047E+01	6.777E+01
.700	4.875E+01	5.228E+01	6.968E+01	6.486E+01
.800	4.307E+01	4.840E+01	7.153E+01	6.176E+01
.900	3.887E+01	4.388E+01	6.780E+01	5.951E+01

TABLE A-35

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+07	.0010	1.000	88.955

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.1055
.200	.1166	.1045
.400	.2294	.1018
.600	.3290	.0977
.700	.3694	.0954
.800	.4016	.0931
.900	.4255	.0910

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.1055
.200	.1167	.1045
.400	.2317	.1019
.600	.3411	.0977
.700	.3917	.0953
.800	.4381	.0929
.900	.4804	.0907

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.866E+01	5.867E+01	2.157E+02	2.157E+02
.200	5.805E+01	5.863E+01	2.123E+02	2.158E+02
.400	5.438E+01	5.847E+01	1.992E+02	2.165E+02
.600	4.420E+01	5.809E+01	1.715E+02	2.179E+02
.700	3.654E+01	5.777E+01	1.538E+02	2.191E+02
.800	2.816E+01	5.732E+01	1.391E+02	2.210E+02
.900	1.949E+01	5.651E+01	1.513E+02	2.250E+02

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.866E+01	5.867E+01	2.157E+02	2.157E+02
.200	5.851E+01	5.844E+01	2.145E+02	2.138E+02
.400	5.670E+01	5.726E+01	2.105E+02	2.077E+02
.600	5.245E+01	5.396E+01	2.039E+02	1.958E+02
.700	4.876E+01	5.118E+01	2.016E+02	1.878E+02
.800	4.452E+01	4.770E+01	2.056E+02	1.792E+02
.900	4.029E+01	4.355E+01	2.447E+02	1.723E+02

TABLE A-36

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO.OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	RL/DO	ROTATION/C
54.00	4	1	.800	.800	1.000E+03	.0020	1.000	47.611

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	4.2728
.200	.1537	4.2187
.400	.2953	4.0620
.600	.3976	3.8440
.700	.4268	3.7576
.800	.4449	3.7020
.900	.4556	3.6810

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	4.2728
.200	.1537	4.2192
.400	.2997	4.0626
.600	.4201	3.8603
.700	.4659	3.7714
.800	.5020	3.7047
.900	.5317	3.6589

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.777E-01	7.777E-01	4.693E+00	4.693E+00
.200	7.528E-01	7.697E-01	4.613E+00	4.685E+00
.400	6.335E-01	7.551E-01	4.137E+00	4.615E+00
.600	3.649E-01	7.081E-01	3.119E+00	4.785E+00
.700	2.291E-01	6.771E-01	2.768E+00	4.838E+00
.800	1.382E-01	6.463E-01	3.312E+00	4.935E+00
.900	8.189E-02	6.050E-01	1.081E+01	5.403E+00

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	7.777E-01	7.777E-01	4.693E+00	4.693E+00
.200	7.543E-01	7.717E-01	4.663E+00	4.647E+00
.400	6.909E-01	7.441E-01	4.509E+00	4.436E+00
.600	5.124E-01	6.620E-01	4.430E+00	4.149E+00
.700	4.078E-01	6.024E-01	4.624E+00	3.975E+00
.800	3.226E-01	5.420E-01	5.871E+00	3.875E+00
.900	2.847E-01	4.864E-01	1.621E+01	4.238E+00

TABLE A-37

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

C-42

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+04	.0020	1.000	57.105

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1.9438
.200	.1322	1.9236
.400	.2585	1.8640
.600	.3637	1.7758
.700	.4015	1.7303
.800	.4291	1.6872
.900	.4459	1.6572

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1.9438
.200	.1323	1.9237
.400	.2618	1.8643
.600	.3807	1.7764
.700	.4324	1.7287
.800	.4759	1.6861
.900	.5099	1.6566

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.657E-01	6.658E-01	1.132E+01	1.132E+01
.200	6.575E-01	6.638E-01	1.108E+01	1.132E+01
.400	5.982E-01	6.625E-01	1.020E+01	1.128E+01
.600	4.366E-01	6.470E-01	8.337E+00	1.137E+01
.700	3.359E-01	6.361E-01	7.233E+00	1.151E+01
.800	2.168E-01	6.327E-01	6.806E+00	1.155E+01
.900	1.292E-01	6.105E-01	1.333E+01	1.204E+01

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
6.657E-01	6.658E-01	1.132E+01	1.132E+01
6.593E-01	6.632E-01	1.123E+01	1.119E+01
6.289E-01	6.456E-01	1.095E+01	1.079E+01
5.564E-01	5.949E-01	1.049E+01	1.004E+01
4.804E-01	5.531E-01	1.045E+01	9.569E+00
3.873E-01	5.046E-01	1.129E+01	9.117E+00
3.095E-01	4.515E-01	2.116E+01	9.175E+00

TABLE A-38

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO.OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
50.00	4	1	.800	.800	1.000E+05	.0020	1.000	62.344

