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Performance of Oil Pumping Rings

An Analytical and Experimental Study

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January 1986

Prepared for NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Lewis Research Center Under Contract DEN 3–256

for U.S. DEPARTMENT OF ENERGY Conservation and Renewable Energy Office of Vehicle and Engine R&D

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TABLE OF CONTENTS

SECTION		PAGE
	NOMENCLATURE	v
	SUMMARY	1
1.0	INTRODUCTION	2
2.0	ANALYSIS WITH CONSTANT PARAMETERS	3
	2.1 Basic Equations	3
	2.2 Simplified Approach	7
	2.3 The Backstroke	9
	2.3.1 Analytical Approach	9
	2.3.2 Nature of Solution	11
	2.3.3 Performance Characteristics	15
3.0	ANALYSIS WITH VARIABLE PARAMETERS	25
	3.1 Thermal Effects	25
	3.1.1 The Energy Equation	25
	3.1.2 Lubricant Flow	26
	3.1.3 Modeling of Thermal Problem	33
·	3.1.4 Calculation Procedure	35
	3.2 Variable Velocity and Squeeze-Film Effects	38
	3.3 Starvation	52
	3.4 Nonparallel Contours	54
4.0	PARAMETRIC STUDY	58

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TABLE OF CONTENTS (CONT'D)

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SECTION		PAGE
5.0	EXPERIMENTAL PROGRAM	74
	5.1 Tests with Large Babbitt Ring	77
	5.2 Tests with the Rulon and Carbon Ring	81
	5.3 Tests with the Small Babbitt Ring	85
6.0	DISCUSSION OF RESULTS	86
	6.1 Empirical Correction for Starvation	87
	6.2 Effects of Viscosity	98
	6.3 Suggested Design Procedure	98
7.0	CONCLUSIONS	100
8.0	REFERENCES	101
	APPENDIX A: PRELIMINARY ANALYSIS OF PUMPING LENINGRADER	;
	SEAL	102
	APPENDIX B: COMPUTER PROGRAM "RING"	116
	APPENDIX C: RESULTS OF EXPERIMENTS - NEW SERIES	181
	APPENDIX D: FIGURES SHOWING COMPARISON WITH EXPERIMENTAL DATA AND UNCORRECTED THEORY	203

iv

NOMENCLATURE

A	Thermal constant, $\frac{6u_o U_o L}{\rho c_p C^2}$, (degree)
. C	Radial clearance
с _м	Clearance at upstream edge when $\delta \neq 0$
d	Diameter
D	Flexural rigidity, $Et^3/[12(1 - v^2)]$
E	Elastic modulus
F	Radial shear force/unit circumferential length
Ĩ.	Dimensionless shear force FC ² /(6µU ₀ L ²)
Hz	Hertz
к	Dimensionless flow rate, $\frac{Q}{\pi R U_{o} C}$
^K eff	Effective value of K corrected for starvation
L	Hydrodynamic land width
L ₁ .	Effective distance from fixed end to start of film
ĩ ₁	Dimensionless length, L ₁ /L
P(x)	Radial loading function; see Equation (2-2)
Q	Volumetric flow rate
Q	Flow for $p_f = 0$
R .	Radius of ring
Т	Temperature
Ĩ.	Dimensionless Temperature, $\frac{\rho c_p C^2 (T - T_o)}{6\mu_o U_o L}$
U o	Average rod velocity
v	Normal velocity
с _р	Specific heat
e	Length over which p _o acts

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NOMENCLATURE (CONT'D)

f	Frequency
h	Film thickness
h ₁	Film thickness at $x = 0$
^h 2	Film thickness at $x = L$
h [*] 2	Film thickness slope dh_2/dx at $x = L$
ĥ	(h/C)
k	Integration constant
p	Hydrodynamic pressure
^p f	Sealed Pressure
^p fm	Maximum sealed pressure $(Q = 0)$
P _o	Clamping pressure
P	Dimensionless pressure pC ² /(6µU _c L)
\tilde{p}_{f}	Dimensionless sealed pressure $p_f C^2 / (6 \mu U_o L)$
S .	Stroke
t	Ring thickness; time
u	Velocity
W	Elastic deflection
x	Position variable
×c	Position variable at cavitation point
У	Variable across film
α	Geometric bending parameter, $\frac{t^2(R + \frac{t}{2})^2}{12L^4(1 - v^2)}$
β	Elastohydrodynamic parameter, $\frac{6\mu U_{o}L}{C^{2}} = \frac{\left(R + \frac{t}{2}\right)^{2}}{CtE}$
δ	Slope of tapered surface, $(C - C_M)/L$
ε	Dimensionless loading length, e/L

vi

NOMENCLATURE (CONT'D)

η	Dimensionless film height, (y/h)				
μ	Viscosity				
^µ o	Inlet reference viscosity for thermal analysis				
μ	Viscous heating function, rate of heat generated/unit area				
φ	μ/μ				
ρ	Density				
ν	Poisson's Ratio				
ξ	Dimensionless position variable x/L				
σ	Squeeze film parameter (4L/S)				
ψ	Stream function				
λ	Dimensionless starvation factor				
	SUBSCRIPTS				
с	Cavitation				
F	Forward flow				
E	Elastic				
f .	At x = L				
m	Maximum				
R	Back flow; backstroke				
1	At leading edge				
2	At trailing edge				

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SUMMARY

A steady-state design computer program has been developed to predict the performance of pumping rings as functions of geometry, applied loading, speed, ring modulus, and fluid viscosity. Additional analyses have been developed to predict transient behavior of the ring and the effects of temperature rises occurring in the hydrodynamic film between the ring and shaft. The analysis was initially compared with previous experimental data and then used to design additional rings for further testing.

Tests were performed with Rulon, carbon-graphite, and babbitt rings. Two different shaft diameters were used for the babbitt rings. The design analysis was used to size all of the rings and to select the ranges of clearances, thickness, and loading. Although full quantitative agreement was lacking, relative agreement existed in that rings that were predicted to perform well theoretically, generally performed well experimentally. Some causes for discrepancies between theory and experiment are believed to be due to starvation, leakage past the secondary seal at high pressures, and uncertainties in the small clearances and local inlet temperatures to the pumping ring.

The design criteria that evolved require the applied loading to be of the order of the desired pumping pressure, the flow requirements and tolerances to dictate clearance, and the elastic modulus and ring compliance to be such that the deflection under load statically results in clamping at very small interferences so that back flow is inhibited, but that excessive power loss and wear do not occur.

It was found that the pumping ring could be used to generate its own loading pressure without any priming if an initial taper was applied to the ring. However, for untapered rings, an initial loading had to be applied before self-pumping could be obtained.

A separate preliminary analysis has been performed for a pumping Leningrader seal. This analysis can be used to predict the film thickness and flow rate through the seal as a function of pressure, speed, loading, and geometry.

1.0 INTRODUCTION

An analysis of pumping rings was performed under certain simplifying conditions in previous phases of this work [1]. These conditions consisted of first ignoring the contribution, if any, of the back flow occurring during the return stroke of the rod. Other simplifications related to the use of constant or average parameters, namely constant viscosity and mean rod velocity, throughout the stroke. The latter also presumed the neglect of squeeze film forces due to the variation of film thickness engendered by the harmonic motion of the rod.

The comparison of experimental data with theoretical results based on the simplified analysis showed good agreement with respect to maximum pressures generated by the pumping ring. The flows produced at reservoir pressures below the maximum, however, were consistently lower in the experiments than those indicated by the analysis. The agreement between theory and experiment for the carbon-graphite rings [1] has been found to be incorrect due to an erroneous use of an excessively low viscosity in the theoretical computation.

The present work, an extension of the previous effort, is aimed at advancing the analysis of pumping rings. Thermal effects and variable rod velocity were included and, with it, the effects of squeeze film action in the fluid film. The analysis was extended to include the backstroke and concurrent cavitation and their effect on net flow. The new analysis was then used to run a parametric study in order to obtain optimized configurations of pumping rings of different shapes and materials including the effects of a geometric taper. The results of tests run on these optimized designs were then compared with calculations based on the new analysis.

A separate, preliminary analysis of the pumping Leningrader seal has also been performed. Since this analysis is separate from the pumping ring work, its results are presented in Appendix A.

2.0 ANALYSIS WITH CONSTANT PARAMETERS

2.1 Basic Equations

The equation governing deflection, w, of an axisymmetric shell under bending is

$$\frac{E t^{3}}{12(1-v^{2})} \frac{d^{4}w}{dx^{4}} + \frac{Et}{R^{2}}w = -P(x)$$
(2-1)

Referring to Figure 2-1, the radially outward loading, P(x), may be expressed in terms of the clamping load, p_{a} , and the hydrodynamic pressure, p_{a} , as follows:

$$P(x) = \begin{cases} 0, & -L_{1} \le x \le 0 \\ p, & 0 \le x \le L - e \\ p - p_{0}, & L - e \le x \le L \end{cases}$$
(2-2)

The hydrodynamic pressure, p, is determined from the solution of the Reynolds Equation

$$\frac{dp}{dx} = 6\mu U_0 \left(\frac{h-k}{h^3}\right)$$
(2-3)

with the geometry of the hydrodynamic film as given in Figure 2-2. k is a constant of integration related to the flow, and U is the average speed, which is related to the frequency, f, and the stroke, s, by:

$$U_{2} = 2fs$$

This velocity represents the average of the sinusoidal velocity over each half cycle. If the system contains two opposing pumping rings, it is double acting and the average velocity, U_0 is assumed to prevail over the entire cycle (though in two different pumping rings) for the forward stroke, as well as for the backstroke. In this manner, the transient problem is reduced to and simplified into a quasi-steady-state process. For a single ring, the resulting flow should be divided by 2.





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Fig. 2-2 The Hydrodynamic Film

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The film thickness, h, appearing in Equation (2-3) is related to the deflection, w, by

$$h = (C - w), 0 \le x \le L$$

The system of equations given by Equations (2-1) through (2-3) represents a fifth-order set of differential equations requiring five boundary conditions, in addition to a sixth condition for the evaluation of the constant, k, appearing in Equation (2-3). Two conditions result from the clamped-end requirement

$$w = \frac{dw}{dx} = 0$$
 at $x = -L_1$

Two conditions resulting from the prescribed pressures at x = 0 and L

p = 0 at x = 0 $p = p_f$ at x = L

where p_f is the sealed pressure. The remaining two conditions relate to the free-end requiring zero moment and zero shear, or

$$\frac{d^2 w}{dx^2} = \frac{d^3 w}{dx^3} = 0 \text{ at } x = L$$

The method of solving this set of equations subject to the specified boundary conditions is outlined in Reference [1]. The solution and the results of this analysis, reported in Reference [1], are based on the constancy of both viscosity and speed, namely

 $\mu = \mu_0 = \text{constant}$ $U = U_0 = 2\text{fs} = \text{constant}$

The analysis in Reference [1] did not consider the backstroke and was thus only applicable to sufficiently high loads and low elastic moduli to result in clamping during the backstroke.

2.2 Simplified Approach

A scrutiny of the pumping ring solutions formulated in Section 2.1 shows that the shape of the film over the hydrodynamic portion of the ring is nearly linear for the entire range of ring parameters and operating conditions. A few such examples are shown in Figure 2-3. Consequently, the problem can be considerably simplified if one postulates that the configuration of the film is tapered similar to that of a plane slider. In addition, a constant taper (shown in Figure 2-2) makes it possible to later treat the backstroke and accompanying cavitation. Mathematically a constant taper implies that h' = constant. The pertinent expressions for the hydrodynamic component of pumping ring action are then given by

$$\tilde{h}(\xi) = \tilde{h}_2 + \Delta \tilde{h}(1 - \xi)$$
 (2-4)

$$\tilde{p}(\tilde{h}) = 1/(\tilde{h}_2 - \tilde{h}_1) - 1/\tilde{h} + k'/(2\tilde{h}^2) + C_1$$
(2-5)

where

$$k' = [2\tilde{h}_{1}\tilde{h}_{2}/(\tilde{h}_{1} + \tilde{h}_{2})][1 - (\tilde{h}_{1}\tilde{h}_{2}\tilde{p}_{f})]$$

$$C_1 = [1/(\tilde{h}_1 \tilde{h}_2)][1 + (\tilde{h}_2^2 \tilde{p}_f)]$$

The elastic deformation equation remains the same and may be written in dimensionless form as

$$\alpha \ (d^{4}\tilde{h}/d\xi^{4}) + \tilde{h} = \begin{cases} 1 \text{ for } -\tilde{L}_{1} \leq \xi \leq 0 \\ 1 + \beta \tilde{p} \text{ for } 0 \leq \xi \leq 1 - \varepsilon \\ 1 + \beta (\tilde{p} - \tilde{p}_{0}) \text{ for } 1 - \varepsilon \leq \xi \leq 1 \end{cases}$$
(2-6)

The solution algorithm thus consists of determining values for \tilde{h}_2 and $\Delta \tilde{h}$ by the use of the secant method. Equation (2-6) is solved subject to the previously stated elasticity boundary conditions. Convergence is achieved



Fig. 2-3 Shape of Film Thickness for Various Values of \tilde{p}_{f}

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when the values of $\tilde{h}(1)$ and $\tilde{h}'(1)$ computed from the solution to Equation (2-6) are within the prescribed tolerance limit of the values of \tilde{h}_2 and $-\Delta \tilde{h}$ used in calculating \tilde{p} from Equations (2-4) and (2-5).

2.3 The Backstroke

2.3.1 Analytical Approach

The previous analysis assumed clamping during the backstroke. This is valid for very high loadings, or for highly flexible pumping rings. Lower ring loadings which do not cause clamping during the entire backstroke may be desirable for pumping ring design in order to reduce wear. Also, when the upstream pressure is high, the ring may stay open during the reverse stroke, even under high clamping forces. Thus, backstroke effects are here added on to the analytical model.

The basic equations remain unchanged except for two important aspects. One is that the shaft motion will be in the negative x direction; thus Reynolds Equation assumes the form

$$d\tilde{p}/d\xi = -[(\tilde{h} - K)/\tilde{h}^3]$$
 (2-7)

The other critical modification consists in the appearance of cavitation. As shown in Figure 2-4, due to the divergence of the film in the direction of motion, there may not be enough fluid to fill the gap at sufficiently high values of h. The fluid film will then break up into a pattern of streamers similar to that which occurs in the diverging films of a journal bearing. From continuity requirements, the downstream boundary conditions of ξ_c , where the film ends, must then satisfy the following boundary conditions:

$$(d\tilde{p}/d\xi)$$
 at $\xi = \xi = 0$

 $\tilde{p}(\xi_c) = 0$

(2-8)



P_f



Fig. 2-4 Pumping Ring During Reverse Stroke

To account for cavitation during the backstroke, the equations are integrated backward from $\xi = 1$. As for the forward stroke solution, values of \tilde{h}_2 and $\Delta \tilde{h}$ must be determined by using the secant method. Selected values for \tilde{h}_2 and $\Delta \tilde{h}$ are used in determining $\tilde{h}(\xi)$ from Equation (2-4) which is in turn substituted in the Reynolds Equation (2-7). The resulting equation is then integrated analytically, subject to the constraints that $\tilde{p}(1) = \tilde{p}_f$, and either the condition given by Equation (2-8) for $0 < \xi_c < 1$ or the condition $\tilde{p}(0) = 0$ if cavitation is not predicted to occur. These conditions are sufficient to determine the constant, K, ξ_c (if applicable), and the pressure distribution, $\tilde{p}(\xi)$. Equation (2-6) may now be integrated backward from $\xi = 1$, with the boundary condition at $\xi = 1$ such that

 $\tilde{h}(1) = \tilde{h}_2$ $\tilde{h}'(1) = -\Delta \tilde{h}$ $\tilde{h}''(1) = \tilde{h}'''(1) = 0$

The secant method is then used to find the values of \tilde{h}_2 and $\Delta \tilde{h}$ that make the quantities $|\tilde{h}(-\tilde{L}_1) - 1|$ and $|\tilde{h}'(-\tilde{L}_1)|$ be within prescribed tolerance limits. The solutions so obtained provide dimensionless values of the film thickness profile, the pressure profiles and the flow rates for prescribed values of parameters α , β , \tilde{p}_{0} , \tilde{p}_{f} , ε , and \tilde{L}_{1} .

2.3.2 Nature of Solution

The nature of the solution for the backstroke depends very much on the value of p_f relative to the clamping force, p_o . It is thus first necessary to describe the conditions which are apt to generate either high or low levels of p_f .

If a pumping ring delivers oil to a closed reservoir of finite volume, the parameters α , β , ϵ , and \tilde{p}_0 describing the pumping ring will predetermine the maximum p_f that the pumping ring is likely to generate. At that point, i.e., when p_{fm} is reached, there will be no further inflow into the reservoir, and the pressure in the reservoir will be maintained by pumping ring action at p_{fm} . In Figure 2-5 this situation would be represented by both valves A and B being closed. However, should there be an outflow from the reservoir, that



Fig. 2-5 Conditions Determining Level of p_f

is, were value A open, then the pumping ring would be delivering a net inflow equal to the amount of outflow, with the pressure in the reservoir below the maximum, i.e., $p_f < p_{fm}$. On the other hand, if an external pump were to deliver a certain flow, then it is possible to have $p_f > p_{fm}$. The pumping ring would then be overloaded. The net flow over a cycle would be negative and the outflow through the pumping ring would equal the inflow delivered by the pump. Since there is no external pump in the present system, the overloaded condition will be of academic interest only.

The interaction of pumping ring behavior versus conditions in the reservoir has a direct bearing on the nature of the backstroke solution. The mechanism can be summarized as follows:

- If p_f is low, i.e., if there is an appreciable outflow from the reservoir, the film during the backstroke always cavitates. It is only by having a cavitating backstroke that a net inflow can be maintained over a complete cycle.
- At high values of p_f, there are generally two possible solutions, namely:
 - High h₂ with a noncavitating film
 - Low h₂ with a cavitating film

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Such a double set of possible solutions is shown in Figure 2-6, both the same $\tilde{p}_f = 2.7$ and $\tilde{p}_o = 3.5$. The performance of the pumping ring under these two sets of conditions is as follows:

	Noncavitating	Cavitating		
Back ĥ ₂	0.482	0.120		
Forward \tilde{h}_2	, 0.580	0.580		
Back K	-1.433	-0.225		
Forward K	-0.42	-0.42		
Net K	-1.85	-0.642		
ξ _{cav}		0.87		



Fig. 2-6 Two Possible Reverse Stroke Solutions for High Values of \tilde{p}_{f}

• If there is no supply of oil to the reservoir by a pump, that is, if the pressure, p_f, is generated by the pumping ring only, then the solution of a high h₂ with a noncavitating film is practically impossible, since a thick noncavitating film would produce a net outflow so that no high p_f producing that outflow could possibly be generated in the first place.

Thus, in conclusion, for practical cases of an active pumping ring, the backstroke is always accompanied by cavitation.

2.3.3 Performance Characteristics

For the practical range of ring operation, the pumping ring will, in most cases, cavitate during the backstroke. When the condition of $(\tilde{d}p/\tilde{d}\xi)|\xi_{c} = 0$ is introduced during the backstroke, the resulting film thickness, pressures, and flows are significantly altered from the full film case. Table 2-1 gives the detailed characteristics of cavitating pumping rings as a function of sealed pressure, \tilde{p}_{r} . Particularly significant for these purposes is the amount of back flow and its effect on the net pumping accomplished over a complete cycle. Figures 2-7 and 2-8 show the pressure distribution during the forward and reverse strokes for a range of \tilde{p}_{f} from 0 to 5. As seen, cases of 0 $\leq \tilde{p}_{f} \leq 3$ produce cavitation, and the fluid film and corresponding positive pressures for these cases occupy merely a fraction of the interspace. This reduced pressure profile naturally has a strong effect on the film thickness distribution shown in Figures 2-9 and 2-10. Although \tilde{h}_2 for the noncavitating cases, \tilde{p}_{f} > 3, is about the same for the forward and backstrokes, there is a manyfold (5 to 10 times) decrease in \tilde{h}_2 during a cavitating backstroke. The shapes of the pressure profiles for a range of values of \tilde{p}_{0} (all previous .plots were for \tilde{p}_{o} = 3.0) are shown in Figure 2-11.

A scrutiny of the data contained in Table 2-1, as well as of the accompanying plots, reveals the following interesting features regarding cavitating versus noncavitating films.

TABLE 2-1

PERFORMANCE OF CAVITATING PUMPING RINGS

 $\alpha = 0.0282$

 $\beta = 0.257$

$\varepsilon = 0.518$

 $\tilde{L}_1 = 1.57$

 $\tilde{p} = 3.5$

₽ _f	Flow, K		F	ĥ min		(p /p)	
	Pf	Forward Stroke	Reverse Stroke	Net	°c -	Forward Stroke	Reverse Stroke
	0.355	0.0452	0 310	1.0	0 212	0.045	0.74
Ŭ	0.555	0.04J2	0.510	1.0	0.215	0.045	0.74
1.0	0.315	0.0635	0.252	0.983	0.285	0.045	1.011
1.5	0.244	0.0759	0.168	0.975	0.342	0.052	1.0
2.0	0.0877	0.0954	-0.008	0.963	0.422	0.059	1.0
2.5	-0.227	0.903	-1.130	0.0604	0.527	0.342	1.0
3.0	-0.786	2.068	-2.854	None	0.652	0.603	1.0
3.5	-1.6650	3.284	-4.949	None	0.790	0.771	1.0





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Fig. 2-8 Pressure Distribution During Reverse Stroke



Fig. 2-9 Film Thickness Distribution during Forward Stroke



Fig. 2-10 Film Thickness Distribution during Reverse Stroke



Fig. 2-11 Pressure Profile for Reverse Stroke

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- The change from a cavitating to a noncavitating film is rapid. This is shown in Figures 2-12 and 2-13 where the transition region $(2.0 < \tilde{p}_f < 3.0)$ is plotted in some detail. The onset of cavitation seems to occur at about $\tilde{p}_f = 2.5$ where $\xi_c \simeq 0$.
- Noncavitating films seem to be accompanied by a net reverse flow even during the forward stroke, emphasizing the previous remark that such cases would be of little practical interest in the application of pumping rings.
- The total net flow, including both the forward and backstrokes, becomes negative, even for cavitating films at about $\tilde{p}_f \simeq 2.0$.



Fig. 2-12 Film Thickness at Transition from Cavitating to Noncavitating Condition





3.0 ANALYSIS WITH VARIABLE PARAMETERS

This part of the analysis not only abandons the assumptions of constant speed and constant viscosity but also considers some other factors which were previously neglected. Specifically, the analysis included the following elements:

- Thermal effects
- Variable speed
- Squeeze film action
- Starvation
- Nonparallel contours.

Of course, the analysis also retained the backstroke and accompanying cavitation. However, since for the cavitating backstroke, the film thickness is of limited extent, the refinements of variable temperature were not included for that part of the cycle. Thermal effects and transient effects were considered separately to obtain their individual influence. This provides the quantitative corrections associated with these effects without adding the high degree of complexity of a fully coupled analysis.

3.1 Thermal Effects

3.1.1 The Energy Equation

Since no side leakage exists, the one-dimensional energy equation could be used. This, of course, assumes that temperature variation with y can be averaged, a fact which, as will be seen later, is particularly relevant here. It was also assumed that all the heat generated is convected away by the lubricant.

Ignoring conduction, the one-dimensional energy equation can be written as,

$$\rho cu(\partial T/\partial x) = \mu [(\partial u/\partial y)^2]$$
(3-1)

Since, from one-dimensional bearing theory

$$u = \frac{1}{2\mu} \left(\frac{\partial p}{\partial x}\right) y \left(y - h\right) + U_{o} \left(\frac{h - y}{y}\right)$$
(3-2)

Equation (3-1) can be integrated with respect to y in the interval $0 \le y \le h$ to yield

$$\rho c \left(\frac{U_o h}{2} - \frac{h^3}{12\mu} \frac{\partial p}{\partial x}\right) \left(\frac{\partial T}{\partial x}\right) = \left[\frac{h^3}{12\mu} \left(\frac{\partial p}{\partial x}\right)^2 + \frac{\mu U_o}{h}\right]$$
(3-3)

or

$$\begin{pmatrix} \frac{\partial T}{\partial x} \end{pmatrix} = \frac{1}{\rho c} \qquad \begin{bmatrix} \frac{h^3}{12\mu} & \left(\frac{\partial p}{\partial x}\right)^2 + \frac{\mu O}{h} \\ \frac{U}{2} & \frac{h}{12\mu} & \frac{\partial p}{\partial x} \end{bmatrix}$$

Normalizing and utilizing the relationship

$$(1/\tilde{\mu})(\partial \tilde{p}/\partial \xi) = (\tilde{h} - K)/(\tilde{h}^3)$$

the following can be obtained

$$\partial T/\partial \xi = [\tilde{\mu}(\xi)/K] \{ [(\tilde{h} - K)^2/(\tilde{h}^3)] + [1/(3\tilde{h})] \}$$

where

$$\tilde{T} = \frac{6\mu_0 U_0 L(T - T_0)}{\rho c (C^2)}$$

3.1.2 Lubricant Flow

The flow pattern at the interface of a pumping ring was somewhat problematic. The nature of this flow can be visualized in Figure 3-1. As shown in Figure 3-1a, at zero or low upstream pressure, the flow is mainly forward, with only a small pocket of fluid circulating near the inlet of the film. This recirculating flow is induced by the adverse hydrodynamic pressure gradient prevailing near x = 0. When the level of p_f rises, more and more of the forward flow near

(3-4)

(3-5)



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Fig. 3-1 Lubricant Flow in the Fluid Film

the stationary surface is blocked and eventually reversed (Figure 3-1c) by the static pressure gradient induced by p_f . Eventually, when the upstream pressure is sufficiently high, fluid from the sealed chamber begins to leak backwards along the stationary surface. When the magnitude of p_f becomes very high (Figure 3-1d), most of the flow is backward, with only thin, vanishing layers of forward and recirculating flows maintained near the moving surface.

Thus, in general, there are three layers of flow possessing the following characteristics:

- Forward Flow This flow is along the moving surface. It enters at a temperature, T_0 , that prevails at x = 0 and is heated on its way to the reservoir to some T_{max} at x = L.
- Recirculating Flow This flow also enters at a temperature, T_o, but various portions of that flow penetrate only part way into the film before they are reversed and returned to their source. It should be noted that the bulk of the flow recirculates near the entrance, where h is large. It undergoes relatively little viscous shearing, resulting in low energy dissipation to the fluid.
- Reverse Flow This flow originates in the reservoir entering at a temperature, T_f , and is heated while traveling upstream. Its maximum temperature is reached at the entrance to the pumping ring, at x = 0.

In view of these characteristics, only fluid which transverses the whole length, L, i.e., only the forward and reverse flows, was considered instrumental in carrying away the dissipated heat. Since the bulk of the intermediate layer recirculates near the entrance where the temperature differential is relatively small, its effect is left out of the heat balance. This treatment represents a conservative approach because inclusion of the recirculating flow would yield lower temperatures and thus safer operating conditions than those predicted by the present method.
The first task was to find expressions for the three flow regimes in terms of ring geometry and its operating conditions. Defining a dimensionless transverse coordinate and a dimensionless velocity by

$$\tilde{u}(y) = (u/U_{o}); \eta(\xi) = [y/h]$$

the velocity from Equation (3-2) may be expressed in dimensionless form as

$$u = 3(1 - K/h) \eta(\eta - 1) + (1 - \eta)$$
(3-6)

The line of zero velocity, or the line below which all fluid flows forward and above which the flow is backward, is easily obtained from Equation (3-6) by writing u = 0 which yields the locus

$$n(\xi) \Big|_{u=0} = n^{*}(\xi) = \frac{1}{3[1-K/h(\xi)]}$$
(3-7)

At a given ξ , the total flow contained between the moving surface and any point (η, ξ) line is given by

$$\psi(\eta,\xi) = \tilde{h} \int_{\Omega}^{\eta} u(\eta') d\eta$$

and after integration yields

$$\psi(\eta,\xi) = \tilde{h}\eta(\eta-1)^2 + K\eta^2 (3/2 - \eta)$$
(3-8)

By assigning to $\psi(\eta, \xi)$ various constant values, the flow streamlines are obtained. The net flow, of course, is contained between $\eta = 0$ and $\eta = 1$ or

$$\psi(1,\xi) = \hat{q}_{NET} = (K/2)$$

which is shear flow at $\tilde{h} = K$ where $(d\tilde{p}/d\xi) = 0$.

The film thickness is given by

 $\tilde{h} = \tilde{h}_2 [1 + (a - 1)(1 - \xi)]$

So that the value of (K/2) for an isoviscous, linear slider is given by

$$\frac{K}{\tilde{h}_2} = \frac{2a}{a+1} \left(1 - a\tilde{p}_f \tilde{h}_2^2\right)$$

where

$$a = \left(\frac{\tilde{h}_2 - h'_2}{\tilde{h}_2}\right)$$

For the variable viscosity case where $\mu = \mu(\xi)$, the value of K is

$$K = \frac{-\tilde{p}_{f}}{\int_{0}^{1} \frac{\tilde{\mu}d\xi}{\tilde{h}^{2}}}$$

The individual streamlines are obtained by assigning different constants to $\psi(n,\xi)$ in Equation (3-7). A sample plot of such streamlines for a = 3 and different values of $\tilde{p}_f \tilde{h}_2^2$ is shown in Figure 3-2. Reverse flow will commence when the dividing streamline between the forward and recirculating flow reaches $\xi = 1$. This, from Equation (3-7), occurs at

$$n^{*}(1) = \frac{1}{3[1 - K/h_{2}]} = 1$$
 (3-11)

or at $(K/\tilde{h}_2) = 2/3$. At values of $K/\tilde{h}_2^2 < 2/3$, the tangent point of the recirculating envelope at $\xi = 1$ will lie below $\eta^* = 1$, opening up a passage for reverse flow. Below the recirculating envelope the fluid will, as shown in Figure 3-3, flow forward at a rate of

$$\tilde{q}_{F} = \psi[\eta^{*}(1), 1]$$

whereas, above the envelope there will be reverse flow at a rate of

$$\tilde{q}_{R} = \tilde{q}_{F} - \tilde{q}_{NET} = \psi[\eta^{*}(1), 1] - (K/2)$$

(3 - 12)

(3-9)

(3-10)





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Fig. 3-3 Mapping of the Three Flow Regions

3.1.3 Modeling of Thermal Problem

As stated previously, the viscous heating is assumed to be convected away only by the fluid that passes the interspace, be it to the right or to the left. For this purpose, the interspace is modeled so as to be filled with these two streams, i.e. a forward flow, q_F , and a reverse flow, q_R , as shown in Figure 3-4. By designating

$$f = q_F / (q_F + q_R)$$
 (3-13)

 $f\theta(x)$ will be the heat convected to the right by q_F and (1-f) θ the heat connected to the left by q_R . Likewise, temperatures will be averaged across the film (i.e., in the y but not in the x direction) with $T_F(x)$ and $T_R(x)$ representing the temperature profiles generated in the two flow layers, q_F and q_R . The overall average temperature profile will be obtained from

 $T(x) = f T_{p}(x) + (1 - f) T_{p}(x)$ (3-14)

The viscosity at each x station will be based on this averaged temperature, i.e.

$$\mu(\mathbf{x}) = \mu[\mathbf{T}(\mathbf{x})].$$

The expression for the viscous heating (Section 3.1.1) is exact in the sense that the losses are calculated over the exact velocity profile, including the region of recirculating flow, namely.

$$\phi(x) = \mu(x) o^{f^{h}} (du/dy)^{2} dy \qquad (3-15)$$

where u (x,y) is the velocity profile shown in Figure 3-3. Consistent with the flow model, $\mu(x)$ in the calculation of this viscous shear will be that corresponding to the average temperature T(x).

It should be noted that, whereas with no reverse flow $(q_R = 0)$, the temperature at the inlet to the film is a constant equal to T_o , this is no longer true when reverse flow sets in. The reverse flow, starting at an initial temperature, T_f ,



Fig. 3-4 Subdivision of Flow for Convective Heat Transfer

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will reach a maximum at x = 0 and, since temperatures are averaged across y, the inlet temperature will be some $T_0' > T_0$.

3.1.4 Calculation Procedure

The procedure to be followed in calculating thermal effects in the fluid film is, in view of the previous discussion, as follows:

a. The differential equation to be solved is

$$\frac{d\bar{p}}{d\xi} = \tilde{\mu}(\xi) \left[\frac{\bar{h} - K}{\bar{h}^3} \right]$$

where due to the variable viscosity $\mu(\xi)$



and

$$\mu(\xi) = F\left[T_{o} + \frac{6\mu U L}{\rho c C^{2}} \tilde{T}(\xi)\right]$$

b. If $(K/\tilde{h}_2) > 2/3$, there is no reverse flow and

$$\frac{d\tilde{T}}{d\xi} = \frac{\mu(\xi)}{K} \left[\frac{(\tilde{h} - K)^2}{\tilde{h}^3} + \frac{1}{3\tilde{h}} \right]$$
(3-16)

with $T = T_o \text{ at } \xi = 0$.

c. If $(K/h_2) < 2/3$, there is reverse flow, and the following quantities have to be established in order to account for both the forward and backward streams:

$$\eta^{*} = \eta^{*}(1) = \frac{1}{3\left[1 - \frac{K}{\tilde{h}_{2}}\right]}$$

$$K_{F} = 2\tilde{h}_{2} \eta^{*}(\eta^{*} - 1)^{2} + 2K(\eta^{*})^{2} [3/2 - \eta^{*}] = 2\tilde{q}_{F}$$

$$K_{R} = K_{F} - K = 2q_{R}$$

$$K_{T} = K_{F} + K_{R} = 2K_{F} - K = 2(q_{F} + q_{R}) = 2q_{T}$$

$$\frac{d\tilde{T}}{d\xi} = -\frac{\tilde{\mu}(\xi)}{K_{T}} \left[\frac{(\tilde{h} - K)^{2}}{\tilde{h}^{3}} + \frac{1}{3\tilde{h}}\right]$$
(3-17)

Equation (3-17) needs a solution with two different boundary conditions:

• For
$$T_F(\xi)$$
, $T = T_o$ at $\xi = 0$
• For $T_p(\xi)$, $T = T_e$ at $\xi = 1$

The averaged temperature, any given ξ , is thus

$$\tilde{T}(\xi) + \frac{\tilde{T}_{R}K_{F} + \tilde{T}_{L}K_{R}}{K_{T}}$$
 (3-18)

where

$$\tilde{T} = \frac{\rho c C^2 (T - T_o)}{6\mu_o U_o L}$$

A sample solution for the temperature profile in the fluid film for various values of upstream pressure is given in Figure 3-5. The solutions are for the case of equal upstream and downstream boundary temperatures. Curves which start at $T = 86^{\circ}F$ are those without reverse flow and thus have what may be called a conventional profile. However, at $\tilde{p}_{f} > 1.5$, there is reverse flow and, due to the averaging of temperatures across y, the inlet temperature is higher than



Fig. 3-5 Temperature Profile as Function of \tilde{p}_{f}

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86°F. It is interesting to note that, due to the cooling effect of the backward flow, the maximum temperatures in the film actually decrease as the back flow increases above a certain level. Thus, for $p_f = 0, T_{max} = 107^{\circ}F$, and for $p_f = 3.0, T_{max} = 92^{\circ}F$ and occurs not at the trailing but at the leading edge of the film. The highest temperatures occur at some intermediate combination of forward and backward flows; in this particular example it happens at $p_f = 2.0$ with T_{max} reaching 120°F.

3.2 Variable Velocity and Squeeze-Film Effects

Throughout the previous discussions, the rod velocity was considered to be constant, given by $U_0 = 2sf$. This, of course, represents the average velocity over each half cycle. In actuality, the rod, driving a crankshaft, moves with a variable velocity given by

 $u = u_{max} \cos \pi 2 ft$

where

$$u_{max} = fs = \pi U_o/2$$

Consequently, a normal velocity component and squeeze film forces are imposed on the ring, as shown in Figure 3-6. These are generated by a variation of the hydrodynamic forces and of film thickness, as a function of the variable velocity. The normal velocity introduces perturbations on nearly all the relevant quantities, such as film thickness, pressures, flows, extent of cavitation, and others.

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When variable velocity and squeeze-film effects are included, the Reynolds Equation becomes:

$$(\partial/\partial\xi) [\tilde{h}^{3}(\partial p/\partial\xi)] = (\pi/2) [\cos\tau(\partial h/\partial\xi) + \sigma(\partial h/\partial\tau)]$$

(3-19)





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Fig. 3-6 Variable Velocity and Squeeze Film Effects

where σ is the squeeze-film parameter given by $\sigma = 4L/s$, and τ is the dimensionless time $\tau = 2\pi f t$.

The relevant boundary conditions are:

- For no caviation: $\tilde{p}(0) = 0$; $\tilde{p}(1) = \tilde{p}_{f}$
- For cavitation: $\tilde{p}(1) = \tilde{p}_f$, $\frac{d\tilde{p}}{d\xi}\Big|_{\xi = \xi_o} = 0$

The one-dimensional, transient Reynolds Equation, given by Equation (3-19), may be solved with the use of the implicit time-transient method. $\partial h/d\tau$ may be written as:

$$(\partial h/\partial \tau) = [h_{(i)} - h_{(i-1)}]/\Delta \tau$$

where the subscript i in parentheses denotes the ith time step, and $\Delta \tau$ is the interval between the ith and (i-1)th time steps. Hence

$$\tilde{h}_{(i)} = \tilde{h}_{2(i)} + \Delta \tilde{h}_{(i)} (1 - \xi)$$

and the discretized form of Equation (3-19) is written as

$$\frac{d}{d\xi} [\tilde{h}_{(i)}^{3} \frac{d\tilde{p}_{(i)}}{d\xi}] = \frac{\pi}{2} \{ [-\cos \tau_{(i)} \Delta \tilde{h}_{(i)}] + \sigma \frac{[\tilde{h}_{(i)} - \tilde{h}_{(i-1)}]}{\Delta \tau} \}$$
(3-20)

If it is assumed that $\tilde{h}_{(i-1)}$ is known, then Equation (3-20) can be integrated analytically to obtain $\tilde{p}_{(i)}$ as a function of ξ at the ith time step. The elasticity equation, Equation (2-6), remains unchanged except for the time dependence of \tilde{p} , and may be coupled with the solution to Equation (3-20) and solved at each time step as described previously for the steady-state solution. Values of \tilde{h}_2 and $\Delta \tilde{h}$ at the previous time step $(\tilde{h}_{2(i-1)}, \Delta \tilde{h}_{(i-1)})$ were used in evaluating $\tilde{h}_{(i-1)}$ in Equation (3-20) and for initial guesses for $\tilde{h}_{2(i)}$ and $\Delta \tilde{h}_{(i)}$ for use in the secant method. Quasi-static solutions ($\sigma = 0$) were obtained at the middle of the forward stroke ($\tau = 0$) to start the marching procedure. Solutions were then computed at successive time steps until periodic solutions were obtained.

Sample solutions were run on a pumping ring having the following dimensionless characteristics:

$$\alpha = 0.0282$$
, $\beta = 0.2569$, $\varepsilon = 0.518$, L, = 1.567, $\sigma = 4.0$

Three cases were considered, at different combinations of \tilde{p}_f and \tilde{p}_o ; the $\tilde{p}_o = 4.0$ solution also represents a case where the ring is clamped on the backstroke. The three cases were all solved for steady-state (u = u_o), quasi-static ($\sigma = 0$), and transient conditions to show the effects of squeeze film on ring performance. The value of $\sigma = 4.0$ is quite large for practical applications as it corresponds to a stroke, s, equal to the bearing land, L. For present applications, σ is generally less than 1. The large value was used to exaggerate the effects of squeeze film for purposes of illustration and interpretation. Graphs for film thickness, flow, and pressure profiles are given in Figures 3-7 through 3-14, whereas the values of the component flows are itemized in Table 3-1. Note should be taken that $\tau = 0$ corresponds in these plots to rod position at u = u_{max} , i.e., at the midpoint of its forward stroke.

Considering first the effects of variable velocity alone (quasi-static solution), the plots show the following trends:

- The film thickness variation during the forward stroke follows the sinusoidal shape of the velocity curve. During the backstroke velocity, variation has no effect whenever cavitation commences at the trailing edge and a small effect when cavitation is located at $\xi < 1$ (Figure 3-9).
- The flow curve follows the shape of the velocity curve throughout the cycle, except, of course, when, due to a clamped ring, the flow during the backstroke is zero. In the particular case of Figure 3-14, the flow, after peaking at u_{max} , became negative at the end of the forward stroke $(u \rightarrow 0)$. However, upon commencing the backstroke, the ring clamped and flow ceased.



Fig. 3-7 Film Thickness $\tilde{h}_2^{}$ as Function of Time



Fig. 3-8 Flow Parameter Versus Time









Fig. 3-11 Pressure Profiles as Function of Time for Quasi-Static Analysis



Fig. 3-12 Pressure Profiles as Function of Time for Transient Analysis



Fig. 3-13 Film Thickness \tilde{h}_2 Versus Time



τ, Deg.

Fig. 3-14 Flow Parameters Versus Time

TABLE 3-1

EFFECTS OF VARIABLE VELOCITY AND SQUEEZE FILM ON FLOW

 $\alpha = 0.0282$ $\beta = 0.2569$ $\varepsilon = 0.518$ $\tilde{L}_1 = 1.5614$

$\sigma = 4.0$

			FORWARD		REVERSE		NET	
p o	P _f	Analysis [*]	Q	ΔÇ,%	Q	۵0, %	Q	ΔQ, %
3.0	0	S	0.4542	Ref.	0.1816	Ref.	0.1363	Rëf
		QS	0.4687	+ 3.2	0.1811	0.28	0.1438	+ 5.5
		Т	0.4231	- 6.9	0.1731	4.7	0.1250	- 8.3
3.0	1.0	S ·	0.3392	Ref.	0.4080	Ref.	- 0.0344	Ref.
		QS	0.3524	+ 3.9	0.4059	- 0.8	- 0.0268	22
		Т	0.3020	- 11.0	0.4110	+ 0.7	- 0.0545	58
4.0	2.4	S	0.0948	Ref.	0		0.0474	Ref.
		QS	0.1348	+ 42	0	. <u></u>	0.0677	+ 43
		Т	0.0711	+ 25	0.1165	· •	0.0227	- 148

* S - Static

QS – Quasi-static

T - Transient

- Variable velocity has the effect of increasing the absolute values of all flows; that is, even though it boosts both the forward and back flows, the net flow is increased. Table 3-1 shows this increase to be of the order of several percent for the case of $p_f = 0$. The high percentage changes shown for other cases should not be given too much significance since they center about very low flow levels when a small variation is apt to produce deceptively large effects in terms of percentages.
- The pressures are, of course, positive over the entire ring during the forward stroke, as shown by the 0- π range of the constant lines on Figure 3-11. Their magnitude, too, follows the velocity curve. During the backstroke, $\pi/2 < \tau < 3\pi/2$, cavitation sets in as high negative velocities are approached ($\tau \rightarrow \pi$); they tend, however, to disappear at the beginning and end of the backstroke, when the negative velocities are low.

The inclusion of squeeze-film effects have the following effect:

- The largest film thickness does not occur at u_{max} . The peak is delayed so that it is reached after u_{max} . Likewise, the onset of constant h during the reverse stroke does not commence at u = 0, but is also delayed. Thus, squeeze films have the effect of producing a phase shift in the film thickness curve. The shift is fairly large, varying from 50° to 90° in the three cases considered. However, the absolute values of h seem not to be affected.
- The effect on the flow curves is similar in that there is a phase shift with little change in their magnitude. Both the forward and net flows are reduced in comparison to either the steady-state or quasi-static solutions; the amount of back flow tends to increase under the influence of squeeze film forces. Since the quasi-static solution gives higher flows and the static solution gives lower flow than the constant parameter approach, the inclusion of variable velocity without squeeze film effects would yield errors of at least 10%.

• Unlike the behavior in the quasi-static solution, the pressure curves are not identical over the $0-\pi$ and π -2 halves of the cycle. The pressures are lower when squeeze film effects are included, except over the latter half of the backstroke, when a closing gap helps to increase the pressures above those of the quasi-static analysis.

3.3 Starvation

An estimate of the effect of starvation can be obtained by first considering the clamped case where the area under the bearing land, 0 < x < L, is predicted to be completely dry at the end of the backstroke. The average film thickness in this area is $\Delta h/2$, and the average Couette flow per unit of circumferential length is $U_0 \Delta h/4$. The time, t_s , for the starved volume to fill up would thus be the cross-sectional area $\Delta hL/2$ divided by the flow per unit of circumferential length. Thus,

 $t_{s} = (\Delta h L/2) / (U_{o} \Delta h/4)$

The distance traveled prior to flooding is $U_{Ot_S} = 2L$. This would reduce the effective forward stroke by an amount equal to 2L. The value of t_S given above will be somewhat low in that it does not account for the development of a resisting pressure gradient that will occur as the starved volume fills up nor does it account for any inertial effects in the entrance region that could impede the start of the filling process. In order to account for these effects when analyzing experimental data, multiply t_S by a factor λ which will in general be greater than or equal to 1. Thus,

 $s_{eff} = s - 2L\lambda$

and the dimensionless flow rate Keff becomes

 $K_{eff} = K (s_{eff}/s) = K [1 - \lambda(2L/s)]$ (3-21)

The starvation process is, of course, much more complex than that treated here, especially in the unclamped case where there is a partial film and the film is exposed to the sealed pressure, p_o, so that the cavity could be

trapped in the middle. In order to understand more fully the influence of starvation on pumping ring performance, transparent model experiments should be performed so that the size and behavior of the partial film can be observed and modeled. In the interim, a simple model was adopted to estimate the effect of starvation on pumping for either the clamped or cavitating, nonclamped case.

If the film cavitates during the backstroke at $\xi = \xi_c$, the film thickness at the point, h_c , is

$$h_c = h_2 + \Delta h(1 - \xi_c)$$

and the void volume (volume of gas or vapor in the cavitated region) per unit of circumferential length, V_c , would be

$$V_{c} = (h_{2} + \Delta h - h_{c}) L \xi_{c}/2 = L \xi_{c}^{2} \Delta h/2$$

If it is assumed that the void volume must fill up before significant pumping can begin and if it fills based on Couette flow at the average film thickness of the cavitated region, the incoming flow per unit of circumferential length would be U_0 (h₂ + Δ h + h_c)/4, and the starvation time, t_s, would be V_c divided by that flow

$$t_{s} = (2L\xi_{c}^{2}\Delta h) / [U_{o}(h_{2} + \Delta h + h_{c})]$$

As for the clamped case, the effective forward stroke would be reduced by λU_0 t_s. If the dimensionless flow in the forward stroke is denoted by K_f and the backstroke by K_R, then

$$K_{f eff} = K_{f} (s - \lambda U_{o} t_{s})/s$$

$$= K_{f} \left[1 - 2\lambda \left(\frac{L}{s} \right) \frac{\xi^{2} \Delta h}{h_{2} + \Delta h + h_{c}} \right]$$

$$= K_{f} \left[1 - 2\lambda \left(\frac{L}{s} \right) \frac{\xi^{2} \Delta h}{2h_{2} + \Delta h (2 - \xi_{c})} \right]$$

and

$$K_{eff} = K_{f eff} - K_{R}$$

For the clamped condition, $K_R = 0$, $\xi_c = 1$ and $\tilde{h}_2 = 0$; thus Equation (3-22) reduces to Equation (3-21).

In order to show the effects of starvation, the data for a clamped carbon graphite ring is given in Figure 3-15. The dotted curves include the effects of starvation for a value of $\lambda = 1$. It can be seen that, although the inclusion of the effects of starvation reduces the discrepancy between theory and experiment, it does not resolve the lack of agreement. The effect of values of $\lambda > 1$ will be shown later when comparing theory to experiment.

As a result of the uncertainty regarding the mechanisms of the starvation process, the effects of starvation are not included in the parametric studies in Section 4.0. It is recommended, however, that Equation (3-22) be used to estimate potential effects of starvation when designing pumping rings. The dimensionless starved net flow is given as an output to the computer program RING listed in Appendix B of this report.

3.4 Nonparallel Contours

Essentially, the contours considered are tapered surfaces with a constant slope as shown in Figure 3-16. The reference clearance is that at the trailing edge of the ring; the leading edge clearance is designated by C_{M} . The slope parameter, δ , is then given by

$$\delta = (dh/dx) = (C - C_{M})/L$$

(3-23)

(3-24)

In terms of the nondimensional quantities h and ξ , the slope is given by

$$\tilde{\delta} = (dh/d\xi) = (C - C_M)/C = (1 - \tilde{C}_M)$$

(3-22)



Fig. 3-15 Effect of Starvation on Performance of Carbon Pumping Ring

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Fig. 3-16 Geometric Taper on Pumping Ring

The clearance ratio $\tilde{C}_{M} = (C_{M}/C)$ in terms of this δ is then given by:

$$\tilde{C}_{\rm M} = 1 - L\delta/C \tag{3-25}$$

The effect of using tapers on the performance of pumping rings is discussed in Section 5.0. Briefly, it can be said that the use of tapers has little effect, except in cases of low clamping load, p_0 , or high values of E, i.e., when there is little elastic deflection of the ring. Clearly, when there is no deflection at all, a taper would constitute the sole mechanism of generating hydrodynamic pressures. In practical applications where deflections are present, the effect of tapers is minimal.

4.0 PARAMETRIC STUDY

A study was made regarding the impact of various structural and operational parameters on the performance of the pumping rings. These parameters include:

- Modulus of Elasticity (E)
- Poisson's Ratio (V)
- Clearance (C)
- Length (L & L_1)
- Ring Thickness (t)
- Taper (δ)
- Loading (p and e).

The computer runs that provide the results of the parametric study are based on the constant-parameter approach without starvation but including the effects of the backstroke and attendant cavitation. Thermal and transient effects were omitted because, as shown on Figure 4-1, their effect is not of the sort as to qualitatively change the behavior of the pumping ring. The constant parameter analysis should be sufficient to reveal the essential features of the parametric relationships without the undue complications of the more elaborate analysis.

Since it would ultimately be desirable to optimize the design of pumping rings, the question arises as to what constitutes an optimum. Given the purposes for which these devices are customarily used, an optimum ring was deemed to be one which, within given constraints such as reasonable values of p_0 , C, etc., can maintain the highest possible sealing pressure without excessive wear. This implies the highest values of p_f and a low, preferably zero, frictional force F. Thus, a ring design which generates high p_f and just clamps shut upon reversing the stroke would fulfill this criterion. An additional quantity of interest, perhaps, is also the maximum flow Q_0 (flow at $p_f = 0$), that such a ring can produce. Thus, in the plots that follow, the items of p_f , F, and Q_0 will be the items against which ring performance will be measured.

The parametric study was conducted by first establishing a standard or reference design and then by varying its parameters, one at a time, to values below



Fig. 4-1 Modifications Due to Thermal and Transient Effects

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and above the reference quantities. The parameters for this standard ring are given in Table 4-1 along with selected departures from the standard set. Including the standard, most parameters have four computed points from which optimization plots can be made. The results of the parametric study are summarized in Table 4-2; more relevant plots are portrayed in Figures 4-2 through 4-11. In Figure 4-4, the reason the film thickness h2 drops with an increase in clearance, is due to the drop in p_{fm} ; a high p_{fm} usually helps to contract the clamping pressure and thus maintain a high h2. In Figure 4-6, the explanation for an increase in flow with a rise in length L is that with a greater L the hydrodynamic effects are increased, and thus, also the flow. As seen, four parameters, the lengths L and L₁, taper δ , and Poisson's ratio have little effect on performance. Of the two important variables, namely, clearance and clamping force, the first has to be raised above its optimum for maximum p_f, and the latter reduced below the optimum, if large frictional forces are to be avoided. Since the clamping force is given by the product of po and e, Figure 4-12 shows the effects of using the same clamping force, 31.96 KN/m (182.5 1b per in.) of circumference, but by varying the relative values of p_0 and e. As seen, higher values of p_f are achieved when p_0 is high, while higher values of Q_0 are achieved when e is high. The differences, however, are not striking.

It should be pointed out that the particular optima recorded in Table 4-2, such as t = 2.54 mm (0.1 in.), C = 25.4 microns (1 mil), etc., are valid in the range of parameters characterizing the particular ring specified in Table 4-1. Thus, for example, for a material with a much higher E value, optimum results would be achieved with lower values of clearance and ring thickness. The opposite would be true for a material with a value of E much below the 34.5 GPa $(5 \times 10^6 \text{ psi})$ assigned to the standard design.

TABLE 4-1

STANDARD DESIGN FOR PARAMETRIC STUDY

10.3 MPa (1500 psi) P_o = 3.175 mm (0.125 in.)е = 49°C (120°F), μ = 59 x 10⁻³ Pa-sec, (8.6 x 10⁻⁶ Reyns) т $3.45 \cdot 10^4$ MPa (5 \cdot 10⁶ psi) Ε 0.36 æ ν 12.7 mm (0.5 in.) s æ 35 Hz f 12.7 mm (0.5 in.) R = 6.35 mm (0.25 in.) L = 10.2 mm (0.4 in.) L₁ = $0.019 \text{ mm} (0.75 \times 10^{-3})$ С in.) = 1.9 mm (0.075 in.) t δ 0 VARIATIONS IN PARAMETERS 0.0063 mm, 0.0127 mm, 0.0381 mm ($0.25 \times 10^{-3} \text{in.}$, $0.5 \times 10^{-3} \text{in.}$, $1.5 \times 10^{-3} \text{in.}$) $6.895 \cdot 10^3$ MPa, $20.7 \cdot 10^3$ MPa, $68.95 \cdot 10^3$ MPa, $207 \cdot 10^3$ MPa (10^6 psi, $3 \cdot 10^6$ psi, $10 \cdot 10^6$ psi, $30 \cdot 10^6$ psi)

L: 5.1 mm, 7.6 mm, 10.2 mm (0.2 in., 0.3 in., 0.4 in.)

p.: 5.17 MPa, 6.895 MPa, 13.79 MPa (750 psi, 1,000 psi, 2,000 psi)

v: 0.25, 0.5

C:

E:

L 6.35 mm, 15.2 mm (0.25 in, 0.6 in.)

 δ : -10^{-3} , $-2 \cdot 10^{-3}$, $-3 \cdot 10^{-3}$

TABLE 4-2

OPTIMUM PARAMETERS FOR STANDARD RING

(See Table 4-1)

			For Pfm		
ITEM		RANGE EVALUATED	SUBJECT TO F=0	for q _o	
E	psi 10 ⁻⁶	1 - 30	5.5	6	
	MPa 10 ⁻³	6.89 - 207	41.3	41.3	
بر		0.25 - 0.5	No Effect	No Effect	
С	mils	0.25 - 1.5	1.0	1.0	
	microns	6.35 - 38.1	25.4	25.4	
L	in	0.2 - 0.4	No Effect	Highest	
	mm	5.08 - 10.16			
	in	0.25 - 0.6	No Effect	No Effect	
	mm	6.35 - 15.2		·	
t	in	0.05 - 0.15	0.100	0.102	
	mm	1.27 - 3.81	2.54	2.64	
δ		$0 - (-3 \cdot 10^{-3})$	No Effect	0	
· Po*	psi	750 - 2,000	1100	1050	
	MPa	5.17 - 13.8	7.5	7.20	

*See Also Fig. 4-12.

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Fig. 4-3 Effect of E on Q_0


Fig. 4-4 Effect of C on Performance



Fig. 4-5 Effect of L on Performance



Fig. 4-6

• · . · p_o, MPa



Fig. 4-7 Effects of t and p_0 on Q_0

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Fig. 4-8 Effect of t on Performance



Fig. 4-9 Effects of Taper on Performance



Fig. 4-10 Effect of δ on Q



Fig. 4-11 Effect of $\mathbf{p}_{_{\textbf{O}}}$ on Performance



5.0 EXPERIMENTAL PROGRAM

Following the optimization of the candidate rings, tests were run on three rings to verify their performance and their agreement with theoretical predictions. The test rig and the experimental procedures were the same as those used on the tests described in Ref. [1].

The pumping ring program, given in Appendix B based on the analysis performed here, has been used to select ring designs for experimental testing. Initially, a set of studies was performed with steel, babbitt, and Rulon J rings as examples of a high, medium, and low modulus pumping ring. Overall dimensions were selected consistent with the experimental test rig. The principal design variables to be evaluated within the applied pressure, p_0 , the clearance, c, and the average thickness, t. A target value of p_0 of 1500 psi was used; however, it was found not feasible to design to this pressure with the low modulus Rulon ring. Sample geometries that have been arrived at are shown in Table 5-1. The general configuration of the pumping rings submitted for test is shown in Figure 5-1.

The principal criterion used involves being able to significantly deflect the ring to obtain pumping action without excessive clamping during the backstroke, which would result in excessive wear.

Based on the criterion above, the design of the steel ring would require relatively small thickness and a small clearance to obtain suitable compliance and deflection characteristics. The tolerances required seem excessive for the present application, and it is thought that steel rings would only be applicable in situations requiring much higher pressures. It was thus decided to confine testing to medium and low modulus materials ranging between babbitt, carbon graphite, and Rulon. The test rig and experimental procedures were the same as those used on the test.

One problem area revealed in the course of testing concerns the clamping load. Difficulties were encountered in testing the carbon and Rulon rings, and often such attempts at testing led to breakage of the specimens. It was also noted that some of the babbitt rings were severely worn, not at the downstream end



SAMPLE GEOMETRIES AND CONDITIONS FOR PARAMETRIC STUDY OF CANDIDATE TEST RINGS

L = 6.73 mm (0.265 in.), $L_1 = 7.62 \text{ mm}$ (0.30 in.), $\delta = 0$, s = 38.1 mm (1.5 in.),

f = 35 Hz.

ITEM	STEEL	BABBITT	RULON J	
R, mm	9.5	9.5	9.5	
(in.)	(0.38)	(0.38)	(0.38)	
E, MPa	$207 \cdot 10^3$	51.10 ³	$1.72 \cdot 10^3$	
(psi)	(30 x 10 ⁶)	(7.5 x 10 ⁶)	(0.25 x 10 ⁶)	
ν	0.3	0.36	- 0.46	
p _o , MPa	10.34	10.34	5.17	
(psi)	(1500)	(1500)	(750)	
C, microns	8.96	19	50.8	
(mils)	(0.35)	(0.75)	(2)	
t, mm	1.27	1.90	3.81	
(in.)	(0.05)	(0.075)	(0.15)	

where wear might be anticipated but far upstream, ahead of the actual pumping area, as shown in Figure 5-2a. This led to the conclusion shown in Figure 5-2b that the high-pressure oil used for clamping leaked past the O-ring and, by pressing against bracket A, effectively produced a sealed chamber over the OD of the ring. The pumping ring was thus loaded with a pressure, P_o , over the entire length (L_1 + L) instead of only the narrow region, e, covered by the O-ring. This unpresidented pressure loading gave the ring the flared shape shown in Figure 5-2b which led to high wear upstream of the active pumping area and to breakage of the weaker rings.

The problem was resolved by opening relief passages behind bracket A so that any fluid leaking past the O-ring would be scavenged outside. Since the leakage past the O-ring occurs only when p_f approaches p_o , such leakage should not affect the build-up of sealed pressure p_f at levels below p_o . With the relief grooves in place, all unsatisfactory tests were repeated; no further difficulties in testing the Rulon and carbon rings were encountered. It should also be noted here that the sealed pressure p_f was not observed to significantly exceed the loading pressure p_o . This is believed to be a result of leakage past the O-ring, which occurs when p_g starts to exceed p_o , as indicated in Figure 5-3.

The rings tested were made of either babbitt, carbon graphite, or Rulon. The geometry and dimensions of the various rings tested are as summarized in Table 5-2 and, except for one item (Item VII), had the following two dimensions in common:

Shaft Diameter - 19.05 mm

Inside Diameter of Back Section (over length L_1) - 19.3 mm

The viscosities of the oil used are those given in Figure C-1 of Appendix C.

5.1 Tests with Large Babbitt Ring

The 19.05-mm diameter babbitt ring was tested at three frequencies, 60, 35, and 10 Hz, and at two strokes, 50.8 mm and 25.4 mm. The parameters investigated were the pumping ring length (L), clearance (C), and the effect of a taper (δ). Tables C-1 through C-4 in Appendix C give the detailed results of





b) Distortion of Ring

Fig. 5-2 Leakage of High Pressure Oil Past O-Ring

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Fig. 5-3 Schematic of Leakage Past O-Ring at High Sealed Pressures

TABLE 1	5-2
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I.D. NO.	MATERIAL	R mm (in.)	0.D. mm (in.)	L ₁ mm (in.)	L mm (in.)	C microns (mils)	$-\delta \times 10^3$	TEST I.D. NO
I.	Babbitt	9.52 (.375)	21.6 (.850)	7.56 (0.298)	6.78 (.267)	11.43 (0.45)	0	A-1-A-1
II			21.5 (.846)		6.78 (.267)	19.05 (0.75)		A-2-A-1
III			21.4 (.843)		4.83 (.190)	12.70 (0.50)*		<u>A</u> -1-B-1
IV	ł	Ŧ	21.4 (.843)	¥	6.78 (.267)	25.4 (1.0)*	3.75	A-1-A-2
V	Carbon	9.52 (.375)	22.07 (.869)	7.56 (0.298)	6.78 (.267)	20.32 (0.8)	0	C-1-A-1
VI	Rulon	9.52 (.375)	24.15 (.951)	7.56 (0.298)	6.78 (.267)	42.55 (1,675)*		B-1-A-1
VII	Babbitt	6.00 (.236)	13.92 (.548)	5.59 (0.22)	5.08 (.200)	8.89 (0.35)		D-1-A-1

LIST OF PUMPING RINGS TESTED

* Average of two rings.

the tests. The self-pressurization runs represent an arrangement in which the clamping pressure was provided by the sealed pressures generated by the pumping ring. This represents the case of $p_0 = p_f$ at any instance. It turned out that, in order to start the untapered pumping ring, a priming pressure was required (that is, when at the start, $p_f = 0$, no self-clamping was possible). Some initial $p_{fo} > 0$ had to be provided by external means in order to enable the pumping ring to apply self-pressurization and build up a p_f beyond the initially supplied priming pressure, p_{fo} . The tapered rings were found to be self-priming.

With regard to the effect of the several variables tested, the plots suggest the following:

- <u>Effect of Clearance</u> Table 5-3 shows the changes in maximum flow and pressure induced by changing the clearance from 11.4 microns to 19 microns. These changes are minimal, indicating that the optimum lies within the range of values.
- <u>Effect of Length</u> As shown in Table 5-4, there is a definite advantage to a higher length, L, with regard to maximum flow rates; but the shorter rings produced higher maximum levels of sealed pressure, P_{fm}.
- Effect of Taper Table 5-5 confirms what can be intuitively deduced as the desirability of having a geometric taper. At high clamping pressures when ring deflections are large, the geometric taper is counterproductive. However, at $p_0 = 3.45$ MPa, a taper produces higher flow rates and higher levels of maximum pressure.