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.7326
.200	.1206	.7258
.400	.2374	.7058
.600	.3396	.6755
.700	.3803	.6584
.800	.4121	.6418
.900	.4344	.6276

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.7326
.200	.1208	.7258
.400	.2396	.7060
.600	.3527	.6755
.700	.4045	.6581
.800	.4515	.6409
.900	.4924	.6261

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	6.072E-01	6.073E-01	3.031E+01	3.031E+01
.200	6.013E-01	6.068E-01	2.985E+01	3.034E+01
.400	5.609E-01	6.046E-01	2.797E+01	3.045E+01
.600	4.481E-01	5.994E-01	2.378E+01	3.068E+01
.700	3.667E-01	5.956E-01	2.108E+01	3.086E+01
.800	2.700E-01	5.926E-01	1.900E+01	3.109E+01
.900	1.815E-01	5.825E-01	2.329E+01	3.179E+01

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
6.072E-01	6.073E-01	3.031E+01	3.031E+01
6.037E-01	6.054E-01	3.016E+01	3.006E+01
5.855E-01	5.933E-01	2.964E+01	2.920E+01
5.423E-01	5.589E-01	2.865E+01	2.744E+01
4.946E-01	5.274E-01	2.843E+01	2.630E+01
4.417E-01	4.893E-01	2.930E+01	2.506E+01
3.712E-01	4.437E-01	3.821E+01	2.424E+01

TABLE A-39

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

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***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO.OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.800	.800	1.000E+06	.0020	1.000	65.688

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.2572
.200	.1112	.2550
.400	.2203	.2486
.600	.3201	.2384
.700	.3625	.2323
.800	.3970	.2263
.900	.4227	.2208

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.2572
.200	.1114	.2550
.400	.2222	.2486
.600	.3316	.2383
.700	.3835	.2322
.800	.4317	.2260
.900	.4757	.2204

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.591E-01	5.592E-01	8.695E+01	8.695E+01
.200	5.563E-01	5.595E-01	8.575E+01	8.704E+01
.400	5.318E-01	5.605E-01	8.091E+01	8.733E+01
.600	4.540E-01	5.619E-01	7.017E+01	8.799E+01
.700	3.890E-01	5.677E-01	6.297E+01	8.818E+01
.800	3.027E-01	5.667E-01	5.697E+01	8.914E+01
.900	2.112E-01	5.617E-01	6.197E+01	9.098E+01

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.591E-01	5.591E-01	8.695E+01	8.695E+01
.200	5.583E-01	5.582E-01	8.655E+01	8.629E+01
.400	5.520E-01	5.506E-01	8.517E+01	8.402E+01
.600	5.359E-01	5.268E-01	8.259E+01	7.935E+01
.700	5.042E-01	5.025E-01	8.189E+01	7.624E+01
.800	4.609E-01	4.714E-01	8.378E+01	7.286E+01
.900	4.207E-01	4.314E-01	1.001E+02	7.014E+01

TABLE A-40

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRAOPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+07	.0020	1.000	67.909

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.0869
.200	.1057	.0862
.400	.2103	.0841
.600	.3074	.0808
.700	.3495	.0788
.800	.3849	.0768
.900	.4120	.0749

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.0869
.200	.1058	.0862
.400	.2119	.0841
.600	.3169	.0808
.700	.3678	.0788
.800	.4165	.0767
.900	.4629	.0747

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	5.310E-01	5.311E-01	2.544E+02	2.544E+02
.200	5.305E-01	5.318E-01	2.511E+02	2.546E+02
.400	5.144E-01	5.341E-01	2.382E+02	2.556E+02
.600	4.497E-01	5.379E-01	2.095E+02	2.576E+02
.700	3.905E-01	5.403E-01	1.901E+02	2.592E+02
.800	3.199E-01	5.418E-01	1.721E+02	2.618E+02
.900	2.371E-01	5.417E-01	1.797E+02	2.666E+02

*****--LOAD BETWEEN PADS--*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
5.310E-01	5.311E-01	2.544E+02	2.544E+02
5.320E-01	5.309E-01	2.533E+02	2.526E+02
5.314E-01	5.262E-01	2.498E+02	2.465E+02
5.181E-01	5.068E-01	2.438E+02	2.343E+02
5.004E-01	4.875E-01	2.418E+02	2.257E+02
4.875E-01	4.613E-01	2.451E+02	2.160E+02
4.466E-01	4.255E-01	2.659E+02	2.076E+02

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* * * * * GEOMETRY AND OPERATING CONDITIONS * * * * *

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD BETWEEN PADS*****

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	P. RAMETER	PARAMETER
0.000	-0000	3.8769
.200	1465	3.8289
.400	2893	3.6849
.600	4109	3.4951
.700	4579	3.4100
.800	4946	3.3461
.900	5244	3.3031