5.2 Tests with the Rulon and Carbon Ring

The detailed results of the tests on the Rulon and carbon rings are given in Tables C-5 and C-6 in Appendix C. In both rings, the higher clamping pressures produced higher reservoir pressures, p_{fm} , but the lower values of p_o yielded higher maximum flow rates. This trend was already noticeable with the babbitt ring, but as the value of E drops, it becomes more pronounced so that,

EFFECT OF CLEARANCE

RUNS I AND II

. D	S	f, Hz	Q ₀ , gm/min		P _{fm} , MPa	
^F o MPa (psi)	mm (in.)		C = 0.0114 mm (0.45 mil)	C = 0.019 mm (0.75 mil)	C = 0.0114 mm (0.45 mil)	C = 0.019 mm (0.75 mil)
8.62 (1250)	50.8 (2)	60	43	42	9	9
. (1100)	(2)	35	21	22	: 9 ·	9
	·	10	4	4	8.8	8.8
6.895	50.8	60	50	51	7.2	7.2
(1000)	(2)	35	24	27	7.2	7.2
		10	4	4	7.2	7.2
8.62 (1250)	25.4 (1)	60	7	7.5	8.8	9.2

EFFECT OF REDUCED LENGTH L

"" RUNS I AND III

			Q ₀ , gm/min		P _{fm} , ^{MPa}	
^p o MPa (psi)	s mm (in.)	f. Hz	L=6.78 mm (0.267 in.)	L=4.83 mm (0.19 in.)	L=6.78 mm (0.267 in.)	L=4.83 mm (0.19 in.)
6.895 (1000)	50.8 (2)	60	50	34	7.2	7.8
		35	25	17	7.2	7.8
			.4	2,5	7.2	7.0
3.45 (500)	50.8 (2)	60	59	51	3.8	7.2
		35	28	27	3.8	7.2
		10	3.5	3.5	3.8	7.2
8.62 (1250)	25.4 (1)		70	60	8.8	8.0

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RUNS I AND IV

			Q _o , gm/min		p _{fm} , MPa		
P _o MPa (psi)	s mm (in.)	f _, Hz	$\delta = 0$	δ=-3.75·10 ⁻³	δ = 0	δ=-3.75·10 ⁻³	
8.62	50.8	60	42	32			
(1250)	(2)	35	22	17	9.2	9.2	
		10	4	4	8.9	9.0	
6.895	50.8	60	50	42	9.2	7.2	
	(2)	35	24	18			
		10	4	2	•	7.5	
3.45	50.8	60	60	> 80	3.8	4.2	
(300)	(2)	35	28	38	3.8	4.2	
		10	4	4	3.8	3.8	
8.62 (1250)	25.4 (1)	60	7	2.5	8.8	8.8	

for the Rulon rings, Q_0 at $p_0 = 1.72$ MPa (250 psi) is two or three times the value of Q_0 at $p_0 = 5.17$ (750 psi).

5.3 Tests with the Small Babbitt Ring

The results for the 6-mm radius babbitt ring are given in Table C-7. The diameter was reduced roughly 1/3 as compared to the large rings. Neither the flows, Q_0 , nor the maximum sealed pressure, p_{fm} , were much affected by the change in size.

6.0 DISCUSSION OF RESULTS

Three sets of comparative results are presented in Appendix D.

- The babbitt rings, which comprise the large size with two different clearances and a small size ring
- The carbon graphite ring
- The Rulon ring.

The theoretical curves presented in Appendix D were obtained without the starvation correction and without allowance for the fact that the sealed pressure does not exceed the loading pressure due to leakage past the O-ring.

A number of qualitative conclusions can be drawn from a study of the figures in Appendix D. The major discrepancy observable is the fact that the measured flows are substantially smaller than those predicted by theory at zero sealed pressure. This is believed to be partially due to effects of starvation as will be discussed later. For practical purposes, this discrepancy is not believed to be a major one in that the pumping rings will normally be used to develop a buffer pressure as opposed to being designed to deliver prescribed flow rate. The predicted maximum developable pressure at zero net flow was found to be in better agreement with the experimental data. Again, all of the curves that predict sealed pressure higher than the loading pressures should be truncated at the loading pressure value due to leakage past the secondary seal.

It is important to note that all of the data presented in Appendix D was obtained with seals that were sized and designed with the analysis contained here. In all cases, as predicted, the seals did perform the task of developing and maintaining the designed sealed pressures. Significant pressures could not be developed for steel rings where the theory indicated that sufficient deflection would not be obtainable to provide adequate pumping. Although the analysis presented so far does not accurately predict deliverable flow, it can be used reliably to size and design pumping rings. In order to obtain and improve fit to the flow data, a two-constant empirical relationship has been determined from the data for babbitt pumping rings to attempt to

account for starvation. The results of this fit when compared with experimental data are described below.

6.1 Empirical Correction for Starvation

An empirical relationship for the starvation factor, λ , as a function of L/s of the form

$$\lambda = 0.74 (s/L)^{0.58}$$

has been obtained by fitting flow rates at zero sealed pressure for ring No. I at $p_0 = 8.62$ MPa. Comparisons have been made for rings I - III over a range of frequencies, strokes, loading pressures, sealed pressures, and geometries. Values of λ obtained from the above equations varied between 1.6 and 2.4 for all the cases shown in Figures 6-1 through 6-10.

Comparisons of the data for a 50.8-mm stroke at 35 Hz in Figure 6-1 with those for a 25.4-mm stroke at 60 Hz shown in Figure 6-4 indicate that, even though the speeds (product of stroke and frequency) are fairly close together, the short stroke data in Figure 6-4 shows a factor of 3 less flow. This is very much in keeping with the starvation analysis that predicts that reduced flow will occur when the land length becomes an appreciable fraction of the stroke. If starvation is neglected, the theory would predict the flows to be solely a function of the product of frequency and stroke. Even though only a twoconstant fit was used, the agreement between theory and experiment for all of the cases involving the small clearance babbitt ring looks reasonably good.

Figure 6-6 shows the comparison between theory and experiment with the larger clearance babbitt ring. The shaded area shows the difference between predictions for a 0.75-mil clearance and a 0.65-mil clearance. The difference being well within the limit of the measurements. In general, the data tend to indicate that the 0.65-mil clearance is probably closer to the truth. This appears to be particularly true when one looks at the data at 10 Hz. Again, the agreement is reasonably good and no additional constants were used in fitting the data for the large clearance ring.







Fig. 6-2 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring I (s = 50.8 mm; p_0 = 6.89 MPa)



Fig. 6-3 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring I (s = 50.8 mm; p_0 = 3.45 MPa)

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Fig. 6-4 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring I (s = 25.4 mm; p_0 = 8.62 MPa)

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Fig. 6-5 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring II (s = 50.8 mm; $p_0 = 10.34$ MPa)

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Fig. 6-6 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring II. (s = 50.8 mm; p_0 = 8.62 MPa)



Fig. 6-7 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring II $(s = 50.8 \text{ mm}; p_0 = 6.89 \text{ MPa})$



Fig. 6-8 Comparison Metween Corrected Theory and Experiment for Babbitt Pumping Ring II (s = 25.4 mm; p_0 = 8.62 MPa)





Fig. 6-9 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring III (s - 50.8 mm; $p_0 = 10.3$ MPa)



Flow Rate, gm/min

Fig. 6-10 Comparison Between Corrected Theory and Experiment for Babbitt Pumping Ring III $(s = 50.8 \text{ mm}; p_0 = 6.89 \text{ MPa})$

Figures 6-9 and 6-10 show comparisons between theory and experiment for the shorter length ring. The increased discrepancies indicate that the starvation correction depends more on the stroke than on the seal land. This could be an effect of inertia in the inlet region. In general, the starvation correction, along with the constraint that the end pressure doesn't exceed the loading pressure, provides much better agreement between theory and experiments but is still somewhat incomplete.

6.2 Effects of Viscosity

Since the viscosity cannot be measured at the interface (it is, in fact, measured several inches upstream of the inlet) and since the clearances are very small, both parameters could, in actuality, differ from the assumed values. Major reductions in viscosity, such as that which would occur if the actual temperature were 100°F higher than the measured inlet temperature, would provide remarkably improved agreement between theory and experiment. This fact was observed in numerous parametric studies which are not presented here in that no justification has been found for this temperature rise.

6.3 Suggested Design Procedure

The most effective use of a pumping ring is believed to be for generating a buffer pressure to back up another seal. Thus, if one were to seal gas at 10 MPa from oil at ambient pressure, the pumping ring should be used to develop the 10 MPa backup pressure in a buffer reservoir, thus alleviating the pressure gradient on the primary seal. This should provide prolonged life for the sealing system since the pumping ring is essentially a "light contact" device.

Clearances should be selected based on shaft diameters and machining tolerances. Values of C/R should be of the order of 10^{-3} , thus resembling bearing clearances rather than the tight clearances (or interference) that one would generally find in a seal.

The loading pressure should be of the order of the desired buffer pressure. Back leakage past the O-ring could thus provide a potential relief valve to protect against excessive pressure buildup in the buffer chamber.

The computer program RING (given in Appendix B) should then be used to arrive at a combination of material properties (E, V) and geometries (t, e, L, L₁) so that the computed value of P_{fm} is equal to the desired buffer pressure, and a small amount of clamping is predicted to occur during the back stroke. Allowances should be made for some wear to occur due to friction resulting from the radial shear force F.

If the pumping ring is designed to generate its own loading pressure, $p_0 = p_f$, an initial taper should be used. Values of C_M/C of the order of 2-3 have been shown to be adequate for obtaining self-pumping without the need for external priming. Caution should be used here in providing pressure relief to avoid overloading.

Finally, if the pumping ring is used as a flow device, rather than a pressure generator, allowances should be made for the fact that the analysis tends to overpredict flow under many circumstances. In general, the "starved net flow" prediction generated by RING should be within a factor of 2 of the flow that one would expect to obtain in practice, based upon the measurements reported here.

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7.0 CONCLUSIONS

A design analysis has been developed for predicting pressure-flow relationships for various input geometries, speeds, fluid viscosities, and elastic moduli of pumping rings. The analysis can be used to size and design pumping rings for various applications. Results of testing with Rulon, babbitt, and carbon-graphite rings at various loads, speeds, and geometries indicate that the analysis can consistently be used to design rings that work well over a fairly broad range of parameters.

The design criteria for selecting the clearance would be dictated by tolerance and flow rate consideration. The applied loading, p_0 , should be the order of the desired pumping pressure. The choice of materials and geometry are then dictated by elasticity considerations so that the deflected ring, under static load, clamps the shaft with a very small force to nearly eliminate the back flow without resulting in excessive friction and ensuing wear and power loss.

The greatest discrepancy between theory and experiment lies in the prediction of flow at zero sealed pressure, Q_0 . Predicted values of Q_0 are substantially higher than those observed experimentally in almost all cases. Predictions of the maximum sealed pressure at zero net flow, p_{fm} , differ from those observed experimentally, in that values of p_{fm} substantially greater than the loading pressure, p_0 , are frequently predicted but have never been observed.

The analysis shows that starvation can have a significant influence on Q_0 , although not sufficient to completely explain the discrepancies, and that leakage past the O-ring could cause p_{fm} not to exceed p_0 . Further causes of discrepancy could be due to uncertainties in the clearance and the local temperature at the inlet to the pumping ring.

It was found experimentally that the use of tapers on pumping rings enabled the rings to self-pump up to high sealed pressures. The untapered rings, in general, needed to be initially loaded until a sufficiently high sealed pressure could be generated to load the ring. No priming was necessary for the tapered rings. Theory indicates that performance of a tapered ring and an untapered ring at the same minimum film thickness are similar under significant loading, but the tapered ring is predicted to pump even when unloaded.
8.0 REFERENCES

 "Experimental Evaluation of Oil Pumping Rings," M. W. Eusepi, J. A. Walowit, M. Cohen, DOE/NASA/0119-81/1, NASA CR-165271, U.S. Department of Energy, April 1981.

APPENDIX A

PRELIMINARY AN	ALYSIS OF PUMPING LENINGRADER SEAL
the second s	NOMENCLATURE
δ , where the transmission of the transmission δ	Interference
	3. States and the second second second second second second second second second second second second second second second second second second second se
W	Radial inward deflection
	ann an taraichte ann an taraichte an taraichte an taraichte an taraichte ann an taraichte ann an taraichte an t
h and the second s	Film thickness
x ₁ , x ₂	Coordinate variables
p	Interface pressure
	(1, 1, 1, 2, 2, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3,
р _g	Sealed gas pressure
p.	Interference pressure
	en en la seconda de la companya de l
P	Ambient oil pressure
E Standard Standard Standard	Elastic modulus of seal
ν	Poisson's ratio
	n an tha an
t	Thickness of steel
, . _	
R	Radius
$P = P \cdot \frac{3}{2} \cdot (1 - 2)$	Planning
D = Et / [12(1-0)]	riexural rigidity
f(v)	Shape of undeformed seal ring relative to
1(x)	shaft radius
μ	Viscosity
θ	Inlet slope

L, L₁

Lengths shown in Figure A-4 102 Figure A-1 is a schematic of a pumping Leningrader seal cross section mounted on a shaft. The seal, which is preloaded against the shaft with an interference fit, is loaded by a backup spring and by high-pressure gas, which acts behind the seal and is separated from the oil by the static sealing land. The long, chamfered inlet region provides the pumping action in that it forms a gradual inlet which tends to trap or to provide a preferred direction for flow when the shaft moves toward the cooling supply. (This is referred to as the forward stroke.) During the backstroke, the seal (as drawn in Figure A-1) tends to rub and wipe oil away. Thus, any oil that leaks toward the high-pressure gas tends to be pumped back toward the cooling oil reservoir.

Figure A-2 shows the actual dimensions of the seal used in an automotive Stirling engine. The dotted line denotes the geometry used in the initial modeling of the seal discussed below.

A preliminary model has been developed for a seal with a constant thickness as shown in Figure A-3. The pressure profile drawn under the seal is the pressure anticipated to occur between the seal and the shaft during the forward stroke. The pressure on the far left corresponds to the high-pressure gas, and the pressure on the right represents the oil pressure. The constant pressure, p_i , denotes the compressive radial stress associated with the interference fit of the ring on the shaft. The gas pressure is assumed to act along the outside of the seal with an imaginary secondary seal separating the gas from the oil. The deformation of the seal is assumed to be governed by the elasticity equations for a thin axisymmetric cylindrical shell.

$$D(d^4w/dx^4) + (Et/R^2)w = -(p - p_g)$$
 (A-1)

The geometric variables and coordinate system are shown in Figure A-4; w denotes the inward radial deflection, E denotes the elastic modulus of the seal, and D denotes the flexural rigidity defined as:

$$D = Et^{3} / [12(1 - v^{2})]$$

where v is Poissons ratio for the seal.







Fig. A-2 Seal Geometry for Automotive Stirling Engine Application



Fig. A-3 Pressures Acting on Pumping Leningrader Seal Used in Preliminary Analysis

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The quantity, p, enotes the pressure in the interface between the shaft and the seal which will be determined by the Reynolds Equation for axisymmetric steady-state motion during the forward stroke given by:

$$dp/dx = 6\mu U_{o}[(h - h^{*})/h^{3}]$$
 (A-2)

where h is the local hydrodynamic film thickness, μ is the viscosity of the oil, U is the average velocity during the forward stroke, and h* is a constant of integration to be determined from the boundary conditions.

The film thickness h is related to the elastic deflection w by:

$$h = f(x) - w$$

where f(x) is the radius of the undeformed seal relative to the shaft radius. For the model depicted in Figure A-4, f(x) is given by:

(A-3)

$$f(x) = \begin{cases} -\delta &, \quad 0 \le x \le L \\ & \\ -\delta &- \theta x, \quad -L_1 \le x \le 0 \end{cases}$$
(A-4)

The boundary conditions on the elasticity equation come from the requirement that both ends of the seal are free (forces and moments are zero at each end of the seal). The boundary conditions on the Reynolds equation comes from the requirements that the hydrodynamic pressures equal the prescribed gas pressure at the high-pressure side and the prescribed oil pressure on the low-pressure side. These may be written as:

$$d^{2}w/dx^{2} = d^{3}w/dx^{3} = 0$$
 at $x = -L_{1}$ and $x = L$ (A-5)

$$p = p_{g} \text{ at } x = -L_{1} \tag{A-6}$$

$$p = p_{o} at x = L$$
 (A-7)

Equations (A-1, hrough (A-7) represent a fifth-order nonlinear system corresponding to the mo'el under consideration. A number of approximations that are characteristic of elastohydrodynamic lubrication may be introduced. These are based largely on the fact that the hydrodynamic film thickness, h, will be small compared with the interference fit, δ . The elastohydrodynamic behavior may be characterized by three zones:

- an inlet zone where the film develops
- a contact zone where the film thickness is nearly constant
- an exit zone where the pressure drops to ambient.

This type of behavior has been seen in many other types of elastohydrodynamic lubrication, e.g., Hertzian contacts in rolling element bearings, elastomeric bearings and foil bearings.

A.1 Contact Zone Solution

The contact zone is the region extending from x = 0 to the start of the exit zone which will be localized near x = L. In that region, from Equation (A-4), $f(x) = -\delta$ and from Equation (A-3), $w = -\delta - h$, which may be approximated by $w = \delta$ since $|h/\delta| << 1$. With w being constant, the left-hand term in Equation (A-1) will vanish; hence the relationship

$$p - p_{z} \equiv p_{z} = (Et\delta)/R^{2}$$
, contact zone pressure (A-8)

Since p as determined in Equation (A-8) is constant in the contact zone, the left-hand hand term in Equation (A-2) will vanish and the result will be $h = h^*$, constant (contact zone film thickness).

Equation (A-8) is essentially the dry contact pressure resulting from the interference fit. The dry contact profile would also contain a radial shear load at the sharp corner at x = 0. With a small amount of wear, however, this corner will be rounded, thus alleviating the radial shear load without radically affecting the inlet film shape. Equation (A-8) will then be assumed to prevail throughout the contact zone with the value of h* to be determined by matching the pressure obtained from the solution to the equations for the inlet zone.

A.2 Inlet Zone Solution

In order to match the solution in the inlet zone with the contact zone solution, the pressure and flow must be continuous at x = 0. This results in the constraint

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and the second second

(A-9)

(A-12)

 $p = p_g + p_i$ at x = 0

and

$$dp/dx = 0$$
 at $x = 0$

which is equivalent to

$$h = h^* at x = 0$$
 (A-10)

For values of θ of the order of a few degrees or more, the pressure will vary from its limiting values of $p_g + p_i$ at x = 0 to p_g over a relatively small portion of the inlet zone as sketched in Figure A-3. If the shape of the inlet zone is assumed to be unaffected by the pressure distribution in the region, the film thickness relationship is

$$h = h^* - \theta x , x < 0$$

The stretched variable $\xi = -\theta x/h^*$ may now be introduced into Equation (A-2) to obtain

$$dp/d\xi = -6\mu U_0 \xi / [\theta h^* (1 + \xi)^3]$$
 (A-11)

with the constraints

$$p = p_{\sigma} + p_{i} \text{ at } \xi = 0$$

and $p = p_g$ at $\xi = L_1 \theta / h^*$ (A-13)

The quantity L_1^{θ/h^*} will be a large number for practical cases. Equation (A-13) may be replaced by its limiting form

$$p = p_g \text{ at } \xi \neq \infty$$
 (A-14)

Equation (A-11) may readily be integrated to yield

$$p_{i} = \frac{6\mu U_{o}}{\theta h^{\star}} \int_{0}^{\infty} \frac{\xi}{(1+\xi)^{3}} d\xi = 3\mu U_{o} / (\theta h^{\star})$$

Thus the film thickness h* is given by -

$$h^{*} = 3\mu U_{o} / (\theta p_{i}) = 3\mu U_{o} R^{2} / (Et\delta\theta)$$
 (A-15)

which may, in turn, be used to calculate flow.

A.3 Exit Zone Solution

The exit zone solution is the region in the neighborhood of x = L where the pressure must drop from $p_g + p_i$ down to the ambient value of p_o . This will, again, occur over a relatively short region. The film thickness deflection relationship for the exit zone as determined from Equations (A-3) and (A-4) is the same as that for the contact zone and may be written as

 $w = -(h + \delta)$

The above relationship may be substituted for w in Equation (A-1), to obtain

$$D(d^{4}h/dx_{1}^{4}) + Et(\delta + h)/R^{2} = p - p_{g}$$

where $x_1 = L - x$.

Neglecting h compared with δ in the second term of the above equation and employing Equation (A-8), one obtains

$$D(d^{4}h/dx_{1}^{4}) = p - (p_{g} + p_{i})$$
 (A-16)

One may now differentiate Equation (A-16) with respect to x_1 and substitute Equation (A-2) for $-dp/dx_1$ to obtain the exit zone equation

$$D(d^{5}h/dx_{1}^{5}) = -6\mu U_{o} (h - h^{*})/h^{3}$$
 (A-17)

where h^* is now determined from Equation (A-15).

The boundary conditions at $x_1 = 0$ may be obtained from Equations (A-5), (A-7) and (A-16)

$$d^{2}h/dx_{1}^{2} = d^{3}h/dx_{1}^{3} = 0$$
 at $x_{1} = 0$ (A-18)

and

$$D(d^{4}h/dx_{1}^{4}) = p_{0} - p_{g} - p_{i} \text{ at } x = 0$$
 (A-19)

Without going through the formality of introducing a stretching transformation as was done for the inlet zone, the exit zone solution must merge with the contact zone solution as $x_1 \rightarrow \infty$. Thus, we look for a bounded solution with $h \rightarrow h^*$ as $x_1 \rightarrow \infty$.

The above system of equations may be solved numerically by Runge-Kutta integration, however; if the variation in h is not excessive (|h = h*| << h*), then one may replace h^3 appearing in the denominator of the right-hand side of Equation (A-17) with $h*^3$ to obtain a linear system of equations with constant coefficients that may readily be solved algebraicly.

The algebraic solution is in the form:

$$h/h^{\star} = 1 + A_1 e^{-\zeta} + e^{-\lambda} 1^{\zeta} (A_2 \cos \lambda_2 \zeta + A_3 \sin \lambda_2 \zeta)$$

where

$$\zeta = [6\mu U_{o}/(h^{*3}D)]^{1/5} x_{1}$$
, $\lambda_{1} = \cos (2\pi/5)$ and $\lambda_{2} = \sin (2\pi/5)$.

The constants A_1 , A_2 and A_3 are readily determined from Equations (A-18) and (A-19).

A.4 Sample Solution

Film thickness and pressure profiles have been calculated corresponding to the geometry shown in Figure A-2 with the trapezoidal section modeled by the dotted line shown in the figure. A fluid viscosity of 55 cp, an elastic modulus of 1.72 GPa, and a Poisson's ratio of 0.41 have been used in the computation.

As shown on the scale in Figure A-5, the inlet zone film thickness profile is very steep, indicating that only the portion of the inlet zone very near the contact zone is relevant in affecting the film thickness profile, and that the major portion of the seal to the left of this region is probably not necessary. This is again shown in Figure A-6, where the pressure, approximately 1 mm before the start of the contact zone, is very nearly that of the gas (10 MPa). The pressure rises very steeply and joins the pressure in the contact zone smoothly, although it appears to have a sharp corner on the scale in Figure A-6. The pressure profile in the contact zone is constant and equal to the sum of the gas pressure plus the interference pressure (the pressure that would be associated with interference fit statically). Near the exit region, the pressure starts to oscillate, peaks to 18 MPa, and then falls rapidly to 0 (the oil pressure).

Examination of the rapid falloff in pressure at the exit region shows that if the exit oil pressure were raised to be equal to, or even greater than, the gas pressure, there would be little change in the pressure profile except in the immediate vicinity of the exit zone. The film thickness in the contact zone would be virtually unaffected. This indicates that the ambient pressure difference has little effect on the film thickness or the flow rate since the flow is completely dominated by viscous forces. Thus, the seal could be made to provide a film thickness in either direction by adding a chamfer on the reverse side. Such chamfers, which were recommended and tested as part of the Automotive Stirling Engine Program, have been shown to be effective in providing lubrication without excessive leakage in either direction.



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Fig. A-6 Pressure Profile

4 4 7 (MPA)

PRESSURE

APPENDIX B

COMPUTER PROGRAM "RING"

The computer program RING which has been used throughout the report is listed herein. It is written in IBM FORTRAN 77 (VS), and uses an IMSL subroutine ZSCNT. A FORTRAN IV listing of ZSCNT and its subroutines is also included for completeness. The FORTRAN listings are preceded with an input description, an output description, and sample inputs and outputs.

B.1 INPUT DESCRIPTION

All input variables are on a namelist (NAMELIST/INPUTS/). Symbols in the left column denote the FORTRAN names of the namelist variables. Symbols appearing on the right correspond to the nomenclature given at the beginning of the report.

Input Variable Definitions

STRING	A character string of up to 60 characters to identify job
IDIM	Type of input
	0 - Dimensionless (default value)
·	l - Dimensional (any consistent set of units)

Dimensional Inputs (used only if IDIM = 1)

NI	Frequency (Hz), f
SI	Stroke (L), s
CI	Clearance (L), c
ELI	Bearing length (L), L
ELlI	Length of nonbearing portion of ring (L), L_1
EI	Length over which p _o acts (L), e
RI	Shaft radius (L), R
TI	Ring thickness (L), t
ClI	Initial taper, δ (defaults to 0)
POI	Preload pressure (F/L ²), p _o
PFI	Reservoir pressure (F/L ²), pf
RMUI	Lubricant viscosity (FT/L ²), μ
EMOD	Ring modulus of elasticity (F/L ²), E
POIS	Ring Poisson's Ratio, V

Nondimensional Inputs

AL	α
BET	ß
EPS	ε

ELl	L1
C1	$\delta L/C$ (defaults to 0)
P0	Po
PF	Df
ELOS	L/s for starvation calculation (defaults to 0)
NDX	A vector of length 3 containing number of increments for
•	Runge-Kutta integration
	NDX(1) = Number of increments in $1 - \varepsilon \le \xi \le 1$ (defaults to 40)
	NDX(2) = Number of increments in $0 \le \xi \le 1 - \varepsilon$ (defaults to 25)
	NDX(3) = Number of increments in $-L_1 \leq \xi \leq 0$ (defaults to 25)
NDP	A vector of length (3) containing number of points at which
	pressures etc. are saved for printout. NDX(i) should be inte-
	gral multiples of NDP(i). (Defaults are NDP(1) = 10, NDP(2) =
	25, NDP(3) = 25.)
ICAV	Flag calculation of cavitation (backstroke)
	0 - No cavitation (negative pressures allowed)
	2 - Cavitation included, no negative pressures (default value)
IPR	Print Flag
	0 - Short output (default value)
	l - Longer output (print pressure profile etc.)
NMAX	Maximum iterations for secant method solution (default is 10)
NSIG	Number of significant digits in accuracy of solution using

XF A vector of length (2) containing initial guesses for forward stroke secant solution XF(1) = Initial guess for h at $\xi = 1$ XF(2) = Initial guess for dh/d ξ at $\xi = 1$

secant method (default is 4)

If XF(1) and XF(2) are both set equal to 0, the program will attempt to find its own initial guesses. In subsequent runs, values determined from the previous run are used unless explicitly specified.

' XB

A vector length (2) containing initial guesses for h and dh/d ξ for reverse stroke secant solution. Same rules apply to XB as for XF.

B.2 OUTPUT DESCRIPTION

The output starts with a listing of the inputs which are defined in D.1. Dimensional inputs are listed only if IDIM = 1. All outputs are dimensionless.

The Elastic Solution refers to the deflection of the ring when hydrodynamic forces are not present. If the ring is unclampled, h(1) > 0, one line of output is given for the Elastic Solution. If the ring is clamped, h(1) < 0, two lines of output are given. The first line refers to the ring deflection relative to an imaginary shaft that would occur if the shaft were not present (the negative value of h noting the interference). The second line of output includes the effect of the interference force exerted by the shaft on the ring at $\xi = 1$ when h(1) = 0.

Thw Pumping Flow Solution and Back Flow Solution refer to forward and reverse strokes respectively. They will contain one line of output each at IPR = 0 or multiple outputs if IPR = 1.

The following table relates the output caption with the symbols for variables as defined in the nomenclature for the elastic, pumping flow and back flow solution.

Output Caption	Algebraic Symbol
x	ξ
Н	h
Н'	dh/dĘ
H,1	d ² h/dξ ²
· H'''	d ³ h/dξ ³
PRES	Р
FORCE	F

The final output listed under flows relates to dimensionless flow and cavitation output and are given as follows:

Output Caption

Algebraic Symbol

KF (Forward Stroke)
K _R (Reverse Stroke)
ξ _c
$K_F - K_R$
KF eff - KR

B.3 SAMPLE INPUT AND OUTPUT

The sample input and output contained herein correspond to three solutions for a babbitt pumping ring with loading pressures, p_0 , of 3.45, 5.17 and 6.89 MPa (500, 750 and 1000 psi). A full printout (IPR = 1) was requested at p_0 = 3.45 MPa (500 psi). It should be noted that the ring is predicted to be clamped during the backstroke at p_0 = 6.89 MPa (1000 psi). &INPUTS STRING='BABBIT RING A-1-A-1 P0=500 COMPLETE OUTPUT (IPR=1)' SI = 2., NI =35., IDIM=1, C1I =0., ELI =.267, RMUI = .885E-5, CI = .5E - 3, POI =500., • PFI =0., EI =.115, EL11 =.298, RI =.375, EMOD =7.5E6, POIS = XB = 0.,0., IPR=1, TI = .047, POIS =.36, XF = 0., 0.,&END &INPUTS POI=750., STRING ='BABBIT RING A-1-A-1 PO=750', IPR=0, &END &INPUTS POI=1000., STRING ='BABBIT RING A-1-A-1 PO=1000', &END

* PUMPING RING ANALYSIS PROGRAM *

INPUTS STRING = BABBIT RING A-1-A-1 P0=500 COMPLETE OUTPUT (IPR=1) DIMENSIONAL INPUTS ELI = 0.2670000D+00; EL1I = 0.2980000D+00;= 0.11500000D+00; CI= 0.5000000D-03;EI = 0.0000000D+00; TI = 0.4700000D-01;ClI = 0.200000000+01; RI = 0.37500000D+00;SI RMUI = 0.8850000D-05; NI= 0.3500000D+02;POI = 0.50000000+03; PFI= 0.000000000+00;= 0.7500000D+07; POIS = 0.3600000D+00; EMOD IDIM = 1;= 0.66085654D-02; BET = 0.71535454D+01;AL EPS = 0.43071161D+00; P0 = 0.62976163D-01;EL1 = 0.11161049D+01; PF = 0.000000000+00;STARV = 0.32041966D+00; C1= 0.000000000+00;NDX 40. 25, 25; = NDP = 10, 25, 25; NMAX = 10; NSIG = 4: IPR = 1; ICAV = 2; XF 0.0000D+00 \simeq 0.00000D+00 XB 0.00000D+00 0.00000D+00 OUTPUTS ______ * ELASTIC SOLUTION * H''' - Н' н'' X H PRES FORCE 1.0000 0.48845 -0.67281 0.00000 0.00000 0.00000 0.00000 * PUMPING FLOW SOLUTION * Н H' H'' H''' Х PRES 1.0000 0.81814 -0.69559 0.00000 0.00000 0.00000 0.9914 0.82413 -0.69558 -0.00147 0.33645 0.00375 0.83611 0.9742 -0.69548 -0.01254 0.93187 0.01074 0.9569 0.84809 -0.69510 -0.03304 1.43418 0.01709 0.86006 -0.69429 0.9397 1.85487 -0.06149 0.02285 0.9225 0.87201 -0.69294-0.09655 2.20463 0.02805 0.9052 0.88393 -0.69093 -0.137102.49334 0.03274 0.8880 0.89582 -0.68819-0.182162.73019 0.03695 0.8708 0.90764 -0.68464 -0.23092 2.92369 0.04071 0.91940 0.8536 -0.68022 -0.28270 3.08173 0.04405 0.8363 0.93108 -0.67488 -0.336953.21161 0.04701 0.94265 -0.66859 0.8191 -0.393243.32008 0.04960 0.8019 0.95411 -0.66132 -0.45126 3.41339 0.05186

0.7846	0.96543	-0.65304	-0.51080	3.49729	0.05380
0.7674	0.97660	-0.64371	-0.57175	3.57709	0.05545
0.7502	0.98761	-0.63333	-0.63406	3.65768	0.05682
0.7330	0.99842	-0.62186	-0.69781	3.74354	0.05793
0.7157	1.00903	-0.60927	-0.76311	3.83880	0.05881
0.6985	1.01941	-0.59555	-0.83016	3.94719	0.05946
0.6813	1.02954	-0.58066	-0.89921	4.07216	0.05990
0.6640	1.03941	-0.56456	-0.97058	4.21679	0.06015
0.6468	1.04899	-0.54720	-1.04464	4.38389	0.06021
0.6296	1.05825	-0.52854	-1.12178	4.57598	0.06011
0.6124	1.06719	-0.50853	-1.20247	4.79530	0.05984
0.5951	1.07577	-0.48709	-1.28718	5.04382	0.05943
0.5779	1.08396	-0.46415	-1.37644	5.32328	0.05887
0.5693	1.08791	-0.45209	-1.42295	5.47508	0.05855
0.5579	1.09297	-0.43555	-1.48207	4,91228	0.05807
0.5351	1,10249	-0.40062	-1.58150	3.83132	0.05695
0.5124	1,11120	-0.36370	-1.65702	2.81167	0.05564
0.4896	1,11904	-0.32532	-1.71003	1.85497	0.05416
0.4668	1,12600	-0.28598	-1.74199	0.96235	0.05252
0.4660	1,13206	-0.24614	-1.75435	0.13448	0.05073
0.4213	1,13721	-0.20622	-1.74861	-0.62831	0.04881
0.3985	1.14146	-0.16663	-1.72623	-1.32603	0.04676
0.3757	1,14481	-0.12772	-1.68871	-1 95894	0.04461
0.3530	1,14728	-0.08982	-1.63751	-2.52748	0.04401
0.3302	1.14891	-0.05323	-1.57408	-3 03230	0.04250
0.3074	1.14972	-0.01821	-1.49988	-3 47412	0.04001
0.2846	1.14975	0.01500	-1.41633	-3 85377	0.03500
0.2619	1,14905	0.04623	-1.32484	-4.17212	0.03252
0.2391	1,14766	0.07529	-1.22678	-4.43005	0.02989
0.2163	1,14564	0,10206	-1,12353	-4.62844	0.02721
0.1936	1,14303	0.12643	-1.01643	-4.76813	0.02448
0.1708	1,13990	0.14833	-0.90681	-4.84992	0.02171
0.1480	1.13630	0.16772	-0.79599	-4.87453	0.01890
0.1252	1.13228	0.18459	-0.68524	-4.84260	0.01606
0.1025	1.12791	0.19894	-0.57586	-4.75471	0.01319
0.0797	1.12324	0.21083	-0.46912	-4.61129	0.01029
0.0569	1,11833	0.22034	-0.36627	-4.41272	0.00737
0.0342	1,11322	0.22755	-0.26857	-4.15924	0.00443
0.0114	1,10798	0.23262	-0.17726	-3.85102	0.00148
-0.0000	1,10532	0.23439	-0.13439	-3.67640	0.00000
		* BACK FLO	W SOLUTION *		
X	Н	Н'	Н,,,	H * * *	PRES
1.0000	0.48845	-0.67281	0.00000	0.00000	0.00000
0.9914	0.49424	-0.67281	0.00033	-0.07580	0.00000
0.9742	0.50584	-0.67284	0.00279	-0.20473	0.00000
0.9569	0.51743	-0.67292	0.00721	-0.30344	0.00000
0.9397	0.52902	-0.67309	0.01307	-0.37193	0.00000
0.9225	0.54062	-0.67338	0.01985	-0.41019	0.00000
0.9052	0.55223	-0.67378	0.02703	-0.41820	0.00000
0.8880	0.56384	-0.67431	0.03409	-0.39595	0.00000
0.8708	0.57546	-0.67495	0.04050	-0.34341	0.00000
0.8536	0.58710	-0.67570	0.04575	-0.26055	0.00000
0.8363	0.59875	-0.67652	0.04931	-0.14735	0.00000

PUMPING 0.106219D	BA +01 0.4886 ******	CK 04D+00 0. ******	XCAV 999770D+00 *******	NET FLOW 0.573582D+00	STARVED NET 0.2961251	FLOW)+00 ** (
		 ۲ * ۴	LOWS *			
~0.0000	1.00112	-0.13210	-0.0/394	-1.1111	0.00000	
U.UI14 	U.999900 1 00112	-0.13310	-U.09348 _0 4720/	-1./103/ -1.71575		
0.0342	0.99021	-0.12020	-0./3231	-1.71627		
U.U309	0.99240	-0.15620	-0.72251	-1.70033		
U.U/9/	0.98831	-0.19132	-0.80936	-1 60001	0.00000	
U.1025	0.983/4		-0.8463/	-1.608/3	0.00000	
0.1252	0.97873	-0.22987	-0.88250	-1.54421	0.00000	
0.1480	0.9/326	-0.25036	-0.916/6	-1.46164	0.00000	
0.1/08	0.96/32	-0.2/160	-0.94892	-1.35941	0.00000	
0.1936	0.96089	-0.29355	-0.9/851	-1.2358/	0.00000	
0.2163	0.95395	-0.31614	-1.00503	-1.08929	0.00000	
0.2391	0.94649	-0.33930	-1.02793	-0.91790	0.00000	
0.2619	0.93849	-0.36293	-1.04663	-0./1988	0.00000	
0.2846	0.92995	-0.38693	-1.06050	-0.49338	0.00000	
0.3074	0.92087	-0.41118	-1.06887	-0.23653	0.00000	
0.3302	0.91123	-0.43556	-1.07103	0.05260	0.00000	• · ·
0.3530	0.90103	-0.45991	-1.06622	0.37590	0.00000	. •
0.3757	0.89028	-0.48406	-1.05364	0.73528	0.00000	•
0.3985	0.87899	-0.50783	-1.03244	1.13265	0.00000	
0.4213	0.86716	-0.53101	-1.00175	1.56985	0.00000	
0.4440	0.85481	-0.55337	-0.96063	2.04872	0.00000	
0.4668	0.84196	-0.57467	-0.90812	2.57100	0.00000	
0.4896	0.82865	-0.59464	-0.84320	3.13837	0.00000	
0.5124	0.81490	-0.61297	-0.76483	3.75238	0.00000	•
0.5351	0.80075	-0.62936	, -0.67194	4.41448	0.00000	
0.5579	0.78625	-0.64346	-0.56341	5.12594	0.00000	
0.5693	0.77889	-0.64953	-0.50292	5.50054	0.00000	
0.5779	0.77327	-0.65366	-0.45682	5.20518	0.00000	
0.5951	0.76195	-0.66079	-0.37208	4.63653	0.00000	-
0.6124	0.75051	-0.66654	-0.29689	4.09756	0.00000	
0.6296	0.73899	-0.67107	-0.23072	3.58851	0.00000	
0.6468	0.72740	-0.67454	-0.17307	3.10961	0.00000	
0.6640	0.71575	-0.67708	-0.12340	2.66099	0.00000	
0.6813	0.70407	-0.67883	-0.08120	2.24279	0.00000	
0.6985	0.69237	-0.67992	-0.04595	1.85507	0.00000	
0.7157	0.68065	-0.68045	-0.01711	1.49788	0.00000	
0.7330	0.66892	-0.68054	0.00584	1.17126	0.00000	
0.7502	0.65720	-0.68028	0.02343	0.87520	0.00000	
0.7674	0.64548	-0.67976	0.03617	0.60970	0.00000	
0.7846	0.63378	-0.67906	0.04461	0.37472	0.00000	
0.8019	0.62209	-0.67825	0.04926	0.17025	0.00000	
0.8191	0.61041	-0.67738	0.05065	-0.00376	0.00000	
•						

* PUMPING RING ANALYSIS PROGRAM *

INPUTS ******************* STRING = BABBIT RING A-1-A-1 PO=750 DIMENSIONAL INPUTS ELI = 0.26700000 ± 00 ; EL1I = 0.29800000 ± 00 ; EI = 0.11500000D+00; CI = 0.5000000D-03; CII = 0.0000000D+00; TI = 0.47000000D-01; SI = 0.2000000D+01; RI = 0.37500000D+00; RMUI = 0.88500000D-05; NI = 0.35000000D+02; POI = 0.7500000D+03; PFI = 0.0000000D+00; EMOD = 0.7500000D+07; POIS = 0.3600000D+00;IDIM = 1; AL = 0.66085654D-02; BET = 0.71535454D+01; EPS = 0.43071161D+00; P0 = 0.94464244D-01; EL1 = 0.11161049D+01; PF = 0.0000000D+00; STARV = 0.32041966D+00; C1 = 0.0000000D+00; NDX = 40, 25, 25;NDP = 10, 25, 25;NMAX = 10; NSIG = 4; IPR = 0; ICAV = 2; = 0.81814D+00 -0.69559D+00 XF XB = 0.48845D+00 -0.67281D+00OUTPUTS * ELASTIC SOLUTION * H H' H'' H''' PRES X FORCE 0.23267 -1.00922 0.00000 0.00000 0.00000 1.0000 0.00000 _____ * PUMPING FLOW SOLUTION * . Н' X н'' н''' Н PRES 1.0000 0.71873 -0.93560 0.00000 0.00000 0.00000 * BACK FLOW SOLUTION * Н' н'' н''' X Н PRES 1.0000 0.23267 -1.00922 0.00000 0.00000 0.00000 * FLOWS * NET FLOW STARVED NET FLOW PUMPING XCAV BACK 0.100210D+01 0.232747D+00 0.999927D+00 0.769350D+00 0.329915D+00

INPUTS ************************************	*****	*****	****
STRING = BABBIT RING A-1-A-1 P0=1000	****	*****	****
DIMENSIONAL INPUTS			
ELI = 0.26700000D+00; EL1I = 0.298 EI = 0.11500000D+00; CI = 0.500 C1I = 0.00000000D+00; TI = 0.470 SI = 0.20000000D+01; RI = 0.375 RMUI = 0.88500000D-05; NI = 0.350	00000D+00; 00000D-03; 00000D-01; 00000D+00; 00000D+02;		
POI = 0.1000000D+04; PFI = 0.000 EMOD = 0.7500000D+07; POIS = 0.360	00000D+00; 00000D+00;	****	****
IDIM = 1; AL = 0.66085654D-02; BET = 0.7153 EPS = 0.43071161D+00; P0 = 0.1259 EL1 = 0.11161049D+01; PF = 0.0000 STARV = 0.32041966D+00; C1 = 0.0000 NDX = 40, 25, 25; NDP = 10, 25, 25;	5454D+01; 5233D+00; 0000D+00; 0000D+00;		
NMAX = 10; NSIG = 4; IPR = 0; ICAV = 2; XF = 0.71873D+00 -0.93560D+00 XB = 0.23267D+00 -0.10092D+01 ************************************	****	****	****
OUTPUTS ************************************	*****	****	****
* ELASTIC SC	LUTION *		
X H H' H'' 1.0000 -0.02310 -1.34562 0.00000 1.0000 0.00000 -1.28833 0.00000	H''' 0.00000 (-0.70479 (PRES 0.00000 0.00000	FORCE 0.00000 0.00065
* PUMPING FLOW	SOLUTION *		
Х Н Н'	Н''	Н'''	PRES
1.0000 0.63082 -1.13187	0.00000	0.0000	0.00000
* BACK FLOW S	OLUTION *		
X H H' H'' 1.0000 0.00000 -1.28833 0.00000	H''' -0.70479	PRES 0.00000	FORCE 0.00065
* FLOWS	*		
PUMPING BACK XC 0.929129D+00 0.00000D+00 0.1000	AV Ni 0000+01 0.92	ET FLOW S 29129D+00	TARVED NET FLOW 0.333707D+00

B.4 FORTRAN LISTING

FILE: RING FORTRAN L4 MTI MON 01/20/86 14:39:26 PAGE 1 OF 38

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	PROGRAM RING		RIN00010
CŞ VS			RIN00020
C>			-RIN00030
CNOTE:	XLAM=.739*ELOS**	585 IS NOW BUILT INTO PROGRAM	RIN00040
C			RIN00050
С			RIN00060
С	FUNCTION	- PUMPING RING ANALYSIS PROGRAM	RIN00070
С			RIN00080
С	RESTRICTIONS	- STEADY-STATE ANALYSIS ONLY	RIN00090
С			RIN00100
C	REMARKS	~ VS FORTRAN (FORTRAN 77)	RIN00110
С		IMPLICIT DOUBLE PRECISION REAL*8	RIN00120
С			RIN00130
C	EXTERNAL REFERENCES	-	RIN00140
С	FORTRAN ROUTINES		RIN00150
С		DATAN	RIN00160
С	IMSL ROUTINES		RIN00170
С		ZSCNT ; SOLVES THE SYSTEM OF NON-LINEAR	RIN00180
С		EQUATIONS ; LISTING PROVIDED HEREIN BY	. RIN00190
С		PERMISSION OF IMSL.	RIN00200
С	USER ROUTINES		RIN00210
С		AIN ; COMPUTE INVERSE OF 2X2 MATRIX	RIN00220
С		AMU ; MULTIPLY 2 2X2 MATRICES	RIN00230
С		CALCD ; CALCULATE ELASTIC INFLUENCE	RIN00240
С		COEFFICIENTS C,D	RIN00250
C		CHECK ; FOR MULTIPLE RUNS CHECK INPUTS	RIN00260
С		FOR RECALCULATION OF C,D	RIN00270
С		CONST ; CALCULATE SLIDER BEARING PRESSURE	RIN00280
C		CONSTANTS	RIN00290
С		CONST2 ; SAME AS ABOVE	RIN00300
С		DFN1 ; DERIVATIVE FUNCTION USED BY RUK	RIN00310
С		DFN2; """""	RIN00320
С		DFN3; " " " " "	RIN00330
С		ELAS ; DETERMINE ELASTIC SOLUTION	RIN00340
С		(NO HYDRODYNAMICS)	RIN00350
С		ERRMSG ; PRINT ERROR MESSAGE IF *ZSCNT* NO	TRIN00360
С		CONVERGED	RIN00370
C		EVAL ; DEFINE NON-LINEAR SYSTEM IN H AND H	'RIN00380
C		TO BE SOLVED BY *ZSCNT*	RIN00390
С		P ; PRESSURE FUNCTION	RIN00400
С		PRT ; CONVERT FROM W TO H AND PRINT	RIN00410
С		PRTOUT ; PRINT OUT RESULTS	RIN00420
С		RUK ; RUNGE-KUTTA	RIN00430
С	_		RIN00440
С	INPUT/OUTPUT:		RIN00450
С	UNIT DESCRIPT	FION	RIN00460
С	4 TERMIN	NAL I/O	RIN00470
С	5 INPUT	FILE IN NAMELIST FORMAT	RIN00480
С	6 OUTPUT	F FILE	RIN00490
С			RIN00500
С	INPUT VARIABLE DEFIN	VITIONS	RIN00510
С	* NOTE : (D) INDIO	CATES VARIABLE HAS A DEFAULT VALUE	RIN00520
С			RIN00530
С	NAME DESCRIPT	CION .	RIN00540
C	NAMELIST /INPUTS/		RIN00550

.

С		,		RIN00560
С		STRING	CHARACTER STRING TO IDENTIFY JOB (MAX. 60 CHARS.)	RIN00570
С		. IDIM (D)	TYPE OF INPUT	RIN00580
С			0 - DIMENSIONLESS	RIN00590
С			1 - DIMENSIONAL (ANY CONSISTENT SET OF UNITS)	RIN00600
С		· .		RIN00610
С		DIMENSIONAL IN	PUTS (NOTE: UO=2.*NI*SI)	RIN00620
С				RIN00630
С		NI	FREQUENCY (HZ)	RIN00640
С		SI.	STROKE (L)	RIN00650
С		CI	CLEARANCE (L)	RIN00660
С		ELI	BEARING LENGTH (L)	RIN00670
С		ELII	LENGTH OF NON-BEARING PORTION OF RING (L)	RIN00680
C		EI	LENGTH FROM END OF BEARING PRELOADED WITH POI (L)	RIN00690
C		RI	RING RADIUS (L)	RIN00700
Ċ		TI	RING THICKNESS (L)	RIN00710
č		C11 (D)	BEARING SLOPE	RIN00720
č		POT	PRELOAD PRESSURE $(F/L \star \star 2)$	RIN00730
c		PFT	RESERVOIR PRESSURE (F/L**2)	R1N00740
c		RMIT	LUBRICANT VISCOSITY (FT/L**2)	RTN00750
č		FMOD	RING MODULUS OF FLASTICITY $(F/I \star \star 2)$	RTN00750
č		POIS	RING POISSON'S RATIO	RIN00700
č		1010	KING TOTODON D MATTO	DIN00780
č		NON-DIMENSIONA	IINDUTS	
č		NON-DIMINSIONA	L INFOID	DIN00900
c c		AT	$(TT \pm DT) \pm \pm 2/(12 \pm TT \pm \pm 4 \pm (1 - DOTC) \pm \pm 2))$	DINOOSIO
ĉ		AL BET	(T*RI)***2/(T2**EET***4*(T.=FOID)***2/) (T*PWHIT*HO*PT**2*FTT)/(CT**2*TT*FMOD)	DIN00820
c		FDC	IENCTU FOOM FND OF DEFIOND DO (FT/FIT)	RIN00020
c c		EFJ FI1	LENGIN FROM END OF FRELOAD FO (EI/ELI)	RINUU03U
C C		ELI ELI	LENGIN OF NON-BEARING FORITON OF RING (ELII/ELI)	KINUU04U
c			LIS LAND TO STRUKE ANTIO FOR STARVATION CALCULATIC	DINCINUU0JU
C C		ALAM (D)	MULTIPLIES ELUS FUR INGREASED STARVATION	KINU0800
			DERIGAD DECOMPE (CIANO/(CADMUTAMONETT))ADOT	
	•	PU	PRELUAD PRESSURE (CIAA2/(CARMUIAUUAELI))APUI	RINUUSSU
6		Pr	RESERVOIR PRESSURE (CI**2/(O*RMUI*UU*ELI))*PFI	RINUU890
G	•	NDV(2) (D)	DET TA Y THOREWENTS FOR DUT	KINUU9UU
C		NDX(3) (D)	DELIA X INCREMENTS FOR RUK	RINUU91U
C		NDP(3) (D)		RIN00920
C				R1N00930
C		ICAV (D)	FLAG FOR CALCULATION OF CAVITATION (BACK STROKE)	RIN00940
C			U - NO CAVITATION (NEG. PRESSURES ALLOWED)	RIN00950
С			I - CAVITATION (NO NEG. PRESSURES)	RIN00960
С			2 - FIND ITS OWN SOLUTION	RIN00970
С		IPR (D)	PRINT FLAG	RIN00980
С			0 - SHORT OUTPUT	RIN00990
С	. •	· · · ·	1 - LONGER OUTPUT (PRINT PRESSURE PROFILE)	RIN01000
С		NMAX (D)	MAX. ITERATIONS FOR *ZSCNT*	RIN01010
С		NSIG (D)	NO. OF SIGNIFICANT DIGITS IN ACCURACY	RIN01020
С			OF SOLUTION USING *ZSCNT*	RIN01030
С		XF(2)	INITIAL GUESS FOR H AND H' FOR FORWARD STROKE	RIN01040
С		XB(2)	INITIAL GUESS FOR H AND H' FOR BACKWARD STROKE	RIN01050
С		· .		RIN01060
С			`	RIN01070
C>-				-RIN01080
		IMPLICIT REAL*	8 (A-H,O-Z)	RIN01090
С				RIN01100