***** DYNAMIC PERFORMANCE DATA *****

-1-**-LOAD OVER PAD CENTER--***-***

*****-*****-LOAD BETWEEN PADS-*****-*****-*****

ECCENTRICITY		* DYNAMIC COEFFICIENTS *			
RATIO	K(YY)	K(YY)	R(XX)	R(YY)	
0.000	7.399E-01	7.399E-01	5.196E+00	5.196E+00	
.200	7.329E-01	7.350E-01	5.086E+00	5.206E+00	
.400	6.358E-01	7.326E-01	4.656E+00	5.137E+00	
.600	3.916E-01	6.963E-01	3.587E+00	5.233E+00	
.700	2.500E-01	6.688E-01	3.166E+00	5.395E+00	
.800	1.510E-01	6.420E-01	3.623E+00	5.533E+00	
.900	6.769E-02	6.054E-01	1.105E+01	6.025E+00	

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* DYNAMIC COEFFICIENTS *
      K(XX)      K(YY)      B(XX)      B(YY)
7.399E-01      7.399E-01      5.196E+00      5.196E+00
7.287E-01      7.370E-01      5.170E+00      5.151E+00
6.839E-01      7.174E-01      5.038E+00      4.951E+00
5.205E-01      6.469E-01      4.916E+00      4.611E+00
4.135E-01      5.916E-01      5.092E+00      4.417E+00
3.268E-01      5.326E-01      6.318E+00      4.303E+00
2.831E-01      4.804E-01      1.665E+01      4.554E+00

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TABLE A-42

 DEEP POCKET HYDROSTATIC FEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.800	.800	1.000E+04	.0040	1.000	44.497

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1.6691
.200	.1224	1.6523
.400	.2426	1.6025
.600	.3488	1.5262
.700	.3902	1.4838
.800	.4215	1.4427
.900	.4412	1.4119

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	1.6691
.200	.1227	1.6522
.400	.2451	1.6032
.600	.3631	1.5271
.700	.4167	1.4843
.800	.4630	1.4446
.900	.4986	1.4168

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	B(YY)
0.000	6.139E-01	6.139E-01	1.299E+01	1.299E+01
.200	6.137E-01	6.177E-01	1.278E+01	1.293E+01
.400	5.806E-01	6.189E-01	1.194E+01	1.301E+01
.600	4.614E-01	6.161E-01	1.001E+01	1.315E+01
.700	3.743E-01	6.142E-01	8.740E+00	1.325E+01
.800	2.521E-01	6.167E-01	8.083E+00	1.334E+01
.900	1.536E-01	6.005E-01	1.433E+01	1.388E+01

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	B(YY)
6.139E-01	6.139E-01	1.299E+01	1.299E+01
6.190E-01	6.146E-01	1.288E+01	1.284E+01
6.056E-01	6.055E-01	1.270E+01	1.250E+01
5.701E-01	5.725E-01	1.225E+01	1.170E+01
5.034E-01	5.387E-01	1.221E+01	1.119E+01
4.098E-01	4.961E-01	1.301E+01	1.067E+01
3.180E-01	4.457E-01	2.278E+01	1.065E+01

TABLE A-43

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

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***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO 00/C
80.00	4	1	.800	.800	1.000E+05	.0040	1.000	47.583

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.6036
.200	.1395	.5984
.400	.2180	.5829
.600	.3188	.5583
.700	.3622	.5436
.800	.3979	.5287
.900	.4247	.5153

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.6036
.200	.1096	.5984
.400	.2196	.5831
.600	.3296	.5583
.700	.3825	.5436
.800	.4327	.5285
.900	.4779	.5150

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.500E-01	5.501E-01	3.604E+01	3.604E+01
.200	5.502E-01	5.510E-01	3.559E+01	3.609E+01
.400	5.335E-01	5.538E-01	3.372E+01	3.624E+01
.600	4.628E-01	5.582E-01	2.936E+01	3.656E+01
.700	4.027E-01	5.648E-01	2.629E+01	3.673E+01
.800	3.141E-01	5.654E-01	2.369E+01	3.718E+01
.900	2.176E-01	5.634E-01	2.717E+01	3.801E+01

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
5.500E-01	5.501E-01	3.604E+01	3.604E+01
5.516E-01	5.503E-01	3.591E+01	3.579E+01
5.522E-01	5.460E-01	3.543E+01	3.492E+01
5.424E-01	5.261E-01	3.455E+01	3.369E+01
5.258E-01	5.058E-01	3.424E+01	3.180E+01
4.780E-01	4.740E-01	3.524E+01	3.042E+01
4.045E-01	4.338E-01	4.410E+01	2.935E+01

 DEEP POCKET HYDROSTATIC REARING PERFORMANLE DATA

PAR EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	1/D RATIO	ORIFICE RATIO DU/D
80.00	4	1	.800	.800	1.000E+06	.0040	1.000	49.451

-*-*-*-*-LOAD OVER PAD CENTER--*-*-*-*

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0,000	,0000	,2061
,200	,1005	,2045
,400	,2010	,1997
,600	,2977	,1918
,700	,3412	,1869
,800	,3788	,1818
,900	,4090	,1769

*****--LOAD BETWEEN PAIRS--*****

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0.000	-0.0000	,2061
.200	.1006	,2045
.400	.2023	,1997
.600	.3066	,1918
.700	.3585	,1869
.800	.4092	,1817
.900	.4580	,1768