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COMMON/BDIM /CI,ELI,CON1,IDIM
                                                                           RIN01110
      COMMON/BPAR /AL, BET, PO, EPS, PF
                                                                           RIN01120
      COMMON/BCD
                   /XLOC(100),C(100),D(100),NDX(3),NDP(3),DX(3),DP(3)
                                                                           RIN01130
      COMMON/BCOEFF/RK,RC,R1,R2,XCAV,ICAV
                                                                           RIN01140
      COMMON/BINT /IELAS, IBACK, IPR
                                                                           RIN01150
      COMMON/BLAST /X1LAST,X2LAST,F1LAST,F2LAST
                                                                           RIN01160
      COMMON/BELAS /FORCE, HELAS, H1ELAS, H2ELAS, H3ELAS, W1(4), W2(4)
                                                                           RIN01170
      COMMON/BPROF /C1
                                                                           RIN01180
      COMMON/BFLAG /IFLAG, IPLOAD
                                                                           RIN01190
                                                                           RIN01200
      DIMENSION PAR(1), XX(2), XF(2), XB(2), WK(68)
                                                                           RIN01210
      REAL*8
                NFLOW, NI
                                                                           RIN01220
      CHARACTER*60 STRING
                                                                           RTN01230
      LOGICAL
                RECALC
                                                                           RIN01240
      EXTERNAL EVAL, EVAL3, EVAL4
                                                                           RIN01250
      NAMELIST
                /INPUTS/
                                                                           RIN01260
                                                                           RIN01270
      DIMENSIONAL INPUTS
                                                                           RIN01280
                                                                           RIN01290
     + STRING, NI, SI, Cli, CI, RMUI, ELI, POI, PFI, EI, ELLI, RI, TI, EMOD, POIS
                                                                           RIN01300
                                                                           RIN01310
      NON-DIMENSIONAL INPUTS
                                                                           RIN01320
                                                                           RIN01330
     +,BET,PO,EPS,AL,EL1,ELOS,XLAM,
                                                                           RIN01340
     +NDX,NDP,PF,NMAX,IPR,NSIG,ICAV,XF,XB,C1,IDIM
                                                                           RIN01350
                                                                           RIN01360
      PI=4.*DATAN(1.D0)
                                                                           RIN01370
                                                                           RIN01380
      DEFAULTS
                                                                           RIN01390
                                                                           RIN01400
      IDIM=0
                                                                           RIN01410
      ELOS=0.
                                                                           RIN01420
      XLAM=1.
                                                                           RIN01430
      C1I=0.
                                                                           RIN01440
      C1=0.
                                                                           RIN01450
      NDX(1)=40
                                                                           RIN01460
      NDX(2)=25
                                                                           RIN01470
      NDX(3)=25
                                                                           RIN01480
      NDP(1)=10
                                                                           RIN01490
      NDP(2)=25
                                                                           RIN01500
      NDP(3)=25
                                                                           RIN01510
      NMAX=10
                                                                           RIN01520
      NSIG=4
                                                                           RIN01530
      ICAV=2
                                                                           RIN01540
      IPR=0
                                                                           RIN01550
С
                                                                           RIN01560
      IRUN=0
                                                                           RIN01570
2001
      READ(05, INPUTS, END=2000)
                                                                           RIN01580
С
                                                                           RIN01590
      IRUN=IRUN+1
                                                                           -RIN01600
      WRITE(6, '(''1* PUMPING RING ANALYSIS PROGRAM *''./)')
                                                                           RIN01610
      WRITE(6, '('' INPUTS'')')
                                                                           RIN01620
      WRITE(6,'(1X,72(''*''))')
                                                                           RIN01630
      WRITE(6, '('' STRING = '', A60)') STRING
                                                                           RIN01640
      WRITE(6,'(1X.72(''*''))')
                                                                           RIN01650
```

C

IF(IDIM.NE.O)THEN	RTN01660
WRITE(6.'('' DIMENSIONAL INPUTS''./)')	RIN01670
WRITE(6, '('' ELT =''.E15.8.'': ELT =''.E15.8.'':')')	RTN01680
+ELI.ELII	RIN01690
WRITE(6.'('' ET =''.E15.8.'': CT =''.E15.8.'':')')ET.C	TRIN01700
WRITE(6.'(''CIT =''.E15.8.'': TT =''.E15.8.'':')')	RIN01710
+C1I.TI	RTN01720
WRITE(6.'('' ST =''.E15.8.'': RT =''.E15.8.'':')')ST.R	TRTN01730
WRITE(6.'('' RMUT =''.E15.8.'': NT =''.E15.8.'':')')	RTN01740
+RMUI.NI	RIN01750
WRITE(6.'('' '')')	RIN01760
WRITE(6.'('' POT =''.E15.8.'': PFT =''.E15.8.'':')')	RIN01770
+POI_PFI	RTN01780
WRITE(6.'('' EMOD =''.E15.8.'': POIS =''.E15.8.'':')')	RIN01790
+EMOD_POIS	RTN01800
WRITE(6.!(1x.72(!'*!'))')	RTN01810
U0=2.*NI*ST	RTN01820
CON1=6.*RMUT*U0*ELT/CI**2	RIN01830
ELOS=ELI/ST	RTN01840
AL=(TI*(RI+TI*.5))**2/12./ELI**4/(1POIS**2)	RTN01850
BET=CON1*(RI+TI*.5)**2/CI/TI/FMOD	RIN01860
EPS=ET/RLT	RTN01870
ELI=ELIT/ELT	RIN01070
C1=C1T/CT*FLT	RINOISOO
P0=P0T/CON1	RINO1090
PF=PFT/CON1	RIN01900
END IF	RIN01910
IF(ELOS, GT, 1, D-5) XIAM = .739/ELOS ** .585	RIN01920
STARV=ELOS*XLAM	RTN01940
WRITE(6.'('' TDIM =''. $(2, '', '')$)TDIM	RIN01940
WRITE(6.'('' $\Delta T_{1} = 1', E15, 8, 1'; BET_{2} = 1', E15, 8, 1'; 1')) \Delta T_{1}, BET_{2}$	RIN01950
WRITE(6.'('' EPS = ''.E15.8.'': P0 = ''.E15.8.'':'))EPS.P0	RIN01900
WRITE(6.'('' EL1 =''.E15.8.'': PF =''.E15.8.'':')')EL1 PF	RIN01980
WRITE(6.'('' STARV =''.E15.8.'': C1 =''.E15.8.'':'))STARV.C1	KINGI JOU
	RTN01990
WRITE(6,'('' '')')	RIN01990 RIN02000
WRITE(6,'('' '')') WRITE(6,'('' NDX =''.I5,''.''.I5,''.''.I5,'':'')')NDX	RIN01990 RIN02000 RIN02010
WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,'','',I5,'','',I5,'';'')NDP	RIN01990 RIN02000 RIN02010 RIN02020
WRITE(6,'('' '')') WRITE(6,'('' NDX ='',15,'','',15,'',15,'';'')')NDX WRITE(6,'('' NDP ='',15,'','',15,'','',15,'';'')')NDP WRITE(6,'('' '')')	RIN01990 RIN02000 RIN02010 RIN02020 BIN02030
WRITE(6,'('' '')') WRITE(6,'('' NDX ='',15,'','',15,'','',15,'';'')')NDX WRITE(6,'('' NDP ='',15,'','',15,'','',15,'';'')')NDP WRITE(6,'('' NMAX ='',15,''; NSIG ='',15,'';'')')NMAX.NSIG	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040
WRITE(6,'(''')') WRITE(6,'(''NDX ='',15,'','',15,'','',15,'';'')')NDX WRITE(6,'(''NDP ='',15,'','',15,'','',15,'';'')')NDP WRITE(6,'(''NMAX ='',15,''; NSIG ='',15,'';'')')NMAX,NSIG WRITE(6,'(''IPR ='',15,''; ICAV ='',15,'';'')')IPR,ICAV	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02050
WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,'','',I5,'','',I5,'';'')')NDP WRITE(6,'('' NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='',2E15,5)')XF(1),XF(2)	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02050 RIN02060
WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,'','',I5,'','',I5,'';'')')NDP WRITE(6,'('' NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='',2E15.5)')XB(1).XB(2)	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02050 RIN02060 RIN02070
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='', I5,'','', I5,'','', I5,'';'')')NDX WRITE(6,'('' NDP ='', I5,'', '', I5,'', '', I5,'';'')')NDP WRITE(6,'('' NMAX ='', I5,''; NSIG ='', I5,''; '')')NMAX,NSIG WRITE(6,'('' IPR ='', I5,''; ICAV ='', I5,'';'')')IPR, ICAV WRITE(6,'('' XF ='', 2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='', 2E15.5)')XB(1),XB(2) WRITE(6,'(''x''),/)')</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02040 RIN02050 RIN02060 RIN02070 RIN02080
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='', I5,'','', I5,'','', I5,'';'')')NDX WRITE(6,'('' NDP ='', I5,'', '', I5,'', '', I5,'';'')')NDP WRITE(6,'('' NMAX ='', I5,''; NSIG ='', I5,''; '')')NMAX,NSIG WRITE(6,'('' IPR ='', I5,''; ICAV ='', I5,'';'')')IPR, ICAV WRITE(6,'('' XF ='', 2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='', 2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')')</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02040 RIN02050 RIN02060 RIN02060 RIN02070 RIN02080 RIN02090
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='', I5,'','', I5,'','', I5,'';'')')NDX WRITE(6,'('' NDP ='', I5,'', I5,'', I5,'';'')')NDP WRITE(6,'('' NMAX ='', I5,''; NSIG ='', I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='', I5,''; ICAV ='', I5,'';'')')IPR, ICAV WRITE(6,'('' XF ='', 2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='', 2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')')</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02050 RIN02050 RIN02060 RIN02070 RIN02080 RIN02090 RIN02100
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='', I5,'','', I5,'','', I5,'';'')')NDX WRITE(6,'('' NDP ='', I5,'', I5,'', I5,'';'')')NDP WRITE(6,'('' NMAX ='', I5,''; NSIG ='', I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='', I5,''; ICAV ='', I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='', 2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='', 2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')') WRITE(6,'('', 72(''*''))')</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02040 RIN02050 RIN02060 RIN02070 RIN02080 RIN02090 RIN02100 RIN02110
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,'',I5,'','',I5,'';'')')NDP WRITE(6,'('' NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')') IFLAG=0</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02030 RIN02040 RIN02050 RIN02050 RIN02050 RIN02070 RIN02080 RIN02090 RIN02100 RIN02110 RIN02120
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,'',I5,'',I5,'';'')')NDP WRITE(6,'('' NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('' AUT ='',I5,'')') WRITE(6,'('' AUT ='',I5,'')') IFLAG=0 IF(0LT.EPS,AND.EPS.LT.1.)THEN</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02040 RIN02050 RIN02050 RIN02050 RIN02050 RIN02070 RIN02090 RIN02090 RIN02100 RIN02110 RIN02120 RIN02130
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='', I5,'','', I5,'','', I5,'';'')')NDX WRITE(6,'('' NDP ='', I5,'', I5,'', I5,'';'')')NDP WRITE(6,'('' NMAX ='', I5,''; NSIG ='', I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='', I5,''; ICAV ='', I5,'';'')')IPR, ICAV WRITE(6,'('' XF ='', 2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='', 2E15.5)')XB(1),XB(2) WRITE(6,'('' AUA ='', I5,'';')') WRITE(6,'('', AUA ='', I5,'';')') IFLAG=0 IF(0LT.EPS.AND.EPS.LT.1.)THEN IFLAG=1</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02090 RIN02100 RIN02100 RIN02120 RIN02130 RIN02140
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,''; NSIG ='',I5,'';'')')NDP WRITE(6,'('' NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')') IFLAG=0 IF(0LT.EPS.AND.EPS.LT.1.)THEN IFLAG=1 DX(1)=EL1/FLOAT(NDX(1))</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02090 RIN02100 RIN02110 RIN02120 RIN02130 RIN02140 RIN02150
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,'', I5,'',I5,'';'')')NDP WRITE(6,'('' NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')') IFLAG=0 IF(0LT.EPS.AND.EPS.LT.1.)THEN IFLAG=1 DX(1)=EL1/FLOAT(NDX(1)) DP(1)=EL1/FLOAT(NDP(1))</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02040 RIN02050 RIN02050 RIN02060 RIN02060 RIN02070 RIN02080 RIN02090 RIN02100 RIN02100 RIN02110 RIN02120 RIN02130 RIN02140 RIN02150 RIN02160
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,''; NSIC ='',I5,'';'')')NDP WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' ADL EPS.LT.1.)THEN IFLAG=0 IF(0LT.EPS.AND.EPS.LT.1.)THEN IFLAG=1 DX(1)=EL1/FLOAT(NDX(1)) DP(1)=EL1/FLOAT(NDX(1)) DX(2)=(1EPS)/FLOAT(NDX(2))</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02100 RIN02110 RIN02120 RIN02130 RIN02140 RIN02150 RIN02160 RIN02170
<pre>WRITE(6,'('' '')') WRITE(6,'('' NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'('' NDP ='',I5,''; NSIG ='',I5,'';'')')NDP WRITE(6,'('' NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'('' IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'('' XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'('' XB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('' AB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('' OUTPUTS'')') WRITE(6,'('' OUTPUTS'')') WRITE(6,'('',72(''*''))') IFLAG=0 IF(0LT.EPS.AND.EPS.LT.1.)THEN IFLAG=1 DX(1)=EL1/FLOAT(NDX(1)) DP(1)=EL1/FLOAT(NDX(1)) DP(1)=EL1/FLOAT(NDX(2)) DP(2)=(1EPS)/FLOAT(NDX(2)) </pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02040 RIN02050 RIN02050 RIN02050 RIN02050 RIN02070 RIN02090 RIN02090 RIN02100 RIN02120 RIN02130 RIN02140 RIN02140 RIN02150 RIN02160 RIN02170 RIN02180
<pre>WRITE(6,'(''')') WRITE(6,'(''NDX ='',I5,'','',I5,'','',I5,'';'')')NDX WRITE(6,'(''NDP ='',I5,'';'I5,'','',I5,'';'')')NDP WRITE(6,'(''NMAX ='',I5,''; NSIG ='',I5,'';'')')NMAX,NSIG WRITE(6,'(''IPR ='',I5,''; ICAV ='',I5,'';'')')IPR,ICAV WRITE(6,'(''XF ='',2E15.5)')XF(1),XF(2) WRITE(6,'(''XB ='',2E15.5)')XB(1),XB(2) WRITE(6,'(''AB ='',2E15.5)')XB(1),XB(2) WRITE(6,'('AB ='',2E15.5)')YB(1),XB(2) UR(1)=EL1/FLOAT(NDX(1)) DP(1)=EL1/FLOAT(NDX(1)) DP(1)=EL1/FLOAT(NDX(2)) DP(2)=(1EPS)/FLOAT(NDX(2)) DX(3)=EPS/FLOAT(NDX(3))</pre>	RIN01990 RIN02000 RIN02010 RIN02020 RIN02030 RIN02040 RIN02040 RIN02050 RIN02050 RIN02050 RIN02050 RIN02050 RIN02070 RIN02090 RIN02100 RIN02120 RIN02130 RIN02140 RIN02150 RIN02160 RIN02180 RIN02190

132

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RIN02210
ELSE IF(EPS.EQ.1.)THEN
   IFLAG=2
                                                                    RIN02220
                                                                    RIN02230
   DX(1) = EL1/FLOAT(NDX(1))
                                                                    RIN02240
   DP(1)=EL1/FLOAT(NDP(1))
   DX(2)=1./FLOAT(NDX(2))
                                                                    RIN02250
   DP(2)=1./FLOAT(NDP(2))
                                                                    RIN02260
                                                                    RIN02270
   DX(3)=0.
                                                                    RIN02280
   DP(3)=0.
ELSE IF(1..LT.EPS.AND.EPS.LT.EL1+1)THEN
                                                                    RIN02290
   IFLAG=3
                                                                    RIN02300
                                                                    RIN02310
   DX(1) = (EL1+1, -EPS)/FLOAT(NDX(1))
   DP(1)=(EL1+1.-EPS)/FLOAT(NDP(1))
                                                                    RIN02320
   DX(2) = (EPS-1.)/FLOAT(NDX(2))
                                                                     RIN02330
   DP(2)=(EPS-1.)/FLOAT(NDP(2))
                                                                    RIN02340
   DX(3)=1./FLOAT(NDX(3))
                                                                     RIN02350
   DP(3)=1./FLOAT(NDP(3))
                                                                    RIN02360
ELSE IF(EPS.EO.1.+EL1)THEN
                                                                     RIN02370
                                                                     RIN02380
   IFLAG=4
   DX(1)=EL1/FLOAT(NDX(1))
                                                                     RIN02390
   DP(1)=EL1/FLOAT(NDP(1))
                                                                     RIN02400
   DX(2)=1./FLOAT(NDX(2))
                                                                     RIN02410
   DP(2)=1./FLOAT(NDP(2))
                                                                     RIN02420
                                                                     RIN02430
   DX(3)=0.
   DP(3)=0.
                                                                     RIN02440
                                                                    RIN02450
END IF
IF(IFLAG.EQ.0)STOP
                                                                    RIN02460
                                                                    RIN02470
CALL CHECK(AL, BET, EPS, EL1, NDX, NDP, IRUN, RECALC)
                                                                    RIN02480
IF(RECALC)THEN
                                                                     RIN02490
   IF(IFLAG.LE.2)THEN
                                                                     RIN02500
                                                                     RIN02510
      CALL CALCD
                                                                     RIN02520
   ELSE IF(IFLAG.EQ.3)THEN
                                                                     RIN02530
      CALL CALCD3
                     .
   ELSE IF(IFLAG.EQ.4)THEN
                                                                     RIN02540
      CALL CALCD4
                                                                     RIN02550
                                                                     RIN02560
   END IF
ELSE
                                                                     RIN02570
   WRITE(6,'(20X,'' * NOTE: C,D NOT RECALCULATED ! *'')')
                                                                     RIN02580
                                                                     RIN02590
END IF
                                                                     RIN02600
ELASTIC ANALYSIS
                                                                     RIN02610
                                                                     RIN02620
WRITE(6,'('','',72(''-''))')
                                                                     RIN02630
WRITE(6, '(26X, '' * ELASTIC SOLUTION *'', /)')
                                                                     RIN02640
CALL ELAS
                                                                     RIN02650
                                                                     RIN02660
STEADY STATE ANALYSIS
                                                                     RIN02670
                                                                     RIN02680
                                                                     RIN02690
IELAS=0
                                                                     RIN02700
FORWARD FLOW SOLUTION
                                                                     RIN02710
                                                                     RIN02720
IBACK=0
                                                                     RIN02730
WRITE(6,'('' '',72(''-''))')
                                                                     RIN02740
WRITE(6, '(23X, '' * PUMPING FLOW SOLUTION *'', /)')
                                                                     RIN02750
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	IF(XF(1)**2+XF(2)**2.LT.1.D-5)THEN	RIN02760
	XX(1)=1HELAS+.01	RIN02770
	XX(2)=C1-H1ELAS+.01	RIN02780
	ELSE	RTN02790
	XX(1)=1,-XF(1)	RTN02800
	YX(2) = C1 - XF(2)	RIN02000
		DTN02820
	TRATELAC IR 2)THEN	DIN02020
	CALL ZSCHT(FVAL NELC 2 NMAY DAD YY FNODM UP TED)	
	FIGE IF(IFLAC FO 3)THEN	DIN02850
	CALL ZSCNT(FVAL3 NSTC 2 NMAY PAR XY FNORM WE TER)	RIN02850
	RISE IP(IFLAC.EO.4)THEN	RIN02000
	CALL ZSCNT(FVALA NSIC 2 NMAY DAR YY FNORM UK TER)	PIN02880
	RND TF	RTN02800
	TRETTR NE ADCATT FRANSC	DIN02090
	CALL PRTOUT(YY)	PTN02010
	YF(1)=1 -YY(1)	RIN02910
. •	AR(1) = 1 + AR(1) VE(2) = (1 - YY(2))	RIN02920 DIN02020
•		
c		RIN02940 DIN02050
c	RACK FLOW SOLUTION	RINUZ9JU DINO2060
C .	BACK FLOW SOLUTION	DINO2070
L L		RIN02970
	$\frac{1}{10} \frac{1}{10} \frac$	RIN02900
	WRITE(0, (1, 25), 22, 3, 27, 3, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7,	RIN02330
	VR(1)**2+VR(2)**2 IT 1 D=5)THEN	
	$\frac{YY(1)=1 - HFIAS}{YY(1)=1 - HFIAS}$	DIN03010
	xx(1)=1. HERE	
• •		DINO3040
	yy(1)=1 - yB(1)	DTN03050
	xx(1) = 1 - xB(1) xx(2) = 1 - xB(2)	PINO3060
		DIN03070
		RIN03070
· ·	TR(FORCE.LT.1.D-8)THEN	RTN03000
	TF(TFLAG.LE.2)THEN	RIN03100
	CALL ZSCNT (FVAL NSTC 2 NMAY DAR YY ENORM UK TED)	AINO3110
	FLSE IF(IFLAG. FO. 3)THEN	DIN03120
	CALL ZSCNT(EVAL3.NSTG. 2. NMAX PAR XX ENORM WK TER)	RIN03120
	FLSE IF(IFLAG. FO. 4)THEN	RIN03140
	CALL ZSCNT(EVAL4.NSIG.2.NMAX.PAR.XX.FNORM.WK.IFR)	RIN03150
	END IF	RIN03160
	TF(TER.NE.O)CALL ERRMSG	RIN03170
	BFLOW=RK	RIN03180
	END IF	RIN03100
	CALL PRTOUT(XX)	RIN03200
	XB(1)=1XX(1)	RIN03210
	XB(2)=C1-XX(2)	RIN03220
с		RTN03230
-	WRITE(6.'('' ''.72(''-''))')	RIN03240
3000	CONTINUE	RIN03250
	NFLOW=FFLOW-BFLOW	RIN03260
	WRITE(6, '(32X, ''* FLOWS *'', /)')	RTN03270
	WRITE(6.'(5X.''PUMPING''. 10X.''RACK''. 11X.''YCAV'' QY	RINGSZIO
	+ .''NET FLOW''.3X.''STARVED NET FLOW''.)')	RINUJZOU
	SFLOW=NFLOW	RINGS200

134

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DHSTV-ENG(2) RIN03320 IF(IBACK.EQ.1.AND.FORCE.GT.1.D-8)THEN RIN03330 XGAV=1. RIN03300 HSTV=HELAS RIN03300 DHSTV=HELAS RIN03370 IF(XGAV.GT.1.D-6.AND.XCAV.LT.1.000001)SFLOW=FFLOW*(1.+ RIN03370 IF(XGAV.GT.1.D-6.AND.XCAV.LT.1.000001)SFLOW=FFLOW*(1.+ RIN03370 HKITE(6,'(SEL5.6)')FFLOW,BFLOW RIN03390 WRITE(6,'(SEL5.6)')FFLOW,BFLOW RIN03400 + ,XCAV,NFLOW,SFLOW WRITE(6,'(IX,72(''*''),/)') RIN03400 COTO 2001 CALL EXIT RIN03400 SUBROUTINE AIN(A,B) RIN03400 C FUNCTION - CALCULATE INVERSE OF 2X2 MATRIX RIN03400 C RESTRICTIONS - RIN03500 C RESTRICTIONS - RIN03500 C REMARKS - RIN03500 C REMARKS - RIN03500 C REMARKS - RIN03500 C A INPUT MATRIX (INVERSE OF A) RIN03500 C MAME DESCRIPTION RIN03500 C MAME DESCRIPTION RIN03500 C MAME DESCRIPTION RIN03500 C MAME DESCRIPTION RIN03500 C A INPUT MATRIX (INVERSE OF A) RIN03600 C HUNCTION A INPUT MATRIX (INVERSE OF A) RIN03500 C MAME DESCRIPTION RIN03500 C A INPUT MATRIX (INVERSE OF A) RIN03500 C MAME DESCRIPTION RIN03500 C A INPUT MATRIX (INVERSE OF A) RIN03500 C MAME DESCRIPTION RIN03500 C A INPUT MATRIX (INVERSE OF A) RIN03500 C HUNCICI RIN03500 C A INPUT MATRIX (INVERSE OF A) RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03600 C HUNCICI RIN03500 C A INPUT MATRIX (INVERSE OF A) RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03600 C A INPUT MATRIX (INVERSE OF A) RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03600 C A INPUT MATRIX (INVERSE OF A) RIN03600 C HUPLICIT REAL*8 (A-H,O-Z) RIN03600 DIMENSION A(2,2),B(2,2) RIN03600 DA(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03600 B(2,1)=-A(2,1)/D RIN03700 R(2,1)=-A(2,1)/D RIN03700 RIN03710 RETURN RIN03710 RETURN		HSTV=XB(1)			RIN03310
IF(IBACK.EQ.1.AND.FORCE.GT.1.D-8)THEN RIN03340 XCAV=1. RIN03350 HSTV=HELAS RIN03350 DHSTV=HELAS RIN03350 DHSTV=HELAS RIN03370 IF(XCAV.GT.1.D-6.AND.XCAV.LT.1.000001)SFLOW=FFLOW*(1.+ RIN03380 +2.*ELOS*KLAM*XCAV*2*DHSTV(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03400 + XCAV,NFLOW,SFLOW RIN03400 WRITE(6,'(SL5.6')'PFLOUW,BFLOW RIN03400 + XCAV,NFLOW,SFLOW RIN03400 COTO 2001 RIN03430 COTO 2001 RIN03400 COTO 2001 RIN03400 COTO 2001 RIN03400 C RIN03500 C RIN03500 <td< th=""><th></th><th>DHSTV=XB(2)</th><th>_</th><th></th><th>RIN03320</th></td<>		DHSTV=XB(2)	_		RIN03320