***** DYNAMIC PERFORMANCE DATA *****

*****-LOAD OVER PAD CENTER-*****

ECCENTRICITY		* DYNAMIC COEFFICIENTS *		
RATIO	K(XX)	K(YY)	B(XX)	B(YY)
0,000	5.043E-01	5.044E-01	1.055E+02	1.055E+02
,200	5.057E-01	5.054E-01	1.042E+02	1.056E+02
,400	5.019E-01	5.094E-01	9.899E+01	1.059E+02
,600	4.607E-01	5.210E-01	8.756E+01	1.064E+02
,700	4.098E-01	5.264E-01	7.973E+01	1.072E+02
,800	3.424E-01	5.324E-01	7.228E+01	1.083E+02
,900	2.589E-01	5.368E-01	7.520E+01	1.104E+02

*****-LOAD BETWEEN PADS-*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	R(XX)	R(YY)
5.043E-01	5.044E-01	1.055E+02	1.055E+02
5.067E-01	5.048E-01	1.051E+02	1.048E+02
5.190E-01	5.032E-01	1.034E+02	1.022E+02
5.238E-01	4.919E-01	1.012E+02	9.742E+01
5.158E-01	4.762E-01	1.007E+02	9.402E+01
5.066E-01	4.529E-01	1.024E+02	9.009E+01
4.744E-01	4.213E-01	1.194E+02	8.660E+01

DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

* GEOMETRY AND OPERATING CONDITIONS

***** STEADY STATE PERFORMANCE DATA *****

*****-LOAD BETWEEN PADS-*****

ECCENTRICITY	LOAD	TOTAL FLOW
RATIO	PARAMETER	PARAMETER
0.000	.0000	.0681
.200	.0957	.0676
.400	.1925	.0661
.600	.2911	.0636
.700	.3410	.0621
.800	.3914	.0604
.900	.4425	.0587

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD BETWEEN PADS-*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
4.795E-01	4.796E-01	3.157E+02	3.157E+02
4.822E-01	4.803E-01	3.145E+02	3.137E+02
4.903E-01	4.797E-01	3.105E+02	3.070E+02
4.982E-01	4.698E-01	3.041E+02	2.936E+02
5.011E-01	4.578E-01	3.020E+02	2.838E+02
5.158E-01	4.399E-01	3.057E+02	2.722E+02
5.072E-01	4.120E-01	3.488E+02	2.615E+02

TABLE A-46

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS (LAMINAR)	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D0/C
80,00	4	1	,800	,800		,0010	,500	10,049

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0,000	,0000	6,0086
,200	,1857	5,9051
,400	,3393	5,6427
,600	,4230	5,4057
,700	,4431	5,3516
,800	,4556	5,3434
,900	,4640	5,3708

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0,000	,0000	6,0086
,200	,1858	5,9062
,400	,3506	5,6390
,600	,4757	5,3176
,700	,5217	5,1748
,800	,5583	5,0562
,900	,5883	4,9630

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0,000	9,467E-01	9,467E-01	1,433E+00	1,433E+00
,200	8,875E-01	9,279E-01	1,420E+00	1,419E+00
,400	6,073E-01	8,746E-01	1,214E+00	1,382E+00
,600	2,548E-01	7,953E-01	8,036E-01	1,337E+00
,700	1,559E-01	7,494E-01	7,106E-01	1,327E+00
,800	1,012E-01	7,012E-01	9,201E-01	1,355E+00
,900	6,744E-02	6,511E-01	3,046E+00	1,528E+00

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0,000	9,467E-01	9,467E-01	1,433E+00	1,433E+00
,200	8,923E-01	9,309E-01	1,429E+00	1,422E+00
,400	7,368E-01	8,503E-01	1,329E+00	1,359E+00
,600	5,134E-01	6,812E-01	1,325E+00	1,217E+00
,700	4,095E-01	5,821E-01	1,559E+00	1,137E+00
,800	3,268E-01	4,884E-01	2,401E+00	1,037E+00
,900	2,855E-01	4,062E-01	1,032E+01	1,276E+00

TABLE A-47

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

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***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT (DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS (LAMINAR)	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO (D/D)
60.00	4	1	.800	.200		.0010	.750	10.850

***** STEADY STATE PERFORMANCE DATA *****

***** LOAD OVER PAD CENTER *****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	5.7088
.200	.1805	5.6223
.400	.3321	5.3999
.600	.4183	5.1920
.700	.4396	5.1434
.800	.4529	5.1357
.900	.4615	5.1609

***** LOAD BETWEEN PADS *****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	5.7088
.200	.1601	5.6240
.400	.3386	5.4672
.600	.4590	5.1549
.700	.5038	5.0459
.800	.5400	4.9565
.900	.5703	4.8664

***** DYNAMIC PERFORMANCE DATA *****

***** LOAD OVER PAD CENTER *****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	9.192E-01	9.192E-01	2.259E+00	2.259E+00
.200	8.658E-01	8.967E-01	2.240E+00	2.229E+00
.400	6.114E-01	8.335E-01	1.949E+00	2.146E+00
.600	2.694E-01	7.421E-01	1.341E+00	2.039E+00
.700	1.655E-01	6.908E-01	1.214E+00	2.000E+00
.800	1.056E-01	6.379E-01	1.657E+00	2.012E+00
.900	6.832E-02	5.843E-01	6.145E+00	2.262E+00

***** LOAD BETWEEN PADS *****

* DYNAMIC COEFFICIENTS *				
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	9.192E-01	9.192E-01	2.259E+00	2.259E+00
.200	8.648E-01	9.077E-01	2.248E+00	2.239E+00
.400	7.070E-01	8.452E-01	2.178E+00	2.148E+00
.600	4.975E-01	7.102E-01	2.155E+00	1.965E+00
.700	4.022E-01	6.292E-01	2.399E+00	1.871E+00
.800	3.266E-01	5.505E-01	3.475E+00	1.828E+00
.900	2.916E-01	4.791E-01	1.254E+01	2.118E+00

TABLE A-48

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRAPPS (LAMINAR)	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/D
80.00	4	1	.800	.800		.0010	1.000	11.990

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	6.0590
.200	.1768	5.9756
.400	.3268	5.7505
.600	.4145	5.5500
.700	.4366	5.4995
.800	.4504	5.4905
.900	.4591	5.5157

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	6.0590
.200	.1760	5.9779
.400	.3302	5.7735
.600	.4471	5.5419
.700	.4909	5.4442
.800	.5265	5.3651
.900	.5567	5.3035

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	8.995E-01	8.995E-01	2.843E+00	2.843E+00
.200	8.500E-01	8.745E-01	2.825E+00	2.800E+00
.400	6.128E-01	8.054E-01	2.497E+00	2.681E+00
.600	2.791E-01	7.074E-01	1.801E+00	2.525E+00
.700	1.721E-01	6.533E-01	1.712E+00	2.466E+00
.800	1.086E-01	5.984E-01	2.534E+00	2.430E+00
.900	6.846E-02	5.435E-01	1.023E+01	2.849E+00

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	8.995E-01	8.995E-01	2.843E+00	2.843E+00
.200	8.433E-01	8.908E-01	2.829E+00	2.818E+00
.400	6.860E-01	8.398E-01	2.773E+00	2.711E+00
.600	4.846E-01	7.263E-01	2.768E+00	2.517E+00
.700	3.944E-01	6.570E-01	3.074E+00	2.430E+00
.800	3.236E-01	5.887E-01	4.416E+00	2.421E+00
.900	2.931E-01	5.255E-01	1.465E+01	2.866E+00

APPENDIX B

Performance Data for a 4 Pad Hydrostatic Bearing
with one pocket per pad, designed for a
centered pressure ratio of 0.33. Pocket axial length ratio = 0.5

Table of Contents for Appendix B

<u>L/D</u>	<u>GRADPS</u>	<u>C/R</u>	<u>Table No.</u>
0.5	10^3	0.002	B-1
0.5	10^5	0.002	B-2
0.5	10^7	0.002	B-3
1.0	10^3	0.002	B-4
1.0	10^5	0.002	B-5
1.0	10^7	0.002	B-6

NOMENCLATURE AND DEFINITION OF TERMS FOR APPENDIX B

Pad Extent	The circumferential extent of each bearing pad, in degrees (β)
No. of Pads	The number of bearing pads which comprise the complete journal bearing
No. of Pockets	The number of rectangular hydrostatic pockets in each bearing pad
Pocket Width Ratio	The ratio of pocket width in the axial direction to bearing length (L_p/L)
Pocket Length Ratio	The ratio of pocket circumferential length to pad circumferential length (β_p/β)
GRADPS	Supply turbulence parameter = $psC^3\rho/(L\mu^2)$ (non-dimensional)
ps	Supply pressure, lb/in^2
C	Clearance, inches
P	Lubricant density, $lb.in^{-4}sec^2$
L	Bearing length, inches
μ	Viscosity in reyns ($lb.in^{-2}sec.$)
Clearance Ratio	The ratio of machined radial clearance to bearing radius (C/R)
L/D Ratio	The ratio of bearing length to bearing diameter
Orifice Ratio (d_o/C)	The ratio of orifice diameter to clearance which will provide the performance of the particular table (based on a discharged coefficient of 0.6)
Eccentricity Ratio	The ratio of bearing eccentricity to radial clearance
Load Parameter	Normalized bearing load, $W/(psLD)$
W	Bearing load, $lb.$
D	Bearing diameter
Total Flow Parameter	Normalized leakage flow from bearing, $Q\mu/(PsC^3)$

 K_{xx}

Normalized stiffness for motion parallel to the load vector, $\bar{K}_{xx} = CK_{xx}/(PsLD)$

 K_{yy}

Normalized stiffness for motion perpendicular to the load vector, $\bar{K}_{yy} = CK_{yy}/(PsLD)$

 B_{xx}

Normalized damping for motion parallel to the load vector, $\bar{B}_{xx} = 2\pi B_{xx}C/(\mu DL(R/C)^2)$

 B_{yy}

Normalized damping for motion perpendicular to the load vector, $\bar{B}_{yy} = 2\pi B_{yy}C/(\mu DL(R/C)^2)$

 K_{xx}, K_{yy}

Stiffness, lb/in.