XCAV=1. RIN03360 HSTV=HELAS RIN03350 DHSTV=H1ELAS RIN03360 END IF RIN03360 FXCAV.GT.1.D=6.AND.XCAV.LT.1.000001)SFLOW=FFLOW*(1.+ RIN03300 *2.*ELOS*KLAM*XCAV**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03300 wRITE(6,'(5E15.6)')FPLOW,BFLOW RIN03400 *2.*ELOS*KLAM*XCAV**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03400 wRITE(6,'(1X,72(''*''),/)') RIN03400 cOTO 2001 RIN03400 cOTO 2001 RIN03400 cOTO 2001 RIN03400 cOTO 2001 RIN03400 cott END RIN03500 cott ENTERICTION CALCULATE INVERSE OF 2X2 MATRIX <th></th> <th>IF(IBACK.EQ.1</th> <th>AND.FORCE.GT.1.D-8)THEN</th> <th></th> <th>RIN03330</th>		IF(IBACK.EQ.1	AND.FORCE.GT.1.D-8)THEN		RIN03330
HSTV=HELAS RIN03350 DESTV=HIELAS RIN03360 END IF RIN03370 IF(XCAV.CT.1.D=6.AND.XCAV.LT.1.000001)SFLOW=FFLOW*(1.+ RIN03370 #2.*ELOS*XLAM*XCAV*2*DHSTV/(2.*HSTV=DHSTV*(2XCAV)))=BFLOW RIN03390 wRITE(6,'(5E15.6)')FFLOW,BFLOW RIN03400 + ,XCAV,NFLOW,SFLOW RIN03420 GOTO 2001 RIN03420 GOTO 2001 RIN03430 ZOOC CALL EXIT RIN03400 END RIN03450 SUBROUTINE AIN(A,B) RIN03460 C RIN0350 C RIN0350 C RESTRICTIONS C REMARKS C REMARKS C REMARKS C REMARKS		XCAV=1.			RIN03340
DHSTV=HIELAS RIN03360 END IF RIN03370 IF(XCAV.GT.1.D-6.AND.XCAV.LT.1.000001)SFLOW=FFLOW*(1.+ RIN03300 +2.*ELOS*XLAM*XCAV**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03400 +2.*ELOS*XLAM*XCAV**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03400 + ,XCAV,NFLOW,SFLOW RIN03400 + ,XCAV,NFLOW,SFLOW RIN03400 COTO 2001 RIN03400 COTO 2001 RIN03400 COTO 2001 RIN03400 SUBROUTINE AIN(A,B) RIN03460 C RIN0350 C FUNCTION C FUNCTION <th></th> <th>HSTV=HELAS</th> <th></th> <th></th> <th>RIN03350</th>		HSTV=HELAS			RIN03350
END IF RIN03370 IF(XGAV.GT.1.D-6.AND.XCAV.LT.1.000001)SFLOW=FFLOW*(1.+ RIN03380 +2.*ELOS*XLAM*XCAV**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03300 +2.*ELOS*XLAM*XCAV**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03400 + XCAV,NFLOW,SFLOW RIN03400 wHITE(6,'(1X,72(''*''),/)') RIN03400 COTO 2001 RIN03400 2000 CALL EXIT END RIN03450 SUBROUTINE AIN(A,B) RIN03460 C RIN03500 C RESTRICTIONS C RIN03500 C REMARKS C RIN03500 C RIN03500 C RIN03500 C RUN03500 C RESTRICTIONS C RIN03500		DHSTV=H1ELAS			RIN03360
IF(XCAV.GT.1.D-6.AND.XCAV,LT.1.000001)SFLOW=FFLOW*(1.+ RIN0380 +2.*ELOS*XLAM*XCAV**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03300 wRITE(6,'(5EL5.6)')FFLOW,BFLOW RIN03400 wRITE(6,'(1X,72(''*''),/)') RIN03400 cOTO 2001 CALL EXIT RIN03400 END RIN03400 SUBROUTINE AIN(A,B) RIN03400 C		END IF			RIN03370
+2.*ELOS*XLAM*XC4V*2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW RIN03400 WRITE(6,'(5E15.6)')FFLOW,BFLOW RIN03400 + ,XCAV,NFLOW,SFLOW RIN03400 WRITE(6,'(1X,72(''*''),/)') RIN03400 GOTO 2001 RIN03430 2000 CALL EXIT RIN034400 END RIN03450 SUBROUTINE AIN(A,B) RIN03460 C>		IF(XCAV.GT.1.D-6	AND.XCAV.LT.1.000001)SFLOW=FFLOW*	(1.+	RIN03380
WRITE(6, '(SE15.6) ') FPLOW, BFLOW RIN03400 + XCAV, NFLOW, SFLOW RIN03410 WRITE(6, '(IX, 72(''x''), /)') RIN03420 GOTO 2001 RIN03430 2000 CALL EXIT RIN03460 END RIN03450 SUBROUTINE AIN(A, B) RIN03460 C RIN03500 C RESTRICTIONS C REMARKS C RIN03550 C REMARKS C RIN03550 C A INPUT MATRIX C A INPUT MATRIX C RIN03600 C A INPUT MATRIX (INVERSE OF A) <		+2.*ELOS*XLAM*XCA	**2*DHSTV/(2.*HSTV-DHSTV*(2XCAV)))-BFLOW	RIN03390
+ ,XCAV, MPLOW, SFLOW RIN03410 WRITE(6, '(1X, 72(''*'), /)') RIN03420 GOTO 2001 RIN03430 2000 CALL EXIT RIN03440 END RIN03450 SUBROUTINE AIN(A, B) RIN03460 C RIN03470 C RIN03460 C RIN03470 C RIN03460 C RESTRICTIONS C REMARKS		WRITE(6,'(5E15.6)	')FFLOW, BFLOW	· · · ·	RIN03400
wRITE(6,'(1X,72(''*''),/)') RIN03420 GOTO 2001 RIN03440 2000 CALL EXIT RIN03440 END RIN03450 SUBROUTINE AIN(A,B) RIN03460 C RIN03470 C RIN03460 C RIN03500 C RESTRICTIONS C REMARKS C REMARKS C REMARKS C REMARKS C RETERNAL REFERENCES - NONE C RIN03500 C A O NAME DESCRIPTION RIN03500 C A INPUT MATRIX RIN03600 <tr< th=""><th></th><th>+ ,XCAV,NFLOW,SI</th><th>LOW</th><th></th><th>RIN03410</th></tr<>		+ ,XCAV,NFLOW,SI	LOW		RIN03410
COTO 2001 RIN03430 2000 CALL EXIT RIN03440 END RIN03450 SUBROUTINE AIN(A,B) RIN03460 C RIN03460 C>		WRITE(6,'(1X,72('	'*''),/)')		RIN03420
2000 CALL EXIT RIN03460 END RIN03460 SUBROUTINE AIN(A,B) RIN03460 C RIN03500 C RESTRICTIONS C REMARKS C REMARKS C REMARKS C REMARKS C REMARKS C REMARKS C RIN03550 C ACUMENT DEFINITION: C ACUMENT DEFINITION: C A DUTPUT MATRIX RIN03560 C A C A DUTPUT MATRIX RIN03610 C RIN03620 C RIN0360		GOTO 2001			RIN03430
END RIN03450 SUBROUTINE AIN(A,B) RIN03460 C RIN03470 C RIN03480 C RIN03490 C FUNCTION - CALCULATE INVERSE OF 2X2 MATRIX RIN03500 C RESTRICTIONS - RIN03520 C RESTRICTIONS - RIN03520 C REMARKS - RIN03520 C REMARKS - RIN035500 C REMARKS - RIN03550 C REMARKS - RIN035500 C EXTERNAL REFERENCES - NONE RIN03560 C ARGUMENT DEFINITION: RIN03580 C ARGUMENT DEFINITION: RIN03580 C A INPUT MATRIX (INVERSE OF A) RIN03610 C BOUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03600 RIN03600 C C RIN03600 C RIN03600 RIN03600 C RIN03600 RIN03600	2000	CALL EXIT			RIN03440
SUBROUTINE AIN(A,B) RIN03460 C RIN03470 C RIN03480 C RIN03490 C FUNCTION C CALCULATE INVERSE OF 2X2 MATRIX RIN03500 RIN03500 C RESTRICTIONS C RESTRICTIONS C REMARKS C RIN03520 C REMARKS C RIN03550 C RETRINITIONS C REMARKS C RIN03550 C REMARKS C RIN03550 C REXTERNAL REFERENCES - NONE C ARCUMENT DEFINITION: C ARCUMENT DEFINITION: C ARCUMENT MATRIX C RIN03580 C A DESCRIPTION RIN03590 C A INPUT MATRIX RIN03610 C RIN03600 C RIN03600 C RIN03600		END			RIN03450
C>		SUBROUTINE AIN(A	в)		RIN03460
C RIN03480 C FUNCTION - CALCULATE INVERSE OF 2X2 MATRIX RIN03500 C RESTRICTIONS - RIN03510 C RESTRICTIONS - RIN03520 C REMARKS - RIN03540 C REMARKS - RIN03550 C REMARKS - RIN03550 C EXTERNAL REFERENCES - NONE RIN03550 C EXTERNAL REFERENCES - NONE RIN03570 C ARGUMENT DEFINITION: RIN03570 C ARGUMENT DEFINITION: RIN03590 C A INPUT MATRIX RIN03610 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C C RIN03620 RIN03620 C C RIN03640 RIN03640 C DUTPUT MATRIX (INVERSE OF A) RIN03660 RIN03640 C RIN03620 RIN03660 RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03690 RIN036700 B(1,2)=-A(1,2)/D	C>				-RIN03470
C RIN03490 C FUNCTION - CALCULATE INVERSE OF 2X2 MATRIX RIN03500 C RESTRICTIONS - RIN03510 C RESTRICTIONS - RIN03520 C REMARKS - RIN03540 C REMARKS - RIN03540 C REMARKS - RIN03540 C EXTERNAL REFERENCES - NONE RIN03550 C ARGUMENT DEFINITION: RIN03560 C ARGUMENT DEFINITION: RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03600 RIN03620 RIN03630 C MENDION A(2,2),B(2,2) RIN03650 RIN03650 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 RIN03650 B(2,2)=A(1,1)/D RIN03690 R(1,2)=-A(1,2)/D RIN03710 B(1,2)=-A(1,2)/D RIN03710 RIN03710 RETURN RIN03710 RIN03730	c	• *			RIN03480
C FUNCTION - CALCULATE INVERSE OF 2X2 MATRIX RIN03500 C RESTRICTIONS - RIN03510 C RESTRICTIONS - RIN03520 C REMARKS - RIN03530 C REMARKS - RIN03540 C EXTERNAL REFERENCES - NONE RIN03560 C EXTERNAL REFERENCES - NONE RIN03560 C ARGUMENT DEFINITION: RIN03570 C ARGUMENT DEFINITION: RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03600 C RIN03600 RIN03620 RIN03620 C MENDISION A(2,2), B(2,2) RIN03660 RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 RIN03660 B(2,2)=A(1,1)/D RIN03670 RIN036700 B(1,2)=-A(1,2)/D RIN03710 RIN03710 RETURN RIN03720 RIN03720 END RIN03720 RIN03720	C		· · ·		RIN03490
C RESTRICTIONS - RIN03510 C REMARKS - RIN03520 C REMARKS - RIN03540 C REMARKS - RIN03540 C REMARKS - RIN03540 C REMARKS - RIN03540 C REMARKS - RIN03560 C EXTERNAL REFERENCES - NONE RIN03570 C ARGUMENT DEFINITION: RIN03570 C ARGUMENT DESCRIPTION RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03620 RIN03620 RIN03650 C MINDIGO RIN03650 RIN03650 DIMENSION A(2,2),B(2,2) RIN03650 RIN03650 RIN03650 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03650 RIN03650 B(2,2)=A(1,1)/D RIN03690 RIN03690 RIN03690 B(1,2)=-A(1,2)/D RIN03710 RIN03710 RETURN RIN03720 RIN03720 END RIN0	C	FUNCTION	- CALCULATE INVERSE OF 2X2 MA	TRIX	RIN03500
C RESTRICTIONS - RIN03520 C RIN03530 RIN03530 C RIN03540 RIN03540 C RIN03550 RIN03550 C EXTERNAL REFERENCES - NONE RIN03560 C ARGUMENT DEFINITION: RIN03570 C ARGUMENT DEFINITION: RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03620 RIN03620 RIN03620 C MENSION A(2,2),B(2,2) RIN03650 RIN03650 DIMENSION A(2,2),B(2,2) RIN03650 RIN03660 RIN03670 B(1,1)=A(2,2)/D RIN03670 RIN03670 RIN03670 B(1,2)=-A(1,1)/D RIN03710 RIN03700 B(1,2)=-A(1,2)/D RIN03710 RIN03710 RETURN RIN03720 RIN03720 END RIN03730 RIN03730	C				RIN03510
C RIN03530 C REMARKS - C RIN03540 C RIN03550 C EXTERNAL REFERENCES - NONE RIN03550 C ARGUMENT DEFINITION: RIN03570 C ARGUMENT DEFINITION: RIN03580 C A INPUT MATRIX RIN03590 C A INPUT MATRIX (INVERSE OF A) RIN03620 C RIN03620 RIN03620 RIN03620 C	Ĉ.	RESTRICTIONS	-		RIN03520
C REMARKS - RIN03540 C RIN03550 RIN03550 C EXTERNAL REFERENCES - NONE RIN03560 C RIN03570 RIN03570 C ARGUMENT DEFINITION: RIN03580 C NAME DESCRIPTION RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C C RIN03620 RIN03630 C C RIN03630 RIN03630 C DIMENSION A(2,2), B(2,2) RIN03650 RIN03650 DIMENSION A(2,2), B(2,2) RIN03660 RIN03650 B(1,1)=A(2,2)/D RIN03670 B(1,1)=A(2,2)/D RIN03600 RIN03700 B(2,2)=A(1,1)/D RIN03700 B(2,1)=-A(1,2)/D RIN03710 RIN03710 RIN03710 RETURN RIN03730 RIN03730	C	·		· · ·	RIN03530
C RIN03550 C EXTERNAL REFERENCES - NONE RIN03560 C RIN03570 RIN03570 C ARGUMENT DEFINITION: RIN03580 C NAME DESCRIPTION RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C C RIN03620 RIN03630 C DIMENSION A(2,2),B(2,2) RIN03650 RIN03650 DIMENSION A(2,2),B(2,2) RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 B(1,1)=A(2,2)/D RIN03670 B(1,2)=-A(1,2)/D RIN03700 B(2,2)=A(1,1)/D RIN03700 B(1,2)=-A(1,2)/D RIN03710 RIV03700 B(2,1)=-A(2,1)/D RIN03710 RIN03710 RETURN RIN03700 RIN03710 RETURN RIN03710 RIN03710	C	REMARKS	-	•	RIN03540
C EXTERNAL REFERENCES - NONE RIN03560 C RIN03570 RIN03570 C ARGUMENT DEFINITION: RIN03580 C NAME DESCRIPTION RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C C RIN03620 RIN03620 C C RIN03630 RIN03620 C IMPLICIT REAL*8 (A-H,O-Z) RIN03640 RIN03640 DIMENSION A(2,2),B(2,2) RIN03650 RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 RIN03660 B(2,2)=A(1,1)/D RIN03670 RIN03670 B(1,2)=-A(1,2)/D RIN03710 RIN03710 RETURN RIN03720 RIN03720 END RIN03730 RIN03730	C		· · · · · · · · · · · · · · · · · · ·		RIN03550
C RIN03570 C ARGUMENT DEFINITION: RIN03580 C NAME DESCRIPTION RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03620 RIN03620 C C RIN03620 C RIN03620 RIN03620 C C RIN03620 C RIN03640 RIN03620 C RIN03640 RIN03640 DIMENSION A(2,2),B(2,2) RIN03650 DIMENSION A(2,2),B(2,2) RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 B(1,1)=A(2,2)/D RIN03670 B(1,2)=-A(1,2)/D RIN03700 B(2,1)=-A(2,1)/D RIN03710 RETURN RIN03720 END RIN03730	C ·	EXTERNAL REFEREN	CES - NONE	· · · ·	RIN03560
C ARGUMENT DEFINITION: RIN03580 C NAME DESCRIPTION RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03620 RIN03620 C C RIN03630 C IMPLICIT REAL*8 (A-H,O-Z) RIN03650 DIMENSION A(2,2),B(2,2) RIN03650 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 B(2,2)=A(1,1)/D RIN03690 B(1,2)=-A(1,2)/D RIN03700 B(2,1)=-A(2,1)/D RIN03710 RETURN RIN03720 END RIN03730	C			· · ·	RIN03570
C NAME DESCRIPTION RIN03590 C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03620 RIN03620 C C RIN03630 C C RIN03640 C DIMENSION A(2,2),B(2,2) RIN03650 DIMENSION A(2,2),B(2,2) RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03670 B(1,1)=A(2,2)/D RIN03690 B(1,2)=-A(1,2)/D RIN03700 B(2,1)=-A(2,1)/D RIN03700 RETURN RIN03710 END RIN03730	C	ARGUMENT DEFINIT	ION:		RIN03580
C A INPUT MATRIX RIN03600 C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03620 RIN03620 C RIN03630 RIN03630 C>	C	NAME DESC	RIPTION		RIN03590
C B OUTPUT MATRIX (INVERSE OF A) RIN03610 C RIN03620 RIN03630 C RIN03630 RIN03640 C RIN03640 RIN03650 DIMENSION A(2,2),B(2,2) RIN03650 RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03660 RIN03670 B(1,1)=A(2,2)/D RIN03680 B(2,2)=A(1,1)/D B(1,2)=-A(1,2)/D RIN03700 RIN03710 RETURN RIN03720 RIN03720 END RIN03730 RIN03730	Ĉ.	A IN	UT MATRIX	•	RIN03600
C RIN03620 C RIN03630 C>	Ċ	B OU	PUT MATRIX (INVERSE OF A)		RIN03610
C RIN03630 C>	Ĉ		· · · · · · · · · · · · · · · · · · ·		RIN03620
C>RIN03640 IMPLICIT REAL*8 (A-H,O-Z) DIMENSION A(2,2),B(2,2) D=A(1,1)*A(2,2)-A(2,1)*A(1,2) B(1,1)=A(2,2)/D B(1,2)=-A(1,2)/D B(1,2)=-A(1,2)/D RIN03690 B(2,1)=-A(2,1)/D RIN03710 RIN03720 END	Ĉ				RIN03630
IMPLICIT REAL*8 (A-H,O-Z) RIN03650 DIMENSION A(2,2),B(2,2) RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03670 B(1,1)=A(2,2)/D RIN03680 B(2,2)=A(1,1)/D RIN03690 B(1,2)=-A(1,2)/D RIN03700 B(2,1)=-A(2,1)/D RIN03710 RETURN RIN03720 END RIN03730	C>				-RIN03640
DIMENSION A(2,2), B(2,2) RIN03660 D=A(1,1)*A(2,2)-A(2,1)*A(1,2) RIN03670 B(1,1)=A(2,2)/D RIN03680 B(2,2)=A(1,1)/D RIN03690 B(1,2)=-A(1,2)/D RIN03700 B(2,1)=-A(2,1)/D RIN03710 RETURN RIN03720 END RIN03730		IMPLICIT REAL*8	A-H.O-Z)		RIN03650
D=A(1,1)*A(2,2)-A(2,1)*A(1,2) B(1,1)=A(2,2)/D B(2,2)=A(1,1)/D B(1,2)=-A(1,2)/D B(2,1)=-A(2,1)/D RETURN RETURN END RIN03670 RIN03670 RIN03720 RIN03720 RIN03730		DIMENSION A(2.2)	B(2,2)		RIN03660
B(1,1)=A(2,2)/D RIN03680 B(2,2)=A(1,1)/D RIN03690 B(1,2)=-A(1,2)/D RIN03700 B(2,1)=-A(2,1)/D RIN03710 RETURN RIN03720 END RIN03730		D=A(1.1)*A(2.2)-A	(2.1)*A(1.2)	•	RIN03670
B(2,2)=A(1,1)/D B(1,2)=-A(1,2)/D B(2,1)=-A(2,1)/D RETURN END RIN03690 RIN03690 RIN03700 RIN03700 RIN03720 RIN03730		B(1.1)=A(2.2)/D	····	• • • •	RIN03680
B(1,2)=-A(1,2)/D RIN03700 B(2,1)=-A(2,1)/D RIN03710 RETURN RIN03720 END RIN03730		B(2,2)=A(1,1)/D	· · · ·	·	RIN03690
B(2,1)=-A(2,1)/D RIN03710 RETURN RIN03720 END RIN03730		B(1,2) = -A(1,2)/D			RIN03700
RETURN RINO3720 END RINO3730		B(2,1) = -A(2,1)/D			RIN03710
END RIN03730		RETURN			RIN03720
		END	,		RIN03730

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	SUBROUTIN	E AMU(A,	B,C)					RIN03740
C>								-RIN03750
С								RIN03760
С					·			RIN03770
С	FUNCTION		– PER	FORM MATRIX	MULTIPICATION	OF 2X2	MATRIX	RIN03780
С		· .						RIN03790
C	RESTRICT	IONS	-					RIN03800
C								RIN03810
С	REMARKS		-					RIN03820
C :			•		•			RIN03830
C	EXTERNAL	REFEREN	CES - NON	E				RIN03840
С								RIN03850
С	ARGUMENT	DEFINIT	ION:					RIN03860
С	NAME	DESC	RIPTION					RIN03870
С	Α	INP	UT MATRIX	•	,			RIN03880
С	В	INP	UT MATRIX					RIN03890
С	С	OUT	PUT MATRI	X (C=AXB)		i i		RIN03900
С				:				RIN03910
С								RIN03920
C>								-RIN03930
	IMPLICIT E	REAL*8 (A-H,O-Z)					RIN03940
	DIMENSION A(2,2),B(2,2),C(2,2) C(1,1)=A(1,1)*B(1,1)+A(1,2)*B(2,1) C(2,1)=A(2,1)*B(1,1)+A(2,2)*B(2,1)						RIN03950	
							RIN03960	
							RINO3970	
	C(1,2)=A(1,1)*B(1,2)+A(1,2)*B(2,2)						RIN03980	
	C(2,2)=A(2	2,1)*B(1	,2)+A(2,2)*B(2,2)				RIN03990
	RETURN							RIN04000
	END							RIN04010
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	SUBROUTINE CALCD		RIN04020
C>		و ه چ که بند به به به به به او ه به ب	RIN04030
С			RIN04040
C			RIN04050
С	FUNCTION	- CALCULATE INFLUENCE COEFFICIENTS C,D	RIN04060
С		FOR H AND H' AT PSI=1	RIN04070
С			RIN04080
С	RESTRICTIONS	- FOR MULTIPLE RUNS, ONLY COMPUTED WHEN	RIN04090
С		CERTAIN PARAMETERS CHANGE. ALWAYS	RIN04100
С		COMPUTED AT LEAST ONCE.	RIN04110
C			RIN04120
Ċ	REMARKS	- NOTE VARIABLES PASSED IN COMMON	RIN04130
C			RIN04140
C	EXTERNAL REFERENCES	- AIN,AMU,RUK	RIN04150
c			RIN04160
c			RIN04170
C>			RIN04180
-	IMPLICIT REAL*8 (A-H	. 0-Z)	RIN04190
	COMMON/BCD /XLOC(1)	00).c(100).d(100).NDX(3).NDP(3).DX(3).DP(3)	RIN04200
	COMMON/BELAS /FORCE.	HELAS.H1ELAS.H2ELAS.H3ELAS.W1(4).W2(4)	RIN04210
	COMMON/BPAR /AL.BET	.PO.EPS.PF.S.U.DT	RIN04220
	COMMON/BELAG /IELAG	IPLOAD	RIN04230
	DIMENSION YO(4).YT(4	DJ(4), CKJ(4.4)	RIN04240
	DIMENSION XLEN(3)	· · · · · · · · · · · · · · · · · · ·	RIN04250
	DIMENSION A1(2.2.100).A2(2.2.100)	RIN04260
	DIMENSION $B1(2,2,100)$).B2(2.2.100)	RIN04270
	DIMENSION ALL(2,2).A	T(2.2)	RIN04280
	EXTERNAL DFN1		RIN04290
С			RIN04300
•	XLEN(1)=DX(1)*NDX(1)		RIN04310
	XLEN(2) = DX(2) * NDX(2)		RIN04320
`	XI.EN(3) = DX(3) * NDX(3)		RIN04330
	EL = XLEN(1)		RIN04340
	$y_{0}(1)=0$		RIN04350
	$v_0(2) = 0$.		RTN04360
	$v_0(3)=1$	· ·	RIN04370
	$v_{0}(4)=0$		RTN04380
	CALL RHK(DX(1), XLEN(1)FI.1.XNN YO.YO.4.DEN1.YT.D.I.CK.I.4)	RTN04390
	CALL RUK($DX(2)/2$, DP	(2)/2, YNN YNN YO, YO, A, DEN1, YT, D.I. CK.I.A)	RTN04400
	XLOC(1) = XNN	(2)/2) jan (jan (j 10) 10) + jb(b2) 11 jb(jon (j))	RIN04410
	A1(1, 1, 1) = YO(1)		RTN04420
	A1(2, 1, 1) = YO(2)		RTN04420
	A1(2,1,1) = 10(2) A2(1,1,1) = VO(3)		RING4450
	A2(2,1,1) = VO(4)		RTN04450
	DO 100 T=2 NDP(2)		RIND4460
	CALL RUK($DY(2)$ $DP(2)$	XNN XNN YO YO 4 DENI YT DI CKI 4)	RTN04400
	VIOC(T)=VNN	,,,,,,,,	RIN04470
	A1(1 1 1) = VO(1)		RING4400
	A1(2,1,1)=10(1)		RIN04490
	A2(1 1 T) = VO(3)		RIN04510
າມມ	A2(2, 1, 1) = VO(4)		RINGLSON
100	CALL BUR(DY(2)/2 DD	(2)/2. צאא צאא ער ער 4 האיז די די גאא אאא איז א און איז איז א גער א	RINGASZO
	TRITELAC FO 2)COTO 1	\~//~+, /////////////////////////////////	RIN04550
		גע (3)/2 אואא אוא אס אס געשים איז	BINUY 240
	$\frac{1}{2} \frac{1}{2} \frac{1}$	(3// = + 5 MH 5 MH 5 10 5 10 5 4 5 DE H 1 5 1 1 5 DO 5 OK 3 5 4 /	RINUTZE

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	A1(1,1,NDP(2)+1)=YO(1)	RIN04570
	A1(2,1,NDP(2)+1)=YO(2)	RIN04580
	A2(1,1,NDP(2)+1)=YO(3)	RIN04590
	A2(2,1,NDP(2)+1)=YO(4)	RIN04600
	DO 101 $I=2.NDP(3)$	RIN04610
	CALL RUK(DX(3),DP(3),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN04620
	XLOC(NDP(2)+I)=XNN	RIN04630
	A1(1,1,NDP(2)+I)=YO(1)	RIN04640
	A1(2.1.NDP(2)+I)=YO(2)	RIN04650
	A2(1,1,NDP(2)+I)=YO(3)	RIN04660
101	A2(2,1,NDP(2)+I)=YO(4)	RIN04670
	CALL RIK $(DX(3)/2 \dots DP(3)/2 \dots XNN \dots XNN \dots YO \dots YO \dots 4 \dots DFN1 \dots YT \dots DJ \dots CKJ \dots 4)$	RIN04680
111	$W_1(1) = Y_0(1)$	RIN04690
***	$u_1(2) = v_0(2)$	RTN04700
	$u_1(3) = v_0(3)$	RTN04710
	W1(4) = V0(4)	RTN04720
c		RTN04720
0	VO(1)=0	RTN04750
	VO(2)=0	RIN04740 RIN04750
	10(2)-0	RIN04750
	10(3)-0.	DTN04700
	IU(4)-1, CALL DUR(DY(1) VIEN(1) -FI1 YNN VO VO (DEN1 VT DI CRI ()	RIN04770
	CALL RUK $(DX(1), XLER(1), -LLI, XRR, IU, IU, 4, DERI, II, DJ, GXJ, 4)$	DTN04700
	CALL RUK($DX(2)/2$, $DP(2)/2$, XNN , XNN , IO , IO , 4 , $DPNI$, II , DJ , OKJ , 4)	RIN04790
	AI(1,2,1)=IO(1)	. KINU40UU
	A1(2,2,1)=I0(2)	RINU4010 DIN0/020
	A2(1,2,1)=YO(3)	R1N04020
	A2(2,2,1)=IU(4)	RINU403U
	DU 200 $I=2, NDP(2)$	RINU4040
	CALL RUK($DX(2)$, $DP(2)$, XNN , XNN , YO , YO , 4 , $DPNI$, YI , DJ , CKJ , 4)	KINU485U
	A1(1,2,1)=YO(1)	RINU400U
	A1(2,2,1)=YO(2)	RINU4870
	A2(1,2,1)=YO(3)	R1NU4880
200	AZ(2, 2, 1) = YU(4)	K1N04890
	CALL $RUK(DX(2)/2.,DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)$	R1N04900
	1F(1FLAG.EQ.2)GOTU 112	R1N04910
	CALL RUK $(DX(3)/2.,DP(3)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)$	RINU4920
	A1(1,2,NDP(2)+1)=YO(1)	RIN04930
	A1(2,2,NDP(2)+1)=YO(2)	RIN04940
	A2(1,2,NDP(2)+1)=YO(3)	R1N04950
	A2(2,2,NDP(2)+1)=YO(4)	RIN04960
	DO 201 $I=2, NDP(3)$	RIN04970
	CALL RUK(DX(3), DP(3), XNN, XNN, YO, YO, 4, DFN1, YT, DJ, CKJ, 4)	R1N04980
	A1(1,2,NDP(2)+I)=YO(1)	RIN04990
	A1(2,2,NDP(2)+I)=YO(2)	RIN05000
	A2(1,2,NDP(2)+1)=YO(3)	RINOSO10
201	A2(2,2,NDP(2)+I)=YO(4)	RIN05020
	CALL RUK $(DX(3)/2.,DP(3)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)$	RIN05030
112	W2(1)=YO(1)	RIN05040
	W2(2)=YO(2)	RIN05050
	$W_2(3) = YO(3)$	RIN05060
	W2(4)=YO(4)	RIN05070
C		RIN05080
	YO(1)=1.	RIN05090
	YO(2)=0.	RIN05100
	YO(3)=0.	RIN05110
	138	

	YO(4)=0.	RIN05120
	XNN=1.	RIN05130
	IF(IFLAG.EQ.2)GOTO 113	RIN05140
	CALL RUK(-DX(3)/2.,-DP(3)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ.4)	RIN05150
	B1(1,1,NDP(2)+NDP(3))=YO(1)	RIN05160
	B1(2.1,NDP(2)+NDP(3))=YO(2)	RIN05170
	B2(1.1,NDP(2)+NDP(3))=YO(3)	RIN05180
	B2(2,1,NDP(2)+NDP(3))=YO(4)	RIN05190
	DO 300 II=2.NDP(3)	RIN05200
	I = NDP(2) + NDP(3) - II + 1	RIN05210
	CALL $RUK(-DX(3), -DP(3), XNN, XNN, YO, YO, 4, DFN1, YT, DJ, CKJ, 4)$	RIN05220
	B1(1.1.I)=YO(1)	RTN05230
	B1(2,1,T)=YO(2)	RTN05240
	B2(1,1,1)=YO(3)	RTN05250
300	$B_2(2,1,T) = Y_0(4)$	RTN05260
	CALL $RUK(-DX(3)/2DP(3)/2XNN.XNN.YO.YO.4.DFN1.YT.D1.CK1.4)$	RTN05270
113	CALL $RUK(-DX(2)/2DP(2)/2XNN.XNN.YO.YO.4.DFN1.YT.DI.CKI.4)$	RTN05280
	$B_1(1,1,NDP(2)) = YO(1)$	RIN05200
	B1(2,1,NDP(2))=VO(2)	DIN05200
	$R^{2}(1 1 NDP(2)) = VO(3)$	DIN05310
	B2(1,1,MD(2)) = VO(4)	DIN05320
	D(30) TT=2 NDD(2)	RIN05320
	T = NDD(2) - TT = 1	
	CATT PUR(2) = 0 (2) YANY YANY YA (0) (0) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1	RIN05340
	R(1, 1, 1) = VO(1)	
	DI(1,1,1) - IO(1) DI(2,1,1) - VO(2)	RINOS 270
	$p_1(2,1,1) - p_0(2)$	RIN05370
201	$D_2(1,1,1) = IO(3)$ $D_2(2,1,1) = VO(4)$	RINUJJOU~
201	D2(2,1,1)-10(4)	RINUJJ9U DINOS400
C	- vo(1)-0	RINU54UU RINU5410
	V(1) = 0	RINUJ4IU DINO5420
	10(2) - 1	
•		
	10(4)-0.	RINUJ44U DINOS/SO
	ANN-1. TE(TELAC EO 2)COTO 114	
	$\frac{1}{2} \frac{1}{2} \frac{1}$	KINUJ40U
	(ALL RUK(-DA(S)/2, -DP(S)/2, ANN, ANN, IU, IU, 4, DFN1, I1, DJ, UKJ, 4)	RINU54/U
	B1(1,2,NDP(2)+NDP(3))=IU(1)	KINU5480
	B1(2,2,NDP(2)+NDP(3))=YO(2)	RINU5490
	B2(1,2,NDP(2)+NDP(3))=IU(3)	KINUSSUU
	BZ(2,2,NDP(2)+NDP(3)) = YU(4)	RINUSSIU
	DU 400 II=2, NDP(3)	R1N05520
	1 = NUP(2) + NUP(3) - 11 + 1	RIN05530
	CALL RUK(-DX(3),-DP(3),XNN,XNN,YU,YU,4,DFN1,YT,UJ,CKJ,4)	RINU554U
	B1(1,2,1)=YO(1)	RINUSSSU
	B1(2,2,1)=YO(2)	RINUSS60
	B2(1,2,1)=YO(3)	RINU5570
400	B2(2,2,1)=YO(4)	RINUSS80
11/	CALL $KUK(-DX(3)/2., -DP(3)/2., XNN, XNN, YU, YU, 4, DFN1, YT, DJ, CKJ, 4)$	R1N05590
114	UALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN05600
	B1(1,2,NDP(2))=YO(1)	RIN05610
	B1(2,2,NDP(2))=YO(2)	RIN05620
	B2(1,2,NDP(2))=YO(3)	RIN05630
	B2(2,2,NDP(2))=YO(4)	RIN05640
	DO 401 II=2,NDP(2)	RIN05650
	I=NDP(2)-II+1	RIN05660

	CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,Y	(O,4,DFN1,YT,DJ,CKJ,4)	RIN05670
	B1(1,2,I)=YO(1)		RIN05680
	B1(2,2,I)=YO(2)		RIN05690
	B2(1,2,I)=YO(3)		RIN05700
401	B2(2,2,I)=YO(4)		RIN05710
С		· · ·	RIN05720
	DO 500 I=1,NDP(2)		RIN05730
	CALL AIN(A1(1,1,1),A11)		RIN05740
	CALL AMU(A2(1,1,1),A11,AT)		RIN05750
	CALL AMU(AT, $B1(1, 1, 1), A1(1, 1, 1)$)	د	RIN05760
	DO 21 II=1,2		RIN05770
	DO 21 JJ=1,2	,	RIN05780
21	AT(II,JJ)=B2(II,JJ,I)-A1(II,JJ,I)		RIN05790
	CALL AIN(AT, B2(1,1,1))		RIN05800
	C(I)=B2(1,2,I)/AL*DP(2)		RIN05810
	D(I)=B2(2,2,I)/AL*DP(2)		RIN05820
500	CONTINUE		RIN05830
	IF(IFLAG.EQ.2)RETURN		RIN05840
	INDEX1=NDP(2)+1	· · · ·	RIN05850
	INDEX2=NDP(2)+NDP(3)		RIN05860
	DO 501 I=INDEX1,INDEX2		RIN05870
	CALL AIN(A1(1,1,I),A1I)		RIN05880
	CALL AMU(A2(1,1,I),A1I,AT)		RIN05890
	CALL AMU(AT,B1(1,1,I),A1(1,1,I))		RIN05900
	DO 22 II=1,2		RIN05910
	DO 22 JJ=1,2		RIN05920
22	AT(II,JJ)=B2(II,JJ,I)-A1(II,JJ,I)		RIN05930
	CALL AIN(AT,B2(1,1,I))		RIN05940
	C(I)=B2(1,2,I)/AL*DP(3)		RIN05950
٠	D(I)=B2(2,2,I)/AL*DP(3)		RIN05960
501	CONTINUE		RIN05970
С			RIN05980
	RETURN		RIN05990
	END		RIN06000

PAGE 1-3 OF 38

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			4
	SUBROUTINE CALCD3		RÏN06010
C>			RIN06020
С		<i>,</i>	RIN06030
С			RIN06040
С	FUNCTION	- CALCULATE INFLUENCE COEFFICIENTS C.D	RIN06050
С		FOR H AND H' AT PSI=1	RIN06060
С			RIN06070
Ċ	RESTRICTIONS	- FOR MULTIPLE RUNS. ONLY COMPUTED WHEN	RIN06080
C		CERTAIN PARAMETERS CHANGE. ALWAYS	RIN06090
С		COMPUTED AT LEAST ONCE.	RIN06100
С			RIN06110
C	REMARKS	- NOTE VARIABLES PASSED IN COMMON	RIN06120
C			RIN06130
C	EXTERNAL REFERENCES	- ATN, AMU, RUK	RTN06140
C			RIN06150
C			RTN06160
C>			RIN06170
	IMPLICIT REAL*8 (A-H.	.0-7.)	RTN06180
	COMMON/BCD /XLOC(10	10, $C(100)$, $D(100)$, $NDX(3)$, $NDP(3)$, $DX(3)$, $DP(3)$	RIN06190
	COMMON/BELAS /FORCE .	$ELAS_H1ELAS_H2ELAS_H3ELAS_W1(4), W2(4)$	RIN06200
	COMMON/BPAR /AL.BET.	PO.EPS.PF.S.U.DT	RTN06210
	COMMON/BFLAG /TFLAG		RIN06220
	DIMENSION YO(4), YT(4)	$D_{1}(4)$, $CK_{1}(4,4)$	RTN06230
	DIMENSION XLEN(3)		RIN06240
	DIMENSION A1(2,2,100)	(2, 2, 100)	RTN06250
	DIMENSION B1(2,2,100)	$B_2(2,2,100)$	RIN06260
	DIMENSION $A1T(2,2)$, AT	r(2,2)	RTN06270
	EXTERNAL DENI	· · · · · · · · · · · · · · · · · · ·	RTN06280
С			RIN06290
-	XLEN(1)=DX(1)*NDX(1)		RIN06300
	XLEN(2)=DX(2)*NDX(2)		RIN06310
	XLEN(3)=DX(3)*NDX(3)		RIN06320
	EL1=XLEN(1)+XLEN(2)		RTN06330
	YO(1)=0.	,	RÍN06340
	YO(2)=0.		RTN06350
	YO(3)=1.		RIN06360
	YO(4) = 0.		RIN06370
	CALL RUK(DX(1), XLEN(1) EL1, XNN, YO, YO, 4, DEN1, YT, DJ, CKJ, 4)	RIN06380
	CALL RUK($DX(2)/2$, DP((2)/2, XNN, XNN, YO, YO, 4, DFN1, YT, DJ, CKJ, 4)	RTN06390
	XLOC(1)=XNN	(2), 20 julit julit j 20 j 20 j (j 2 i 2 j 2 j 2 i 2 j 2 i 2 j 2 i 2 j 2 i 2 j 2 i 2 j 2 i 2 j 2 i 2 j 2 i 2 j	RIN06400
	A1(1,1,1)=YO(1)		RTN06410
	$A1(2,1,1) \approx YO(2)$		RIN06420
	A2(1,1,1)=YO(3)		RTN06430
	A2(2,1,1)=YO(4)		RTN06440
,	DO 100 I=2.NDP(2)		RTN06450
	CALL RUK($DX(2)$, $DP(2)$)	XNN, XNN, YO, YO, 4, DFN1, YT, DJ, CKJ, 4)	RIN06460
	XLOC(I)=XNN		RTN06470
	$A1(1,1,1) \approx YO(1)$		RTN06480
	A1(2,1,1)=YO(2)		RIN06400
	$A2(1,1,T) \approx VO(3)$		RINDESOD
100	$A2(2,1,1) \approx YO(4)$		RINGESIO
	CALL RUK(DY(2)/2	(2)/2, XNN, XNN, YO, YO, 4, DEN1, YT, DT, CKT (4)	RTN06520
	CALL RIK(DY(3)/2 DP((3)/2, $(3)/2$, $($	RINOKS20
	XLOC(NDP(2)+1)=YMN	(<i>4) / 2 + j Ann j Ann j 10 j 10 j 4 j DE</i> 11 j 11 j 00 j 080 j 4 /	RINO6540
	A1(1, 1, NDP(2)+1) = YO(1)		RTN06550

	(1/2, 1, NDP(2)+1) = VO(2)	DTN06560
	A1(2,1,NDF(2)+1)=10(2)	RINU0JOU
	A2(1,1,NDP(2)+1)=YO(3)	R1N065/0
	A2(2,1,NDP(2)+1)=YO(4)	RIN06580
	DO 101 I=2,NDP(3)	RIN06590
	CALL RUK(DX(3),DP(3),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN06600
	XLOC(NDP(2)+I)=XNN	RIN06610
;	A1(1,1,NDP(2)+I)=YO(1)	RIN06620
	A1(2,1,NDP(2)+I)=YO(2)	RIN06630
	A2(1.1.NDP(2)+I)=YO(3)	RIN06640
101	A2(2,1,NDP(2)+I)=YO(4)	RIN06650
	CALL $RUK(DX(3)/2 \dots DP(3)/2 \dots XNN \dots XNN \dots YO \dots YO \dots 4 \dots DT \dots DJ \dots CK \dots 4)$	RTN06660
	(1) = YO(1)	RIN06670
	$(1)^{1} = V \cap (2)$	RIN06680
	$w_1(2) = v_0(3)$	RIN00000
	W1(3) - 10(3)	RINU0090
•	W1(4)-10(4)	RINU6700
C	······································	KINU6/10
	YU(1)=U.	R1N06/20
	YO(2)=U.	RIN06730
	YO(3)=0.	RIN06740
	YO(4)=1.	RIN06750
	CALL RUK(DX(1),XLEN(1),-EL1,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RINO6760
	CALL RUK(DX(2)/2.,DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN06770
	A1(1,2,1)=YO(1)	RIN06780
	A1(2,2,1)=YO(2)	RIN06790
	A2(1,2,1)=YO(3)	RIN06800
	A2(2,2,1)=YO(4)	RIN06810
	DO 200 I=2,NDP(2)	RIN06820
	CALL RUK(DX(2).DP(2).XNN.XNN.YO.YO.4.DFN1.YT.DJ.CKJ.4)	RIN06830
	A1(1.2.I)=YO(1)	RTN06840
	A1(2,2,1)=YO(2)	RTN06850
	$\Delta 2(1,2,T) = YO(3)$	RIN06860
200	$A_2(1,2,1) = VO(4)$	DTN06970
200	$\frac{1}{2} \frac{1}{2} \frac{1}$	DTN06000
	CALL RUK(DK(2)/2.,DF(2)/2.,ANN,ANN,10,10,4,DFN1,11,DJ,0KJ,4/)	RINU000U
	(ALL KUK(DA(3)/2), DP(3)/2), ANN, ANN, IU, IU, 4, DPNI, II, UJ, UKJ, 4/	RINU6890
	A1(1,2)NDP(2)+1)=10(1)	KINU69UU
	A1(2,2,NDP(2)+1)=IO(2)	R1N06910
	A2(1,2,NDP(2)+1)=YO(3)	R1N06920
	A2(2,2,NDP(2)+1)=YO(4)	RIN06930
	DO 201 $1=2, NDP(3)$	RIN06940
	CALL RUK(DX(3), DP(3), XNN, XNN, YO, YO, 4, DFN1, YT, DJ, CKJ, 4)	RIN06950
	A1(1,2,NDP(2)+I)=YO(1)	RIN06960
	A1(2,2,NDP(2)+I)=YO(2)	RIN06970
	A2(1,2,NDP(2)+I)=YO(3)	RIN06980
201	A2(2,2,NDP(2)+I)=YO(4)	RIN06990
	CALL RUK(DX(3)/2.,DP(3)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN07000
	W2(1)=YO(1)	, RIN07010
	W2(2)=YO(2)	RIN07020
	W2(3)=YO(3)	RIN07030
	W2(4)=YO(4)	RIN07040
С	· · · · · · · · · · · · · · · · · · ·	RIN07050
-	YO(1)=1.	RTN07060
	YO(2)=0.	RTN07070
	YO(3)=0.	RINGTORO
	Y()(4)=0.	RIN07000
	XNN=1.	

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	CALL RUK(-DX(3)/2.,-DP(3)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN07110
	B1(1,1,NDP(2)+NDP(3))=YO(1)	RIN07120
	B1(2,1,NDP(2)+NDP(3))=YO(2)	RIN07130
	B2(1,1,NDP(2)+NDP(3))=YO(3)	RIN07140
	B2(2,1,NDP(2)+NDP(3))=YO(4)	RIN07150
	DO 300 II=2,NDP(3)	RIN07160
	I=NDP(2)+NDP(3)-II+1	RIN07170
	CALL RUK(-DX(3),-DP(3),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN07180
	B1(1,1,I)=YO(1)	RIN07190
	B1(2,1,I)=YO(2)	RIN07200
	B2(1,1,I)=YO(3)	RIN07210
300	B2(2,1,I)=YO(4)	RIN07220
	CALL $RUK(-DX(3)/2DP(3)/2XNN.XNN.YO.YO.4.DFN1.YT.DJ.CKJ.4)$	RIN07230
	CALL $RUK(-DX(2)/2DP(2)/2XNN.XNN.YO.YO.4.DFN1.YT.DJ.CKJ.4)$	RIN07240
	B1(1.1.NDP(2))=YO(1)	RIN07250
	B1(2,1,NDP(2))=YO(2)	RIN07260
	$B_2(1,1,NDP(2)) = YO(3)$	RIN07270
	$B_2(2, 1, NDP(2)) = YO(4)$	RIN07280
	DO(301 TT=2. NDP(2)	RIN07290
	T = NDP(2) - TT + 1	RIN07300
	CALL $RUK(-DX(2), -DP(2), XNN, XNN, YO, YO, 4, DFN1, YT, DJ, CKJ, 4)$	RIN07310
	B1(1,1,T)=YO(1)	RIN07320
	B1(2,1,T)=VO(2)	RTN07330
	$B_2(1,1,1) = YO(3)$	RIN07340
301	$B_2(2, 1, 1) = YO(4)$	RTN07350
C		RIN07360
U	YO(1)=0.	RIN07370
	V(1) = 1	RIN07380
	V(3) = 0.	RIN07390
	V(4) = 0	RIN07400
	YNN=1	RTN07410
	CALL RUK($-DX(3)/2$, $-DP(3)/2$, XNN XNN YO YO 4 DFN1, YT DJ CK L 4)	RIN07410
	R1(1 2 NDP(2)+NDP(3))=VO(1)	RIN07420
	B1(1,2,MD1(2)+MD1(3))=10(1) B1(2,2,MD1(2)+MD1(3))=20(2)	RIN07440
	$B_{2}(1,2,NDP(2)+NDP(3))=VO(3)$	RIN07450
	$B_2(1,2,MD(2)+MD(3))=VO(4)$	RIN07450
	DO(400 TT=2) NDP(3)	RIN07400
	T = NDP(2) + NDP(3) = T = 1	RIN07470
	CALL $PIIK(-DX(3) -DP(3) YNN YNN VO VO 4 DFN1 YT DI CKI 4)$	RIN07400
	B1(1 2 T)=VO(1)	RIN07490
	B1(2,2,1)=10(1)	RIN07510
	$B_{1}(2,2,1) = 10(2)$ $B_{2}(1,2,1) = VO(3)$	RTN07520
400	$R_2(2, 2, 1) - VO(4)$	PTN07530
400	CALL PIIK(-DY(3)/2 -DP(3)/2 YNN YNN YO YO 4 DEN1 YT DI CKI ()	RIN07540
114	CALL RUK $(-D_X(2)/2, -D_Y(2)/2, XNN, XNN, 10, 10, 4, D_Y(1, 11, D_2, 0, 0, 1, 4)$ CALL DIK $(-D_X(2)/2, -D_Y(2)/2, YNN, YNN, YO, YO, 4, D_YN, 11, D_2, 0, 0, 1, 4)$	RIN07550
114	R(1 - 2 NDD(2)) = VO(1)	PIN07560
	B1(1,2,NDP(2))=VO(2)	RIN07570
	B(1,2,NDP(2)) = VO(2)	RIN07580
	B2(1,2,NDF(2)) = 10(3) B2(2,2,NDF(2)) = VO(4)	RIN07500
	DO 401 TT=2 NDD(2)	. BINU1700
	T=NDD(2)_TT+1	DIN07410
	ראיד דער דער אין אווע אווע אווע גער אין דער גער אין גער אין גער	DIN07420
	$\frac{1}{2} = \frac{1}{2} = \frac{1}$	DIN07420
	B1(1,2,1) = IO(1) B1(2,2,1) = VO(2)	DIN07440
	$D_1(2,2,1) = IO(2)$ $P_2(1,2,1) = VO(2)$	DIN0740
	D2\19491/-IU\J/	WTW01030

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401 C	B2(2,2,I)=YO(4)	RIN07660 RIN07670
	DO 500 I=1,NDP(2)	RIN07680
	CALL AIN(A1(1,1,1),A11)	RIN07690
	CALL AMU(A2(1,1,1),A11,AT)	RIN07700
	CALL AMU(AT,B1(1,1,I),A1(1,1,I))	RIN07710
	DO 21 II=1,2	RIN07720
	DO 21 JJ=1,2	RIN07730
21	AT(II,JJ)=B2(II,JJ,I)-A1(II,JJ,I)	RIN07740
	CALL AIN $(AT, B2(1, 1, 1))$	RIN07750
	C(I)=B2(1,2,I)/AL*DP(2)	RIN07760
	D(I)=B2(2,2,I)/AL*DP(2)	RIN07770
500	CONTINUE	RIN07780
	INDEX1=NDP(2)+1	RIN07790
	INDEX2=NDP(2)+NDP(3)	RIN07800
	DO 501 I=INDEX1,INDEX2	RIN07810
	CALL AIN(A1(1,1,1),A11)	RIN07820
	CALL AMU(A2(1,1,1),A11,AT)	RIN07830
	CALL AMU(AT,B1(1,1,I),A1(1,1,I))	RIN07840
	DO 22 II=1,2	RIN07850
	DO 22 JJ=1,2	RIN07860
22	AT(II,JJ)=B2(II,JJ,I)-A1(II,JJ,I)	RIN07870
	CALL AIN(AT,B2(1,1,I))	RIN07880
	C(I)=B2(1,2,I)/AL*DP(3)	RIN07890
	D(I)=B2(2,2,I)/AL*DP(3)	RIN07900
501	CONTINUE	RIN07910
С		RIN07920
	RETURN	RIN07930
	END	RIN07940

	SUBROUTINE CALCD4		RIN07950
C>			RIN07960
С			RIN07970
С			RIN07980
С	FUNCTION	- CALCULATE INFLUENCE COEFFICIENTS C,D	RIN07990
С		FOR H AND H' AT PSI=1	RIN08000
C	·		RIN08010
С	RESTRICTIONS	- FOR MULTIPLE RUNS, ONLY COMPUTED WHEN	RIN08020
С		CERTAIN PARAMETERS CHANGE. ALWAYS	RIN08030
С		COMPUTED AT LEAST ONCE.	RIN08040
С			RIN08050
С	REMARKS	- NOTE VARIABLES PASSED IN COMMON	RIN08060
С			RIN08070
С	EXTERNAL REFERENCES	- AIN,AMU,RUK	RIN08080
С			RIN08090
С		· ·	RIN08100
C>			RIN08110
	IMPLICIT REAL*8 (A-H	,0-Z)	RIN08120
	COMMON/BCD /XLOC(10	00),C(100),D(100),NDX(3),NDP(3),DX(3),DP(3)	RIN08130
	COMMON/BELAS /FORCE,	HELAS, H1ELAS, H2ELAS, H3ELAS, W1(4), W2(4)	RIN08140
	COMMON/BPAR /AL, BET	,PO,EPS,PF,S,U,DT	RIN08150
	COMMON/BFLAG /IFLAG,	IPLOAD	RIN08160
	DIMENSION YO(4), YT(4)),DJ(4),CKJ(4,4)	RIN08170
	DIMENSION XLEN(3)		RIN08180
	DIMENSION A1(2,2,100)),A2(2,2,100)	RIN08190
	DIMENSION B1(2,2,100)),B2(2,2,100)	RIN08200
	DIMENSION All(2,2),A	r(2,2)	RIN08210
	EXTERNAL DFN1		RIN08220
С			RIN08230
	XLEN(1)=DX(1)*NDX(1)		RIN08240
	XLEN(2)=DX(2)*NDX(2)		RIN08250
	XLEN(3)=DX(3)*NDX(3)		RIN08260
	EL1=XLEN(1)		RIN08270
	YO(1)=0.		RIN08280
	YO(2)=0.		RIN08290
	YO(3)=1.		RIN08300
	YO(4)=0.		RIN08310
	CALL RUK(DX(1)/2.,DP	(1)/2.,-EL1,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN08320
	XLOC(1)=XNN		RIN08330
	A1(1,1,1)=YO(1)		RIN08340
	A1(2,1,1)=YO(2)		RIN08350
	A2(1,1,1)=YO(3)		RIN08360
	A2(2,1,1)=YO(4)		RIN08370
	DO 100 $I=2,NDP(1)$		RIN08380
	CALL RUK(DX(1),DP(1)	,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN08390
	XLOC(I)=XNN		RIN08400
	A1(1,1,I)=YO(1)		RIN08410
	A1(2,1,I)=YO(2)		RIN08420
	A2(1,1,1)=YO(3)		RIN08430
100	A2(2,1,I)=YO(4)		RIN08440
	CALL RUK(DX(1)/2.,DP	(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN08450
	CALL RUK(DX(2)/2.,DP	(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN08460
	XLOC(NDP(1)+1)=XNN		RIN08470
	A1(1,1,NDP(1)+1)=YO(1)	RIN08480
	A1(2,1,NDP(1)+1)=YO(2	2)	RIN08490

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	A2(1,1,NDP(1)+1)=YO(3)	RIN08500
	A2(2,1,NDP(1)+1)=YO(4)	RIN08510
•	DO 101 I=2,NDP(2)	RIN08520
	CALL RUK(DX(2),DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN08530
	XLOC(NDP(1)+I)=XNN	RIN08540
	A1(1,1,NDP(1)+I)=YO(1)	RIN08550
	A1(2,1,NDP(1)+I)=YO(2)	RIN08560
	A2(1,1,NDP(1)+I)=YO(3)	RIN08570
101	A2(2,1,NDP(1)+I)=YO(4)	RIN08580
	CALL RUK(DX(2)/2.,DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN08590
	W1(1)=YO(1)	RIN08600
	W1(2)=YO(2)	RIN08610
	W1(3)=YO(3)	RIN08620
	W1(4) = YO(4)	RIN08630
С		RTN08640
•	YO(1)=0.	RTN08650
	$Y_{0}(2)=0$.	RTN08660
	$Y_{0}(3)=0$	RIN08670
	$Y_0(4) = 1$	RIN08680
	CALL RUK($DX(1)/2$, $DP(1)/2$, -EL1, XNN, YO, YO 4 DEN1 VT DI CKI 4)	RIN08690
	$\Delta 1(1, 2, 1) = VO(1)$	RIN00070
	$\Delta 1(2, 2, 1) = VO(2)$	RTN08710
	$A^{2}(1,2,1)=10(2)$	DTN08720
	$A_2(1,2,1) = 10(3)$ $A_2(2,2,1) = VO(4)$	RIN08730
	DO(200 T=2 NDP(1))	PTN08740
	CALL DIR(DY(1) DP(1) YNN YNN YN Y	DIN08750
	A1(1 2 T) = VO(1)	DIN08760
	A1(1,2,1) = 10(1) A1(2,2,1) = 10(1)	DIN08770
	A1(2,2,1) = 10(2) A2(1,2,1) = VO(3)	DIN08780
200	$A_2(1,2,1) - 10(3)$	DTN08700
200	$A_2(2,2,1) = 10(4)$ CALL DIR(DY(1)/2 DD(1)/2 YNN YNN YN Y	RIN08790
	CALL $ROK(DK(1)/2., DE(1)/2., ANN, ANN, 10, 10, 4, DEN1, 11, DJ, CKJ, 4)$	DIN08810
	A1(1, 2, NDD(1)+1)=VO(1)	DIN08820
	A1(1,2,NDP(1)+1)=10(1)	DIN08830
	A1(2,2,NDP(1)+1)=10(2) A2(1,2,NDP(1)+1)=YO(3)	RIN08850
	$A_2(1,2,NDP(1)+1)=10(3)$	R1N00040
	A2(2,2,NDF(1)+1)=10(4)	RIN000JU
	DU 201 1-2, NDr(2) CALL DUR(DY(2) DD(2) YAN YAN YAN YA YA KU YA DI CHI ()	RINU0000
	A1(1,2) NDD(1)+T)=VO(1)	DINOSCO
	A1(1,2,NDP(1)+1)=10(1)	D TNO 9900
	A1(2,2,NDP(1)+1) = 10(2) A2(1,2,NDP(1)+1) = YO(2)	RINU0090
201	A2(1,2,NDP(1)+1) = IO(3) A2(2,2,NDP(1)+1) = VO(4)	RIN00900
201	AZ(2,2,NDP(1)+1) = IO(4) CALL DIP(DP(2)/2 DD(2)/2 VIDI VIDI VO VO (DEN1 VT DI CHI ()	RINU0910
	(ALL ROK(DK(2)/2), DF(2)/2), ANN, ANN, IO, IO, 4, DFN1, II, DJ, (KJ, 4)	RINU0920
	$W_2(1) - IO(1)$	RINU0930
	$W_2(2) - IO(2)$	R1NU0940
	$W_2(3) - IU(3)$	KINU8950
c .	W214/-1014/,	RTN00200
L L	vo(1)+1	KTN0004/0
	IU(I/-I.	KTN08980
	IU(2)-0	KTN08330
	IU(J)-U.	KTN03000
		KIN03010
	$\frac{1}{2} \frac{1}{2} \frac{1}$	KIN09020
	$\begin{array}{c} \text{CALL } KUK(-DX(Z)/Z, -DF(Z)/Z, XNN, XNN, YU, YU, 4, DFN1, YT, DJ, CKJ, 4) \\ \\ \mathbb{P}(A, A, NDF(A)) = NDF(A) = NDF(A) \\ \\ \mathbb{P}(A, A, DF(A)) = NDF(A) \\ \\ \mathbb{P}(A, DF(A)) = NDF(A) \\ \\ \\ \mathbb{P}(A, D) = NDF(A) \\ \\ \mathbb{P}(A, D) = NDF(A) \\ \\ \mathbb{P}(A, D) = NDF(A) \\ \\ \\ \\ \mathbb{P}(A, D) = ND) \\ \\ \\ \\ \mathbb{P}(A, D) = ND) \\ \\ \\ \\ \mathbb{P}(A, D) = ND) \\ \\ \\ \\ \\ \mathbb{P}(A, D) = ND) \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ $	R1N09030
	$D_1(1,1,N)P(1,1)=YU(1)$	R I ND9040

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<pre>B1(1,1,NPP(1)+NPP(2))=V0(3) B2(2,1,NPP(1)+NPP(2))=V0(4) B2(2,1,NPP(1)+NPP(2))=V0(4) B2(2,1,NPP(1)+NPP(2))=V0(4) B1(2,1,1,NPP(1))=V0(2) B2(1,1,1)=V0(1) B1(2,1,1)=V0(1) B2(1,1,1)=V0(1) B2(1,1,1)=V0(1) B2(1,1,NPP(1))=V0(2) B2(1,1,NPP(1))=V0(2) B2(1,1,NPP(1))=V0(2) B2(1,1,NPP(1))=V0(2) B2(1,1,NPP(1))=V0(2) B2(1,1,NPP(1))=V0(3) B2(2,1,NPP(1))=V0(3) B2(2,1,NPP(1))=V0(2)]=V0(1) B2(2,1,NPP(1))=V0(2)]=V0(1) B2(2,1,NPP(1))=V0(2)]=V0(2) B2(1,2,NPP(1))=VP(2)]=V0(3) B2(2,2,NPP(1))=VP(2)]=V0(3) B2(2,2,NPP(1))=VP(2)]=V0(3) B2(1,2,NPP(1))=V0(2)]=V0(3) B2(1,2,NPP(1))=V0(3) B2(1,2,N</pre>		B1(2 + NDP(1) + NDP(2)) = VO(2)	PINOGOSO
bl(1,1,1,NDP(1)+NDP(2))=VO(4) Bl(2,1,1,NDP(1)+NDP(2))=VO(4) CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) Bl(1,1,1)=VO(1) Bl(2,1,1)=VO(2) Bl(1,1,1)=VO(3) CALL RUK(-DX(2)/2,,-DP(2)/2,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) Bl(2,1,1)=VO(3) Bl(2,1,1)=VO(3) CALL RUK(-DX(1)/2,,-DP(2)/2,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) Bl(0,1,NDP(1))=VO(1) Bl(2,1,NDP(1))=VO(2) Bl(1,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) Bl(2,1,NDP(1))=VO(2) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09200 DD 301 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) Bl(2,1,1)=VO(2) Bl(2,1,1)=VO(2) Bl(2,1,1)=VO(2) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09200 YO(1)=0. YO(1)=0. YO(1)=0. RIN09200 YO(2)=1. RIN09200 Bl(2,2,NDP(1)+NDP(2))=VO(1) RIN09200 Bl(2,2,NDP(1)+NDP(2))=VO(2) RIN09200 Bl(2,2,NDP(1)+NDP(2))=VO(1) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09300 Bl(1,2,NDP(1)+NDP(2))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN09400 Bl(1,2,NDP(1))=VO(2) RIN094		$B_1(2,1,ND(1)+ND(2)) = O(2)$	
b1(1,1,NDP(1)/NDP(2) RIN03000 I=NDP(1)+NDP(2)-I1+1 RIN03000 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09100 b1(1,1,1)=YO(1) RIN03100 b1(1,1,1)=YO(2) RIN03100 b2(1,1,1)=YO(2) RIN03100 b2(1,1,1)=YO(3) RIN03130 cALL RUK(-DX(2)/2,.,DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN03130 b2(2,1,1)=YO(3) RIN03100 cALL RUK(-DX(2)/2,.,DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN03100 b1(1,1,NDP(1))=YO(1) RIN03100 b2(2,1,NDP(1))=YO(2) RIN03200 b2(2,1,NDP(1))=YO(3) RIN03200 b2(2,1,I)=YO(1) RIN03200 b1(1,1,I)=YO(1) RIN03200 b1(1,1,I)=YO(1) RIN03200 b1(1,1,I)=YO(1) RIN03200 b1(2,1,I)=YO(2) RIN03200 b1(2,1,I)=YO(1) RIN03200 b1(2,1,I)=YO(3) RIN03200 b1(2,1,I)=YO(4) RIN03200 c RIN03200 y(1)=0. RIN03200 y(0(2)=1. RIN03300 g1(1,2,NPP(1))=NP(D2(1,1,NDP(1)+NDP(2)) = O(3)	RIN09000
DJ J00 11-4, NDP(2) NIN0920 I=NDP(1)+NDP(2)-IT+1 RIN09100 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09100 B1(2,1,1)-FVO(1) RIN09100 B2(1,1,1)-FVO(2) RIN09100 D2(1,1,1)-FVO(2) RIN09120 B2(1,1,1)-FVO(3) RIN09130 D2(2,1,1)-FVO(4) RIN09140 CALL RUK(-DX(1)/2,-DP(1)/2,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09160 B1(1,1,NDP(1))-FVO(3) RIN09170 B2(2,1,NDP(1))-FVO(2) RIN09170 B2(2,1,NDP(1))-FVO(3) RIN09210 D0 301 II-2,NDP(1))-FVO(4) RIN09220 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09220 B1(1,1,I)-FVO(1) RIN09220 B1(1,1,I)-FVO(1) RIN09220 B2(2,1,1,I)-FVO(4) RIN09220 C RIN09220 YO(1)=0. RIN09220 YO(1)=0. RIN09220 YO(2)=1. RIN09300 YO(3)=0. RIN09300 YO(3)=0. RIN09300 YO(4)=0. RIN09300 YO(4)=0. RIN0930		B2(2,1,NDP(1)+NDP(2)) = IO(4)	RIN09070
T=NDP(1)+NDP(2)-11+1 NIN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09100 B1(1,1,1)=YO(1) RIN091100 RIN091100 B1(1,1,1)=YO(1) RIN09120 RIN09120 B2(1,1,1)=YO(3) RIN09130 RIN09130 GALL RUK(-DX(2)/2,DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09160 GALL, RUK(-DX(2)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09170 B1(2,1,NDP(1))=YO(2) RIN09130 RIN09190 B2(1,1,NDP(1))=YO(3) RIN09120 RIN09120 D3 01 II=2,NDP(1)=YO(4) RIN09200 RIN09210 D3 01 II=2,NDP(1),-SO(4) RIN09200 RIN09210 B1(1,1,1)=YO(1) RIN09200 RIN09200 B1(1,1,1)=YO(1) RIN09200 RIN09200 B1(1,1,1)=YO(2) RIN09200 RIN09200 B1(1,1,1)=YO(4) RIN09200 RIN09200 YO(1)=0. RIN09200 RIN09200 YO(2)=1. RIN09200 RIN09300 YO(4)=0. RIN09200 RIN09300 YO(4)=0. RIN09300 RIN09300 YO(4)=0. RIN09300 RIN09300 YO(4)=0. RIN09300 RIN09300		DU = SUU = 11 - 2, NDP(2)	RINU9080
CALL RUK (-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,Y1,DJ,CKJ,4) R1N09100 B1(2,1,1)=YO(2) R1N09100 B1(2,1,1)=YO(4) R1N09100 CALL RUK(-DX(2)/2,DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1N09160 B1(1,1,NDP(1))=YO(1) R1N09100 B2(2,1,NDP(1))=YO(2) R1N09100 B2(2,1,NDP(1))=YO(3) R1N09200 D0 301 [1=2,NDP(1) R1N09200 B2(2,1,NDP(1))=YO(4) R1N09200 B2(2,1,NDP(1))=YO(4) R1N09200 B2(2,1,NDP(1))=YO(4) R1N09200 B1(1,1,1,)=YO(1) R1N09200 B2(2,1,NDP(1))=YO(4) R1N09200 B1(1,1,1,)=YO(1) R1N09200 B1(1,1,1,)=YO(1) R1N09200 B1(1,1,1,)=YO(1) R1N09200 B1(1,1,1,)=YO(1) R1N09200 B1(1,1,1)=YO(1) R1N09200 B1(1,1,1)=YO(1) R1N09200 B2(2,1,1)=YO(2) R1N09200 B2(2,1,1)=YO(2) R1N09200 B2(2,1,1)=YO(2) R1N09200 B2(2,1,1)=YO(2) R1N09200 B2(2,1,1)=YO(2) R1N09200 B2(2,1,1)=YO(2) R1N09200 YO(2)=1. R1N09200 YO(2)=1. R1N09200 YO(3)=0. R1N09200 B1(1,2,NDP(1)+NDP(2))=YO(2) R1N09300 C1 R1N09300 B1(1,2,NDP(1)+NDP(2))=YO(1) R1N09300 B1(1,2,NDP(1)+NDP(2))=YO(3) R1N09300 B1(2,2,NDP(1)+NDP(2))=YO(3) R1N09300 B2(2,2,NDP(1)+NDP(2))=YO(3) R1N09300 B2(2,2,NDP(1)+NDP(2))=YO(3) R1N09300 B2(1,2,1)=YO(3) R1N09300 B2(1,2,1)=YO(3) R1N09300 B2(1,2,1)=YO(2) I=H1 R1N09400 CALL RUK(-DX(2)/2,-DP(2)/2,NN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1N09400 B1(1,2,NDP(1)+NDP(2))=YO(4) R1N09400 B1(1,2,NDP(1)+NDP(2))=YO(4) R1N09400 B1(1,2,NDP(1)+NDP(2))=YO(4) R1N09400 B1(1,2,NDP(1)+NDP(2))=YO(4) R1N09400 B1(1,2,NDP(1)+NDP(2))=YO(4) R1N09400 B1(1,2,NDP(1)+NDP(2))=YO(4) R1N09400 B1(1,2,NDP(1))=YO(4) R1N09400 B1(1,2,NDP(1))=YO(4) R1N09400 B1(1,2,NDP(1))=YO(4) R1N09400 B1(1,2,NDP(1))=YO(4) R1N09400 B1(1,2,NDP(1))=YO(4) R1N09400 B1(1,2,NDP(1))=YO(4) R1N09400 B1(1,2,NDP(1))=YO(4) R1N09500 B1(1,2,NDP(1))=YO(4) R1N09500	•	1 = NDP(1) + NDP(2) = 11 + 1	RINU9U9U
<pre>Bill;,,)=V011 KIN09110 Bill;,1,1)=V0(1) KIN09120 B2(1,1,1)=V0(2) KIN09120 GALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09150 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09150 B1(1,1,NDP(1))=V0(1) KIN09150 B2(2,1,NDP(1))=V0(2) RIN09150 B2(2,1,NDP(1))=V0(2) RIN09150 B2(2,1,NDP(1))=V0(2) RIN09150 B2(2,1,NDP(1))=V0(2) RIN09200 D0 301 II=2,NDP(1) KIN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09200 B1(1,1,1)=V0(1) RIN09200 B1(1,1,1)=V0(1) RIN09200 B1(1,1)=V0(2) RIN09200 B1(1,1)=V0(2) RIN09200 B1(2,1,1)=V0(2) RIN09200 B1(2,1,1)=V0(2) RIN09200 B1(2,1,1)=V0(2) RIN09200 B1(2,1,1)=V0(2) RIN09200 B1(2,1,1)=V0(2) RIN09200 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09200 B1(2,1,1)=V0(2) RIN09200 Y0(1)=0. RIN09200 Y0(2)=1. RIN09200 Y0(2)=1. RIN09200 Y0(2)=1. RIN09200 S1(1,2,NDP(1)+NDP(2))=V0(2) RIN09300 RIN09300 Y0(3)=0. RIN09300 B1(1,2,NDP(1)+NDP(2))=V0(2) RIN09300 B1(1,2,NDP(1)+NDP(2))=V0(2) RIN09300 B1(1,2,NDP(1)+NDP(2))=V0(3) RIN09300 B1(1,2,NDP(1)+NDP(2))=V0(3) RIN09300 GALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09300 GALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09300 GALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09300 GALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 GALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 GALL RUK(-DX(2),-DP(1)/2,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 GALL RUK(-DX(1)/2,-DP(1)/2,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(1,2,NDP(1))=V0(1) RIN09400 B1(1,2,NDP(1))=V0(1) RIN09400 B1(1,2,NDP(1))=V0(1) RIN09500 B1(1,2,NDP(1))=V0(1) RIN09500 B1(1,2,NDP(1))=V0(1) RIN09500 B1(1,2,NDP(1))=V0(2) RIN09500 B1(1,2,NDP(1))=V0(2) RIN09500 B1(1,2,NDP(1))=V0(2) RIN09500 B1(1,2,NDP(1))=V0(3) RIN09500 B1(1,2,NDP(1))=V0(4) RIN09500 B1(1,2,NDP(1))=V0(4) RIN09500 B1(1,2,NDP(1))=V0(4) RIN09500 B1(1,2,NDP(1))=V0(4) RIN09500 B1(1,2,NDP(1))=V0(4) RIN09500 B1(1,2,NDP(1))=V0(4) RIN09500 B1(2,2,NDP(1))=V0(4) RIN09500 B1(2,2,NDP(1))=V0(4) RIN09500 B1(2,2,NDP(1))=V0(4) RIN09500 B1(2,2,</pre>		CALL $RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)$	RINU9100
B1(2,1,1)=YO(2) R1M09120 B2(2,1,1)=YO(3) R1M09130 CALL RUK(-DX(2)/2,DP(2)/2,.XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1M09150 CALL RUK(-DX(1)/2,DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1M09150 B1(1,1,NDP(1))=YO(1) R1M09160 B1(1,1,NDP(1))=YO(2) R1M09160 B2(1,1,NDP(1))=YO(3) R1M09120 B2(1,1,NDP(1))=YO(4) R1M09200 D0 301 II=2,NDP(1) R1M09200 CALL RUK(-CX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1M09200 B1(1,1,1)=YO(1) R1M09200 B1(1,1,1)=YO(1) R1M09200 CALL RUK(-CX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1M09200 B1(2,1,1)=YO(4) R1M09200 C R1M09200 YO(1)=0. R1M09200 YO(3)=0. R1M09200 YO(4)=0. R1M09300 YO(3)=0. R1M09300 YO(4)=0. R1M09300		B1(1,1,1)=YO(1)	RINU9110
B2(1,1,1)=YO(3) RIN09140 00 B2(2,1,1)=YO(4) RIN09140 CALL RUK(-DX(1)/2,.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09150 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09150 B1(1,1,NDP(1))=YO(1) RIN09160 B1(1,1,NDP(1))=YO(2) RIN09160 B2(1,1,I)=YO(1) RIN09170 B2(2,1,NDP(1))=YO(4) RIN09200 D0 301 II=2,NDP(1) RIN09200 D0 301 II=2,NDP(1) RIN09200 B1(1,1,I)=YO(2) RIN09200 B1(1,1,I)=YO(2) RIN09200 B1(1,1,I)=YO(2) RIN09200 B1(1,1,I)=YO(2) RIN09200 B1(1,1,I)=YO(2) RIN09200 B1(1,1,I)=YO(2) RIN09200 B1(1,2,I)=YO(2) RIN09200 YO(1)=O. RIN09220 YO(2)=1. RIN09200 YO(2)=1. RIN09200 YO(1)=0. RIN09200 YO(2)=1. RIN09300 YO(4)=0. RIN09300 YO(4)=0. RIN09300 YO(1)=0. RIN09300		B1(2,1,1)=YO(2)	R1N09120
300 B2(2,1,1)=YO(4) RIN09140 CALL RUK(-DX(1)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09150 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09160 B1(1,1,NDP(1))=YO(1) RIN09150 B2(1,1,NDP(1))=YO(2) RIN09150 B2(1,1,NDP(1))=YO(3) RIN09200 D0 301 II=2,NDP(1) RIN09200 D0 301 II=2,NDP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09220 B1(1,1,1)=YO(1) RIN09200 B1(2,1,1)=YO(2) RIN09200 B1(1,1,1)=YO(1) RIN09200 B1(2,1,1)=YO(2) RIN09200 B1(2,1,1)=YO(2) RIN09200 B1(2,1,1)=YO(3) RIN09200 YO(1)=-0. RIN09200 YO(1)=-0. RIN09200 YO(2)=1. RIN09300 YO(4)=0. RIN09301 YO(4)=0. RIN09300		B2(1,1,1)=YO(3)	RIN09130
CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09150 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09150 B1(1,1,NDP(1))=YO(1) RIN09150 B2(2,1,NDP(1))=YO(2) RIN09150 D0 301 II=2,NDP(1))=YO(4) RIN09200 D0 301 II=2,NDP(1))=YO(4) RIN09200 B1(1,1,I)=YO(1) RIN09200 B1(1,1,I)=YO(1) RIN09200 B1(1,1,I)=YO(1) RIN09200 B1(2,1,I)=YO(2) RIN09230 B1(1,1,I)=YO(2) RIN09250 B2(1,1,I)=YO(2) RIN09250 C2(2,1,I)=YO(4) RIN09260 YO(1)=0. RIN09260 YO(1)=0. RIN09260 YO(1)=0. RIN09270 YO(2)=1. RIN09270 YO(3)=0. RIN09270 B1(2,2,NDP(1)+NDP(2))=YO(1) RIN09310 S1(2,2,NDP(1)+NDP(2))=YO(2) RIN09370 B2(1,2,NDP(1)+NDP(2))=YO(2) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09370 B2(2,2,I)=YO(2) RIN09370 B2(1,2,I)=YO(2) RIN09370 B2(1,2,I)=YO(2) RIN09370 B2(2,2,I)=YO(2) RIN09370 B2(2,2,I)=YO(2) RIN09370 B2(2,2,I)=YO(2) RIN09400 RIN09370 B2(1,2,I)=YO(2) RIN09400 RIN09370 B2(1,2,I)=YO(2) RIN09400 B1(1,2,I)=YO(1) RIN09400 B1(1,2,I)=YO(1) RIN09400 B1(1,2,I)=YO(1) RIN09400 B1(1,2,I)=YO(1) RIN09400 B1(1,2,I)=YO(1) RIN09400 B1(1,2,I)=YO(1) RIN09400 B1(2,2,I)=YO(2) RIN0,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09410 B1(1,2,I)=YO(1) RIN09400 B1(2,2,I)=YO(3) RIN09400 B1(2,2,NDP(1))=YO(2) RIN0,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(2,2,NDP(1))=YO(2) RIN0,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(2,2,NDP(1))=YO(2) RIN09400 B1(2,2,NDP(1))=YO(2) RIN09400 B1(2,2,NDP(1))=YO(2) RIN09400 B1(2,2,NDP(1))=YO(2) RIN09400 B1(2,2,NDP(1))=YO(3) RIN09500 B2(1,2,NDP(1))=YO(3) RIN09500 B2(1,2,NDP(1))=YO(3) RIN09500 B2(1,2,NDP(1))=YO(2) RIN09500 B2(1,2,NDP(1))=YO(2) RIN09500 B2(1,2,NDP(1))=YO(2) RIN05500 B1(1,2,I)=YO(2) RIN05500 B1(1,2,I)=YO(2) RIN05500 B1(1,2,I)=YO(2) RIN05500 B1(1,2,I)=YO(2) RIN05500 B1(1,2,I)=YO(2) RIN05500 B1(1,2,I)=YO(2) RIN05500 B1(2,2,I)=YO(4) RIN05500 B1(2,2,I)=YO(4) RIN05500 B1(1,2,I)=YO(2) RIN05500 B1(2,2,I)=YO(4) RIN05500 B1(2,2,I)=YO(4) RIN05500 B1(2,2,I)=YO(2) RIN05500 B1(2,2,I)=	300	B2(2,1,1)=YO(4)	RIN09140
CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09160 B1(1,1,NDP(1))=YO(2) RIN0910 B2(2,1,NDP(1))=YO(3) RIN09100 D3 01 II=2,NDP(1)=YO(4) RIN09210 I=NDP(1)=II+1 RIN09220 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09230 B1(1,1,1)=YO(1) RIN09240 B1(2,1,1)=YO(2) RIN09260 B2(1,1,1)=YO(3) RIN09260 C301 B2(2,1,1)=YO(4) RIN09270 C4U RUN09270 C4U RUN09270 RIN09370 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09370 B1(1,2,NDP(1)+NDP(2))=YO(2) RIN09370 B1(1,2,NDP(1)+NDP(2))=YO(4) RIN09400 C4U RUN(-DX(1)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(1) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(1) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(1,2,NDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 B2(2,2,DDP(1))=YO(2) RIN09400 RIN09400 RIN09400 RIN09400 RIN09400 RIN09400 RIN09400 RIN09400 RIN09400 RIN09400 RIN		CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN09150
B1(1,1,NPP(1))=YO(1) B1(2,1,NPP(1))=YO(2) B2(2,1,NPP(1))=YO(3) B2(2,1,NPP(1))=YO(4) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,1,T)=YO(1) B1(1,1,T)=YO(1) B1(2,1,T)=YO(2) B2(1,1,T)=YO(2) C(T) C		CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN09160
<pre>B1(2,1,NPP(1))=Y0(2) B1(2,1,NPP(1))=Y0(2) B2(2,1,NDP(1))=Y0(4) B2(2,1,NDP(1))=Y0(4) B1(2,1,NDP(1))=Y0(4) B1(2,1,NDP(1))=Y0(1) I=NDP(1)-T1+1 RIN09220 CALL RUK(-DX(1),-DP(1),XNN,XNN,Y0,Y0,4,DFN1,YT,DJ,CKJ,4) B1(1,1,I)=Y0(1) B1(1,1,I)=Y0(2) B2(1,1,I)=Y0(2) C C C Y0(1)=0. RIN09260 Y0(2)=1. Y0(1)=0. RIN09270 Y0(2)=1. RIN09310 Y0(4)=0. RIN09310 Y0(4)=0. RIN09310 B1(1,2,NDP(1)+NDP(2))=Y0(1) B1(1,2,NDP(1)+NDP(2))=Y0(2) B1(2,2,NDP(1)+NDP(2))=Y0(3) B2(2,2,NDP(1)+NDP(2))=Y0(4) B1(2,2,I)=Y0(4) B1(2,2,I)=Y0(4) B1(2,2,I)=Y0(2) B2(2,2,I)=Y0(2) RIN09360 C C RIN09360 D0 400 II=2,NDP(2))=Y0(3) RIN09370 B2(2,2,NDP(1)+NDP(2))=Y0(4) RIN09370 B2(2,2,I)=Y0(1) RIN09370 R2(2,2,I)=Y0(1) RIN09370 R2(2,2,I)=Y0(2) RIN09420 R1(2,2,I)=Y0(2) RIN09420 R1(2,2,I)=Y0(2) RIN09420 R1(2,2,I)=Y0(2) RIN09420 R1(2,2,NDP(1))=Y0(2) RIN09420 R1(2,2,NDP(1))=Y0(1) RIN09420 R1(2,2,NDP(1))=Y0(2) R1(NDYED R1(1,2,I)=Y0(2) R1(NDYED R1(NDYED</pre>		B1(1,1,NDP(1))=YO(1)	RIN09170