 B_{xx}, B_{yy}

Damping, lb.sec/in.

 Q

Total bearing flow, in³/sec.

TABLE B-1

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO D ₀ /C
80.00	4	1	.500	.500	1,000E+03	10020	.500	19,179

***** STEADY STATE PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1.1322
.200	.1059	1.1142
.400	.2192	1.0563
.600	.2976	.9753
.700	.3110	.9457
.800	.3128	.9293
.900	.3057	.9240

*****LOAD BETWEEN PADS*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1,1322
.200	.1040	1,1147
.400	.2118	1,0622
.600	.3154	,9814
.700	.3600	,9369
.800	,3989	,5949
.900	.4372	,8582

***** DYNAMIC PERFORMANCE DATA *****

*****LOAD OVER PAD CENTER*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	5.166E+01	5.166E+01	2.591E+00	2.591E+00
.200	5.564E+01	5.128E+01	2.813E+00	2.633E+00
.400	5.399E+01	4.991E+01	3.339E+00	2.762E+00
.600	2.136E+01	4.756E+01	4.151E+00	3.153E+00
.700	6.690E+02	4.593E+01	6.031E+00	3.660E+00
.800	2.580E+02	4.397E+01	1.303E+01	4.861E+00
.900	1.256E+01	4.111E+01	5.573E+01	8.999E+00

*****LOAD BETWEEN PADS*****

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
5.166E+01	5.166E+01	2.591E+00	2.591E+00
5.317E+01	5.413E+01	2.780E+00	2.681E+00
5.442E+01	5.853E+01	3.443E+00	2.914E+00
4.794E+01	5.590E+01	5.495E+00	3.235E+00
4.184E+01	4.960E+01	8.791E+00	3.550E+00
3.725E+01	4.104E+01	1.976E+01	4.489E+00
4.337E+01	3.227E+01	8.594E+01	9.452E+00

TABLE B-2

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

B-6

***** GEOMETRY AND OPERATING CONDITIONS *****

PAL EXTENT(LEG)	NO.OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DU/C
80.00	4	1	.500	.500	1.000E+05	.0020	.500	31,908

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.3134
.200	.0789	.3098
.400	.1656	.2987
.600	.2502	.2801
.700	.2812	.2696
.800	.3011	.2597
.900	.3051	.2527

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	e3134
.200	.0781	.3099
.400	.1619	.2992
.600	.2534	.2814
.700	.3015	.2702
.800	.3497	.2582
.900	.3989	.2468

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	3.879E-01	3.879E-01	1.116E+01	1.116E+01
.200	4.151E-01	3.895E-01	1.178E+01	1.129E+01
.400	4.496E-01	3.934E-01	1.332E+01	1.172E+01
.600	3.680E-01	3.999E-01	1.507E+01	1.266E+01
.700	2.778E-01	4.041E-01	1.669E+01	1.344E+01
.800	1.040E-01	4.003E-01	2.302E+01	1.491E+01
.900	-5.291E-02	3.935E-01	6.110E+01	1.883E+01

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	3.879E-01	3.879E-01	1.116E+01	1.116E+01
.200	4.038E-01	4.021E-01	1.169E+01	1.142E+01
.400	4.428E-01	4.331E-01	1.336E+01	1.206E+01
.600	4.747E-01	4.480E-01	1.720E+01	1.288E+01
.700	4.827E-01	4.344E-01	2.154E+01	1.338E+01
.800	4.963E-01	4.016E-01	3.334E+01	1.440E+01
.900	5.318E-01	3.504E-01	9.751E+01	1.911E+01

TABLE B-3

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

* * * * * GEOMETRY AND OPERATING CONDITIONS * * * * *

PAD EXTENT(DES)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
30.00	4	1	.500	.500	1.000E+07	.0020	.500	36.452

* * * * * STEADY STATE PERFORMANCE DATA * * * * *

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0409
.200	.0640	.0405
.400	.1355	.0393
.600	.2119	.0372
.700	.2461	.0359
.800	.2727	.0345
.900	.2853	.0334

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0409
.200	.0634	.0405
.400	.1322	.0393
.600	.2104	.0373
.700	.2540	.0360
.800	.3001	.0346
.900	.3525	.0330

* * * * * DYNAMIC PERFORMANCE DATA * * * * *

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	3.155E-01	3.155E-01	8.049E+01	8.049E+01
.200	3.361E-01	3.172E-01	8.450E+01	8.132E+01
.400	3.832E-01	3.227E-01	9.523E+01	8.411E+01
.600	3.653E-01	3.319E-01	1.104E+02	9.002E+01
.700	3.202E-01	3.391E-01	1.211E+02	9.492E+01
.800	2.023E-01	3.418E-01	1.528E+02	1.031E+02
.900	4.526E-02	3.396E-01	2.716E+02	1.190E+02

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	3.155E-01	3.155E-01	8.049E+01	8.049E+01
.200	3.294E-01	3.269E-01	8.385E+01	8.207E+01
.400	3.683E-01	3.551E-01	9.495E+01	8.644E+01
.600	4.243E-01	3.814E-01	1.198E+02	9.268E+01
.700	4.520E-01	3.841E-01	1.469E+02	9.676E+01
.800	4.809E-01	3.728E-01	2.062E+02	1.032E+02
.900	5.972E-01	3.453E-01	4.041E+02	1.207E+02

TABLE B-4

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

B-8

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.500	.500	1.000E+03	.0020	1.000	22.675

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1.1191
.200	.1013	1.1033
.400	.2089	1.0525
.600	.2885	.9757
.700	.3031	.9445
.800	.3037	.9257
.900	.2919	.9184

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	1.1191
.200	.0995	1.1038
.400	.2012	1.0585
.600	.2973	.9910
.700	.3390	.9550
.800	.3766	.9214
.900	.4158	.8916

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	4.955E-01	4.955E-01	5.290E+00	5.290E+00
.200	5.292E-01	4.901E-01	5.747E+00	5.309E+00
.400	5.180E-01	4.732E-01	6.926E+00	5.493E+00
.600	2.325E-01	4.439E-01	9.166E+00	6.145E+00
.700	6.863E-02	4.251E-01	1.397E+01	6.909E+00
.800	5.214E-02	4.025E-01	3.210E+01	8.736E+00
.900	2.017E-01	3.715E-01	1.477E+02	1.546E+01

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *				
	K(XX)	K(YY)	R(XX)	R(YY)
0.000	4.955E-01	4.955E-01	5.290E+00	5.290E+00
.200	5.049E-01	5.179E-01	5.605E+00	5.452E+00
.400	5.097E-01	5.601E-01	6.724E+00	5.931E+00
.600	4.434E-01	5.503E-01	1.012E+01	6.781E+00
.700	3.960E-01	5.096E-01	1.520E+01	7.621E+00
.800	3.701E-01	4.480E-01	3.092E+01	9.643E+00
.900	4.553E-01	3.803E-01	1.172E+02	1.792E+01

TABLE B-5

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.500	.500	1.000E+05	.0020	1.000	36.380

***** STEADY STATE PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.2881
.200	.0783	.2850
.400	.1628	.2753
.600	.2436	.2591
.700	.2730	.2498
.800	.2902	.2410
.900	.2903	.2341

-----LOAD BETWEEN PADS-----

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	-.0000	.2881
.200	.0777	.2350
.400	.1604	.2757
.600	.2485	.2604
.700	.2935	.2510
.800	.3396	.2410
.900	.3879	.2318

***** DYNAMIC PERFORMANCE DATA *****

-----LOAD OVER PAD CENTER-----

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(YX)	B(YY)
0.000	3.848E-01	3.848E-01	2.502E+01	2.502E+01
.200	4.071E-01	3.865E-01	2.625E+01	2.519E+01
.400	4.353E-01	3.916E-01	2.939E+01	2.580E+01
.600	3.439E-01	3.954E-01	3.421E+01	2.740E+01
.700	2.527E-01	3.990E-01	3.902E+01	2.873E+01
.800	1.018E-01	3.955E-01	5.575E+01	3.131E+01
.900	-1.374E-01	3.830E-01	1.632E+02	3.014E+01

-----LOAD BETWEEN PADS-----

* DYNAMIC COEFFICIENTS *			
K(XX)	K(YY)	B(XX)	B(YY)
3.848E-01	3.848E-01	2.502E+01	2.502E+01
3.989E-01	3.965E-01	2.597E+01	2.550E+01
4.302E-01	4.209E-01	2.925E+01	2.688E+01
4.540E-01	4.284E-01	3.639E+01	2.881E+01
4.529E-01	4.129E-01	4.453E+01	3.016E+01
4.569E-01	3.813E-01	6.323E+01	3.267E+01
5.382E-01	3.343E-01	1.482E+02	4.107E+01

TABLE B-6

 DEEP POCKET HYDROSTATIC BEARING PERFORMANCE DATA

B-10

***** GEOMETRY AND OPERATING CONDITIONS *****

PAD EXTENT(DEG)	NO. OF PADS	NO. OF POCKETS (PER PAD)	POCKET WIDTH RATIO	POCKET LENGTH RATIO	GRADPS	CLEARANCE RATIO	L/D RATIO	ORIFICE RATIO DO/C
80.00	4	1	.500	.500	1.000E+07	.0020	1.000	41.800

***** STEADY STATE PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0380
.200	.0660	.0377
.400	.1384	.0366
.600	.2125	.0347
.700	.2439	.0335
.800	.2660	.0323
.900	.2738	.0312

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	LOAD PARAMETER	TOTAL FLOW PARAMETER
0.000	.0000	.0380
.200	.0656	.0377
.400	.1361	.0366
.600	.2143	.0348
.700	.2564	.0336
.800	.3015	.0324
.900	.3514	.0311

***** DYNAMIC PERFORMANCE DATA *****

*****--LOAD OVER PAD CENTER--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	3.252E-01	3.252E-01	1.803E+02	1.803E+02
.200	3.450E-01	3.272E-01	1.889E+02	1.819E+02
.400	3.726E-01	3.331E-01	2.120E+02	1.872E+02
.600	3.442E-01	3.423E-01	2.467E+02	1.984E+02
.700	2.797E-01	3.475E-01	2.770E+02	2.077E+02
.800	1.584E-01	3.514E-01	3.561E+02	2.221E+02
.900	2.060E-02	3.459E-01	6.480E+02	2.496E+02

*****--LOAD BETWEEN PADS--*****

ECCENTRICITY RATIO	* DYNAMIC COEFFICIENTS *			
	K(XX)	K(YY)	B(XX)	B(YY)
0.000	3.252E-01	3.252E-01	1.803E+02	1.803E+02
.200	3.383E-01	3.349E-01	1.873E+02	1.838E+02
.400	3.725E-01	3.577E-01	2.101E+02	1.934E+02
.600	4.127E-01	3.738E-01	2.596E+02	2.077E+02
.700	4.360E-01	3.701E-01	3.089E+02	2.171E+02
.800	4.651E-01	3.540E-01	4.108E+02	2.318E+02
.900	5.878E-01	3.248E-01	7.302E+02	2.678E+02

APPENDIX C

Off-Design Data

Table of Contents for Appendix C

Fig. No,

$$\left[\frac{\text{Actual Stiffness}}{\text{Stiffness for } \overline{Pr}=0.5} \right] \text{ vs. } \left[\frac{\text{Actual Orifice Diameter}}{\text{Orifice Diameter for } \overline{Pr}=0.5} \right]$$

For bearing of Appendix A

C-1

$$\left[\frac{\text{Actual Flow}}{\text{Flow for } \overline{Pr}=0.5} \right] \text{ vs. } \left[\frac{\text{Actual Orifice Diameter}}{\text{Orifice Diameter for } \overline{Pr}=0.5} \right]$$

For bearing of Appendix A

C-2

$$\left[\frac{\text{Actual Damping}}{\text{Damping for } \overline{Pr}=0.5} \right] \text{ vs. } \left[\frac{\text{Actual Orifice Diameter}}{\text{Orifice Diameter for } \overline{Pr}=0.5} \right]$$

For bearing of Appendix A

C-3

$$\left[\frac{\text{Actual Stiffness}}{\text{Stiffness for } \overline{Pr}=0.33} \right] \text{ vs. } \left[\frac{\text{Actual Orifice Diameter}}{\text{Orifice Diameter for } \overline{Pr}=0.33} \right]$$

For bearing of Appendix B

C-4

$$\left[\frac{\text{Actual Flow}}{\text{Flow for } \overline{Pr}=0.33} \right] \text{ vs. } \left[\frac{\text{Actual Orifice Diameter}}{\text{Orifice Diameter for } \overline{Pr}=0.33} \right]$$

For bearing of Appendix B

C-5

$$\left[\frac{\text{Actual Damping}}{\text{Damping for } \overline{Pr}=0.33} \right] \text{ vs. } \left[\frac{\text{Actual Orifice Diameter}}{\text{Orifice Diameter for } \overline{Pr}=0.33} \right]$$

For bearing of Appendix B

C-6

Fig. C-1 Off-Design Performance for Stiffness.
Pocket Width Ratio = 0.8.

Fig. C-2 Off-Design Performance for Flow.
Pocket Width Ratio = 0.8.

Fig. C-3 Off-Design Performance for Damping.
Pocket Width Ratio = 0.8.

Fig. C-4 Off-Design Performance for Stiffness.
Pocket Width Ratio = 0.5.

Fig. C-5 Off-Design Performance for Flow. Pocket Width Ratio = 0.5.

Fig. C-6 Off-Design Performance for Damping.
Pocket Width Ratio = 0.5.

3

APPENDIX D

Comparison with other

3

Reddecliffe and Vohr (7) have published an analysis for deep pocketed hydrostatic bearings. The main limitation of this analysis is its inability to handle high levels of inertia effects (C/R up to 0.004 with large pockets). The present analysis eliminates this restriction. To gain confidence in the present analysis, typical predictions using the analysis of reference (7) have been used for comparison. A similar bearing to that studied in the present handbook has been investigated, under turbulent conditions with a moderate clearance ratio (0.002).

Figures D-1 and D-2 show comparisons of the two prediction methods for stiffness and flow, as a function of centered pressure ratio. The two prediction methods give similar results. In no case does the discrepancy in either flow or stiffness exceed 5 percent, and a discrepancy of this level may be attributed to detailed differences in the numerical computation approach. This comparison is taken to justify use of the present analysis for generation of the data in this report.

Fig. D-1 Comparison of Present Analysis with that of Reference 7. Stiffness vs Centered Pressure Ratio. $\text{GRADPS} = 10^5$; $C/R = 0.002$.

Fig. D-2 Comparison of Present Analysis with that of Reference 7. Flow vs Centered Pressure Ratio. $GRADPS = 10^5$; $C/R = 0.002$.

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