B2(1,1,NPP(1))=YO(3) RIN09190 B2(1,1,NPP(1))=YO(4) RIN09200 D0 301 II=2,NDP(1) RIN09210 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09230 B1(1,1,I)=YO(1) RIN09240 B1(1,1,I)=YO(2) RIN09260 B2(1,1,I)=YO(3) RIN09260 B2(2,1,I)=YO(3) RIN09260 YO(1)=0. RIN09270 YO(1)=0. RIN09270 YO(2)=1. RIN09270 YO(4)=0. RIN09280 XNN=1. RIN09310 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09310 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(2) RIN09360 B2(2,2,NDP(1)+NDP(2))=YO(2) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09380 D0 400 II=2,NDP(2) RIN09370 B2(1,2,1)=YO(1) RIN09400 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 CALL RUK(-DX(2),-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(1,2,1)=YO(1) RIN09400 RIN09400 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN0		B1(2,1,NDP(1))=YO(2)	RIN09180
B2(2,1,BDP(1))=YO(4) RIN09200 DO 301 LI=2,NDP(1) RIN09210 L=NDP(1)-II+1 RIN09210 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09240 B1(1,1,I)=YO(1) RIN09240 B1(2,1,I)=YO(2) RIN09240 B2(1,1,I)=YO(3) RIN09270 C RIN09270 YO(1)=0. RIN09280 YO(2)=1. RIN09300 YO(3)=0. RIN09310 YO(4)=0. RIN09310 XNN=1. RIN09310 CLL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09340 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09360 B2(1,2,XDP(1)+NDP(2))=YO(3) RIN09360 B2(1,2,XDP(1)+NDP(2))=YO(4) RIN09390 D=Ado 11=2,NDP(2) RIN09360 B1(1,2,1)=YO(1) RIN09360 B1(2,2,1)=YO(3) RIN09400 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(1,2,1)=YO(3) RIN09400 B1(1,2,1)=YO(3) RIN09400 B1(1,2,1)=YO(1) RIN09400 B1(1,2,XDP(1))=YO(2) RIN09400 B1(2,2,XDP(1))=YO(2)		B2(1,1,NDP(1))=YO(3)	RIN09190
D0 301 II=2,NDP(1) RIN09210 I=NDP(1)-II+1 RIN09220 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09230 B1(1,1,I)=YO(2) RIN09250 B2(1,1,I)=YO(3) RIN09250 C RIN09250 YO(1)=0. RIN09250 YO(2)=1. RIN09250 YO(3)=0. RIN09250 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09310 YO(4)=0. RIN09310 YO(4)=0. RIN09310 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09350 B1(1,2,XDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,XDP(1)+NDP(2))=YO(2) RIN09350 B1(2,2,XDP(1)+NDP(2))=YO(3) RIN09350 D0 400 II=2,NDP(2)=II+1 RIN09360 D0 400 II=2,NDP(2)=II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(1,2,1)=YO(3) RIN09400 B1(1,2,1)=YO(3) RIN09400 B1(1,2,1)=YO(3) RIN09400 B1(1,2,1)=YO(3) RIN09400 B1(2,2,I)=YO(2) RIN09400 B1(2,2,I)=YO(2) RIN09400 B1(2,2,I)=YO(2) RIN09400 B1(2,2,I)=YO(3) RIN09400 B1(2,2,I)=YO(3) RIN09400 B1(2,2,I)=YO(3) RIN09400 B1(2,2,I)=YO(3) RIN09400 B1(1,2,NDP(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(2) RIN09400 B1(1,2,NDP(1))=YO(3) RIN09500 B2(2,2,NDP(1))=YO(3) RIN09500 B		B2(2,1,NDP(1))=YO(4)	RIN09200
I=NDP(1)-II+1 RIN09220 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09230 B1(1,1,I)=YO(1) RIN09240 B1(2,1,I)=YO(2) RIN09250 B2(1,1,I)=YO(3) RIN09260 301 B2(2,1,I)=YO(4) RIN09270 C RIN09290 YO(1)=0. RIN09290 YO(2)=1. RIN09290 YO(4)=0. RIN09310 XNN=1. RIN09320 CLL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09300 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(2) RIN09350 B2(1,2,XDP(1)+NDP(2))=YO(3) RIN09380 D0 400 II=2,NDP(2) RIN09380 D0 400 II=2,NDP(2) RIN09310 R1N09420 RIN09420 B1(1,2,I)=YO(1) RIN09420 <td></td> <td>DO 301 II=2,NDP(1)</td> <td>RIN09210</td>		DO 301 II=2,NDP(1)	RIN09210
CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09230 B1(1,1,I)=YO(1) RIN09240 B1(2,1,I)=YO(2) RIN09250 B2(1,1,I)=YO(3) RIN09250 YO(1)=0. RIN09290 YO(2)=1. RIN09290 YO(4)=0. RIN09301 YO(4)=0. RIN09302 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09330 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(2) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(3) RIN09350 D3(2,2,NDP(1)+NDP(2))=YO(4) RIN09350 D400 II=2,NDP(2) =YO(4) RIN09380 D0 400 II=2,NDP(2) =YO(4) RIN09380 D0 400 II=2,NDP(2) =YO(4) RIN09380 B1(1,2,I)=YO(1) RIN0920 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 R1(2,2,I)=YO(2) RIN09400 B1(1,2,I)=YO(2) RIN09400 B1(1,2,I)=YO(2) RIN09400 B1(1,2,I)=YO(2) RIN09400 B1(1,2,NDP(1)+DP(2))=YO(4) RIN09400 B1(1,2,I)=YO(3) RIN09440 B1(1,2,NDP(1))=YO(3) RIN09440 CALL RUK(-DX(1)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(1,2,NDP(1))=YO(1) RIN09400 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 D1=NDP(1)=11+1 RIN0950 D1=NDP(1)=YO(3) RIN0950 B1(1,2,I)=YO(3) RIN0950 B2(1,2,I)=YO(4) RIN09550 B1(2,2,I)=YO(4) RIN09550 B1(2,2,I)=YO(4) RIN09550 B2(2,2,I)=YO(4) RIN09550 B2(2,2,I)=YO(4) RIN09550 B1(2,2,I)=YO(4) RIN09550 B2(2,2,I)=YO(4) RIN09550 B2(2,2,I)=YO(4) RIN09550		I = NDP(1) - II + 1	RIN09220
B1(1,1,1)=Y0(1) B1(2,1,1)=Y0(2) B1(2,1,1)=Y0(3) C Y0(1)=0. Y0(1)=0. Y0(2)=1. Y0(4)=0. XNN=1. CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1)+NDP(2))=Y0(1) B1(2,2,NDP(1)+NDP(2))=Y0(2) B1(2,2,NDP(1)+NDP(2))=Y0(3) B2(1,2,NDP(1)+NDP(2))=Y0(4) B1(1,2,1)=Y0(1) B1(2,2,1)=Y0(1) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,NDP(1)+NDP(2))=XO(3) B2(1,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,NDP(1))=Y0(2) B1(1,2,1)=Y0(1) B1(2,2,1)=Y0(1) B1(1,2,1)=Y0(1) B1(1,2,1)=Y0(1) B1(1,2,1)=Y0(1) B1(1,2,1)=Y0(1) B1(1,2,1)=Y0(1) B1(1,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(1,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,2,1)=Y0(2) B1(2,		CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN09230
B1(2,1,1)=YO(2) B2(1,1,1)=YO(3) RIN09250 R1N09260 R1N09280 YO(1)=0. YO(2)=1. YO(1)=0. YO(2)=1. R1N09300 YO(3)=0. YO(4)=0. XNN=1. CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1)+NDP(2))=YO(1) B1(2,2,NDP(1)+NDP(2))=YO(2) B1(2,2,NDP(1)+NDP(2))=YO(2) B1(2,2,NDP(1)+NDP(2))=YO(3) B2(2,2,NDP(1)+NDP(2))=YO(4) B2(1,2,NDP(1)+NDP(2))=YO(4) B1(1,2,1)=YO(1) B1(1,2,1)=YO(1) B1(1,2,1)=YO(2) CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,1)=YO(1) B1(1,2,1)=YO(2) CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,1)=YO(1) B1(1,2,NDP(1)=YO(2) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1)=YO(1) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1N09440 B2(1,2,NDP(1))=YO(2) CALL RUK(-DX(2)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1N09440 B1(1,2,NDP(1))=YO(3) B1(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(3) B1(1,2,1)=YO(1) B1(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(3) B1(1,2,1)=YO(1) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1N09500 B2(2,2,NDP(1))=YO(3) B1(1,2,1)=YO(1) B1(1,2,1)=YO(1) B1(1,2,1)=YO(1) B1(1,2,1)=YO(1) B1(1,2,1)=YO(1) B1(1,2,1)=YO(2) B1(1,2,1)=YO(2) B1(1,2,1)=YO(3) B1(1,2,1)=YO(3) B1(2,2,1)=YO(4) CALL RUK(-DX(2)/2.,2NN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1N09550 B2(1,2,1)=YO(4) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) R1N09550 B2(1,2,1)=YO(4) B1(1,2,1)=YO(B1(1,1,I)=YO(1)	RIN09240
B2(1,1,1)=YO(3) B2(2,1,1)=YO(4) C YO(1)=0. YO(2)=1. N(N09280 YO(2)=1. RIN09280 YO(4)=0. XNN=1. C C C C C C C C C C C C C		B1(2,1,I)=YO(2)	RIN09250
301 B2(2,1,I)=YO(4) RIN09270 C RIN09280 YO(1)=0. RIN09290 YO(2)=1. RIN09300 YO(3)=0. RIN09310 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09340 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(2) RIN09360 B2(1,2,NDP(1)+NDP(2))=YO(3) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09380 D0 400 II=2,NDP(2) I=NDP(1)+NDP(2)=YO(4) RIN09380 B1(1,2,I)=YO(1) RIN09410 B1(1,2,I)=YO(1) RIN09410 B1(1,2,I)=YO(1) RIN09440 CALL RUK(-DX(2),-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(1,2,I)=YO(3) RIN09440 B1(1,2,I)=YO(3) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(1,2,NDP(1))=YO(2) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(1,2,NDP(1))=YO(1) RIN09440 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(2,2,NDP(1))=YO(2) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 B1(1,2,NDP(1))=YO(2) RIN09510 B0(401 II=2,NDP(1) RIN09510 B0(401 II=2,NDP(1) RIN09550 B2(1,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(4) RIN09550 B2(1,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(4) RIN09550 B1(2,2,I)=YO(B2(1,1,I)=YO(3)	RIN09260
C RIN09280 YO(1)=0. RIN09290 YO(2)=1. RIN09300 YO(3)=0. RIN09310 XNN=1. RIN09310 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09340 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B2(1,2,NDP(1)+NDP(2))=YO(2) RIN09370 B2(1,2,NDP(1)+NDP(2))=YO(3) RIN09370 D0 400 II=2,NDP(2) = YO(4) RIN09380 D0 400 II=2,NDP(2) = YO(4) RIN09380 D0 400 II=2,NDP(2) = II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09410 B1(1,2,I)=YO(1) RIN09420 B2(2,2,I)=YO(2) RIN09430 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B2(2,2,I)=YO(3) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(2,2,NDP(1))=YO(2) RIN09450 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 B1(2,2,NDP(1))=YO(2) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 B1(2,2,NDP(1))=YO(2) RIN09500 B2(2,2,NDP(1))=YO(4) RIN09550 B2(2,2,NDP(1))=YO(4) RIN09550 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09550 B1(2,2,I)=YO(1) RIN09550 B1(2,2,I)=YO(1) RIN09550 B1(2,2,I)=YO(3) RIN09550 B2(1,2,I)=YO(4) RIN09550 B2(1,2,I)=YO(4) RIN09550 B2(1,2,I)=YO(4) RIN09550 B2(1,2,I)=YO(4) RIN09550	301	B2(2,1,I)=YO(4)	RIN09270
Y0(1)=0. RIN09290 Y0(2)=1. RIN09310 Y0(3)=0. RIN09310 Y0(4)=0. RIN09310 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09350 B1(1,2,NDP(1)+NDP(2))=Y0(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=Y0(2) RIN09350 B2(1,2,NDP(1)+NDP(2))=Y0(3) RIN09370 B2(2,2,NDP(1)+NDP(2))=Y0(4) RIN09380 D0 400 II=2,NDP(2) -II+1 RIN09380 I=NDP(1)+NDP(2)-II+1 RIN09390 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09420 B1(2,2,1)=Y0(1) RIN09430 B2(1,2,I)=Y0(3) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(1,2,NDP(1))=Y0(1) RIN09450 CALL RUK(-DX(1)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 B1(2,2,ADP(1))=Y0(2) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 B1(2,2,NDP(1))=Y0(3) RIN09550 B2(1,2,NDP(1))=Y0(4) RIN09550 B2(1,2,I)=Y0(4) RIN09550 B2(1,2,I)=Y0(3) RIN09550 B2(1,2,I)=Y0(3) RIN09550 B1(2,2,I)=Y0(4) RIN09550 B1(2,2,I)=Y0(4) RIN09550 B1(2,2,I)=Y0(2) RIN09550 B1(2,2,I)=Y0(2) RIN09550 B1(2,2,I)=Y0(2) RIN09550 B1(2,2,I)=Y0(2) RIN09550 B1(2,2,I)=Y0(2) RIN09550 B1(2,2,I)=Y0(2) RIN09550 B1(2,2,I)=Y0(4) RIN09550 B1(2,2,I)=Y0(4) RIN09550 B1(2,2,I)=Y0(4) RIN09550	С	· ·	RIN09280
Y0(2)=1. RIN09300 Y0(3)=0. RIN09310 Y0(4)=0. RIN09320 XNN=1. RIN09320 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09340 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(2) RIN09360 B2(1,2,NDP(1)+NDP(2))=YO(4) RIN09380 D0 400 II=2,NDP(2) RIN09380 D0 400 II=2,NDP(2) RIN09380 I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(1,2,I)=YO(1) RIN09401 B1(2,2,I)=YO(2) RIN09401 B1(2,2,I)=YO(2) RIN09400 CALL RUK(-DX(2),-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(2,2,I)=YO(3) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 CALL RUK(-DX(2)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(1,2,NDP(1))=YO(1) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 B1(1,2,NDP(1))=YO(3) RIN09450 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 B1(1,2,I)=YO(3) RIN09510 D0 401 II=2,NDP(1) =YO(4) RIN09510 B2(2,2,NDP(1))=YO(4) RIN09510 D0 401 II=2,NDP(1) =YO(4) RIN09510 B1(1,2,I)=YO(3) RIN09510 B1(1,2,I)=YO(3) RIN09510 B1(2,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(4) RIN09550		YO(1)=0.	RIN09290
Y0(3)=0. RIN09310 Y0(4)=0. RIN09320 XNN=1. RIN09330 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09360 B1(1,2,NDP(1)+NDP(2))=YO(2) RIN09360 B2(1,2,NDP(1)+NDP(2))=YO(3) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09380 D0 400 II=2,NDP(2) RIN09390 I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(2,2,I)=YO(1) RIN09400 B2(1,2,I)=YO(1) RIN09400 B2(1,2,I)=YO(3) RIN09430 B2(1,2,I)=YO(3) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B1(1,2,NDP(1))=YO(4) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(2)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 B1(2,2,NDP(1))=YO(3) RIN09450 B2(1,2,NDP(1))=YO(4) RIN09500 B2(1,2,NDP(1))=YO(4) RIN09500 B2(1,2,NDP(1))=YO(4) RIN09500 B2(1,2,NDP(1))=YO(4) RIN09500 B2(1,2,NDP(1))=YO(4) RIN09500 B2(1,2,I)=YO(3) RIN09500 B2(1,2,I)=YO(3) RIN09500 B2(1,2,I)=YO(3) RIN09500 B2(1,2,I)=YO(4) RIN09500 B2(1,2,I)=Y		YO(2)=1.	RIN09300
Y0(4)=0. RIN09320 XNN=1. RIN09330 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09340 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(3) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09380 D0 400 II=2,NDP(2) RIN09380 I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09410 B1(1,2,I)=YO(1) RIN09420 B1(2,2,I)=YO(2) RIN09430 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B2(2,2,I)=YO(2) RIN09440 B1(2,2,I)=YO(2) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 B1(1,2,NDP(1))=YO(1) RIN09450 B1(1,2,NDP(1))=YO(2) RIN09510 B2(2,2,NDP(1))=YO(4) RIN09510 B2(2,2,NDP(1))=YO(4) RIN09550 B1(1,2,I)=YO(2) RIN09550 B1(1,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(3) RIN09550 B1(2,2,I)=YO(4) RIN09550		YO(3)=0.	RIN09310
<pre>XNN=1. RIN09330 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09340 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B2(1,2,NDP(1)+NDP(2))=YO(2) RIN09360 B2(1,2,NDP(1)+NDP(2))=YO(3) RIN09380 D0 400 II=2,NDP(2) =YO(4) RIN09380 I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09410 B1(1,2,I)=YO(1) RIN09420 B1(1,2,I)=YO(2) RIN09440 B2(1,2,I)=YO(2) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B2(1,2,I)=YO(3) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 B1(1,2,NDP(1))=YO(1) RIN09450 B1(1,2,NDP(1))=YO(2) RIN09450 B1(1,2,NDP(1))=YO(2) RIN09450 B1(1,2,NDP(1))=YO(2) RIN09450 B1(1,2,NDP(1))=YO(2) RIN09450 B1(1,2,NDP(1))=YO(4) RIN09550 B2(1,2,NDP(1))=YO(4) RIN09550 B1(2,2,I)=YO(4) RIN09550 B1(2,2,I)=YO(4) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(2) RIN09550 B1(2,2,I)=YO(4) RIN09550 C</pre>		YO(4)=0.	RIN09320
CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09340 B1(1,2,NDP(1)+NDP(2))=YO(1) RIN09350 B1(2,2,NDP(1)+NDP(2))=YO(2) RIN09360 B2(2,2,NDP(1)+NDP(2))=YO(3) RIN09370 B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09380 D0 400 II=2,NDP(2) RIN09390 I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09410 B1(1,2,I)=YO(1) RIN09420 B1(2,2,I)=YO(2) RIN09430 B2(1,2,I)=YO(3) RIN09440 CALL RUK(-DX(1)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(1)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 B1(2,2,NDP(1))=YO(1) RIN09480 B1(2,2,NDP(1))=YO(2) RIN09480 B1(2,2,NDP(1))=YO(2) RIN09480 B1(2,2,NDP(1))=YO(3) RIN09480 B1(2,2,NDP(1))=YO(3) RIN09490 B2(1,2,NDP(1))=YO(4) RIN09510 D0 401 II=2,NDP(1) RIN09510 B1(2,2,I)=YO(1) RIN09500 B2(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(3) RIN09500 B1(2,2,I)=YO(4) RIN09580 C RIN09580 RIN09580		XNN=1.	RIN09330
B1(1,2,NDP(1)+NDP(2))=YO(1) B1(2,2,NDP(1)+NDP(2))=YO(2) B2(1,2,NDP(1)+NDP(2))=YO(3) B2(2,2,NDP(1)+NDP(2))=YO(4) B2(2,2,NDP(1)+NDP(2))=YO(4) CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(1,2,I)=YO(2) B1(2,2,I)=YO(2) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B2(1,2,I)=YO(3) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(2)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(1,2,NDP(1))=YO(1) B1(1,2,NDP(1))=YO(2) B1(1,2,NDP(1))=YO(4) CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09480 B1(2,2,NDP(1))=YO(4) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09500 B2(2,2,NDP(1))=YO(4) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09500 B1(1,2,I)=YO(2) RIN09500 B1(1,2,I)=YO(4) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(4) C C RIN09500 B1(2,2,I)=YO(4) RIN09500 B1(2,2,I)=YO(4) RIN09500 RIN0950		CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN09340
B1(2,2,NDP(1)+NDP(2))=YO(2) B2(1,2,NDP(1)+NDP(2))=YO(3) B2(2,2,NDP(1)+NDP(2))=YO(4) C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)-TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(2)=TI+1 C4L2,NDP(1)=YO(4) C4L2,NDP(1)=YO(1) B1(1,2,NDP(1))=YO(2) B1(2,2,NDP(1))=YO(2) B1(2,2,NDP(1))=YO(2) B1(1,2,NDP(1))=YO(2) C4L2,NDP(1)=YO(2) C4D2		B1(1,2,NDP(1)+NDP(2))=YO(1)	RIN09350
B2(1,2,NDP(1)+NDP(2))=Y0(3) RIN09370 B2(2,2,NDP(1)+NDP(2))=Y0(4) RIN09380 D0 400 II=2,NDP(2) RIN09390 I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(1,2,I)=Y0(1) RIN09430 B2(1,2,I)=Y0(3) RIN09440 400 B2(2,2,I)=Y0(3) RIN09440 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09470 B1(1,2,NDP(1))=Y0(1) RIN09450 B1(2,2,NDP(1))=Y0(2) RIN09450 B2(2,2,NDP(1))=Y0(2) RIN09510 B2(2,2,NDP(1))=Y0(4) RIN09510 D0 401 II=2,NDP(1) RIN09510 I=NDP(1)-II+1 RIN09510 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09540 B1(1,2,I)=Y0(1) RIN09550 B1(2,2,I)=Y0(2) RIN09570 B1(1,2,I)=Y0(1) RIN09560 B2(1,2,I)=Y0(2) RIN09570 B1(2,2,I)=Y0(2) RIN09560 B2(1,2,I)=Y0(3) <td></td> <td>B1(2,2,NDP(1)+NDP(2))=YO(2)</td> <td>RIN09360</td>		B1(2,2,NDP(1)+NDP(2))=YO(2)	RIN09360
B2(2,2,NDP(1)+NDP(2))=YO(4) RIN09380 DO 400 II=2,NDP(2) RIN09390 I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 B1(1,2,I)=YO(1) RIN09400 B2(2,2,I)=YO(2) RIN09400 B2(1,2,I)=YO(2) RIN09400 B2(1,2,I)=YO(2) RIN09400 B2(1,2,I)=YO(2) RIN09400 B2(2,2,I)=YO(4) RIN09400 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 CALL RUK(-DX(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(1) RIN09400 B1(1,2,NDP(1))=YO(2) RIN09400 B1(1,2,NDP(1))=YO(2) RIN09500 B2(2,2,NDP(1))=YO(3) RIN09510 B2(2,2,NDP(1))=YO(4) RIN09510 D0 401 II=2,NDP(1) RIN09500 B1(1,2,1)=YO(1) RIN09500 B1(1,2,1)=YO(1) RIN09500 B1(1,2,1)=YO(1) RIN09500 B1(1,2,1)=YO(1) RIN09500 B1(1,2,1)=YO(1) RIN09500 B1(2,2,1)=YO(2) RIN09500		B2(1,2,NDP(1)+NDP(2))=YO(3)	RIN09370
DO 400 II=2,NDP(2) I=NDP(1)+NDP(2)-II+1 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09440 B2(2,2,I)=YO(4) CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(1,2,NDP(1))=YO(2) B1(1,2,NDP(1))=YO(3) B1(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(1,2,I)=YO(2) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B1(2,2,I)=YO(3) C 401 B2(2,2,I)=YO(4) C B1(1,2,		B2(2,2,NDP(1)+NDP(2))=YO(4)	RIN09380
<pre>I=NDP(1)+NDP(2)-II+1 RIN09400 CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09410 B1(1,2,I)=YO(1) RIN09420 B1(2,2,I)=YO(2) RIN09430 B2(1,2,I)=YO(3) RIN09440 400 B2(2,2,I)=YO(4) RIN09450 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 B1(1,2,NDP(1))=YO(1) RIN09480 B1(2,2,NDP(1))=YO(2) RIN09490 B2(1,2,NDP(1))=YO(3) RIN09500 B2(2,2,NDP(1))=YO(4) RIN09510 D0 401 II=2,NDP(1) I=NDP(1)-II+1 RIN09510 B1(1,2,I)=YO(1) RIN09500 B1(1,2,I)=YO(1) RIN09500 B1(2,2,I)=YO(1) RIN09500 B1(2,2,I)=YO(2) RIN09500 B1(2,2,I)=YO(4) RIN09570 401 B2(2,2,I)=YO(4) RIN09580 C</pre>		DO 400 II=2,NDP(2)	RIN09390
CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(3) 400 B2(2,2,I)=YO(4) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09400 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(1,2,NDP(1))=YO(2) B1(1,2,NDP(1))=YO(2) B1(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(1,2,I)=YO(2) CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(2) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) C 401 B2(2,2,I)=YO(4) C RIN09500 RIN0950		I=NDP(1)+NDP(2)-II+1	RIN09400
B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 400 B2(2,2,I)=YO(4) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(2,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B1(2,2,I)=YO(4) C 401 B2(2,2,I)=YO(4) C C RIN09500 B1(2,2,I)=YO(4) C RIN09500 B1(2,2,I)=YO(4) C RIN09500 RIN0950		CALL RUK(-DX(2),-DP(2),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN09410
B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 400 B2(2,2,I)=YO(4) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09450 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(2,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(2) B2(2,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B1(2,2,I)=YO(3) C 401 B2(2,2,I)=YO(4) C		B1(1,2,I)=YO(1)	RIN09420
B2(1,2,I)=YO(3) 400 B2(2,2,I)=YO(4) CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(1,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(2) B2(2,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B1(2,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C B1(2,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C B1(1,2,I)=YO(4) C C B1(1,2,I)=YO(4) C C C C C C C C C C C C C		B1(2,2,I)=YO(2)	RIN09430
400 B2(2,2,1)=YO(4) RIN09450 CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09460 B1(1,2,NDP(1))=YO(1) RIN09450 B1(2,2,NDP(1))=YO(2) RIN09450 B2(2,2,NDP(1))=YO(3) RIN09450 B2(2,2,NDP(1))=YO(4) RIN09510 D0 401 II=2,NDP(1) RIN09520 I=NDP(1)-II+1 RIN09530 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09540 B1(1,2,I)=YO(1) RIN09500 B1(1,2,I)=YO(1) RIN09500 B1(2,2,I)=YO(2) RIN09500 B2(1,2,I)=YO(2) RIN09500 B2(1,2,I)=YO(4) RIN09500 B2(1,2,I)=YO(4) RIN09500		B2(1,2,1)=YO(3)	RIN09440
CALL RUK(-DX(2)/2.,-DP(2)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(1,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C ALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09500 B1(1,2,I)=YO(3) AND B2(2,2,I)=YO(4) C RIN09500 RI	400	B2(2,2,1)=YO(4)	RIN09450
CALL RUK(-DX(1)/2.,-DP(1)/2.,XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,NDP(1))=YO(1) B1(2,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09500 B1(1,2,I)=YO(4) RIN09500 B1(1,2,I)=YO(3) C RIN09500 RI		CALL $RUK(-DX(2)/2DP(2)/2XNN.XNN.YO.YO.4.DFN1.YT.DJ.CKJ.4)$	RIN09460
B1(1,2,NDP(1))=YO(1) B1(2,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09540 RIN09540 RIN09540 RIN09550 RIN09550 RIN09550 RIN09550 RIN09550 RIN09550 RIN09550 RIN09590		CALL $RUK(-DX(1)/2DP(1)/2XNN.XNN.YO.YO.4.DFN1.YT.DJ.CKJ.4)$	RIN09470
B1(2,2,NDP(1))=YO(2) B1(2,2,NDP(1))=YO(2) B2(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C B1(2,2,I)=YO(4) B1(2,		B1(1.2.NDP(1))=YO(1)	RIN09480
B2(1,2,NDP(1))=YO(3) B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09540 RIN0		B1(2.2.NDP(1))=YO(2)	RIN09490
B2(2,2,NDP(1))=YO(4) D0 401 II=2,NDP(1) I=NDP(1)-II+1 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09540 RIN09550 RIN09570 RIN09580 RIN09590		B2(1,2,NDP(1))=YO(3)	RIN09500
DO 401 II=2,NDP(1) RIN09520 I=NDP(1)-II+1 RIN09530 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09540 B1(1,2,I)=YO(1) RIN09550 B1(2,2,I)=YO(2) RIN09560 B2(1,2,I)=YO(3) RIN09570 401 B2(2,2,I)=YO(4) C RIN09590		B2(2,2,NDP(1))=YO(4)	RIN09510
I=NDP(1)-II+1 RIN09530 CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) RIN09540 B1(1,2,I)=YO(1) RIN09550 B1(2,2,I)=YO(2) RIN09560 B2(1,2,I)=YO(3) RIN09570 401 B2(2,2,I)=YO(4) C RIN09590		DO = 401 TI = 2 NDP(1)	RIN09520
CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4) B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09540 RIN09550 RIN09560 RIN09570 RIN09580 RIN09590		I = NDP(1) - II + 1	RIN09530
B1(1,2,I)=YO(1) B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09540 RIN09550 RIN09570 RIN09580 RIN09590		CALL $RUK(-DX(1), -DP(1), XNN, XNN, YO, YO, 4, DFN1, YT, D.I, CK, I, 4)$	RTN09540
B1(2,2,I)=YO(2) B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09590		B1(1.2.I)=YO(1)	RIN09550
B2(1,2,I)=YO(3) 401 B2(2,2,I)=YO(4) C RIN09590		B1(2.2.1)=YO(2)	RIN09560
401 B2(2,2,I)=YO(4) C RIN09590		B2(1.2.1)=YO(3)	RIN09570
C RIN09500	401	B2(2.2.1)=YO(4)	RINO9580
	C		RIN09590

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RIN09860

	DO 500 I=1,NDP(1)	RIN09600
	CALL AIN(A1(1,1,1),A11)	RIN09610
	CALL AMU(A2(1,1,I),A1I,AT)	RIN09620
	CALL AMU(AT, $B1(1, 1, 1), A1(1, 1, 1)$)	RIN09630
	DO 21 II=1,2	RIN09640
	DO 21 JJ=1,2	RIN09650
21	AT(II,JJ)=B2(II,JJ,I)-A1(II,JJ,I)	RIN09660
	CALL AIN(AT.B2(1,1,I))	RIN09670
	C(I)=B2(1,2,I)/AL*DP(1)	RINO9680
	D(I)=B2(2,2,I)/AL*DP(1)	RINO9690
500	CONTINUE	RIN09700
	INDEX1=NDP(1)+1	RIN09710
	INDEX2=NDP(1)+NDP(2)	RIN09720
	DO 501 I=INDEX1, INDEX2	RIN09730
	CALL AIN(A1(1,1,I),A1I)	RIN09740
	CALL AMU(A2(1,1,1),A11,AT)	RIN09750
	CALL AMU(AT, B1(1,1,1), A1(1,1,1))	RIN09760
	DO 22 II=1,2	RIN09770
	DO 22 JJ=1,2	RIN09780
22	AT(II,JJ)=B2(II,JJ,I)-A1(II,JJ,I)	RIN09790
	CALL AIN(AT, B2(1,1,1))	RIN09800
	C(I)=B2(1,2,I)/AL*DP(2)	RIN09810
	D(I)=B2(2,2,I)/AL*DP(2)	RIN09820
501	CONTINUE	RIN09830
С	· · · ·	RIN09840
	RETURN	RIN09850

RETURN END

	SUBROUTINE CHECK(AL, BET, EPS, EL1, NDX, NDP, IRUN, RECALC)	RIN09870
C>		-RIN09880
С		RIN09890
С		RIN09900
С	FUNCTION - CHECK INPUT VARIABLES FOR RECALCULATION	RIN09910
С	INFLUENCE COEFFICIENTS C,D	RIN09920
С		RIN09930
С	RESTRICTIONS - ONLY USED FOR MULTIPLE RUNS WITH IRUN.GE.2	RIN09940
С		RIN09950
С	REMARKS -	RIN09960
С		RIN09970
С	EXTERNAL REFERENCES -	RIN09980
С		RIN09990
С	ARGUMENT DEFINITION:	RIN10000
С	NAME DESCRIPTION	RIN10010
С	AL, BET, INPUT VARIABLES, ARE THEY CHANGED ?	RIN10020
С	RECALC LOGICAL VARIABLE, IF .TRUE., RECALCULATE C,D	RIN10030
С		RIN10040
С		RIN10050
c>		-RIN10060
	IMPLICIT REAL*8 (A-H,O-Z)	RIN10070
	COMMON/BOLD /ALOLD, BETOLD, EPSOLD, EL10LD, NDXOLD(3), NDPOLD(3)	RIN10080
	DIMENSION NDX(3),NDP(3)	RIN10090
	LOGICAL RECALC, TEMP	RIN10100
	RECALC=.TRUE.	RIN10110
	IF(IRUN.GT.1)THEN	RIN10120
	TEMP=.TRUE.	RIN10130
	TEMP=TEMP.AND.(AL .EQ. ALOLD)	RIN10140
	TEMP=TEMP.AND.(EPS.EQ.EPSOLD).AND.(EL1.EQ.EL10LD)	RIN10150
	DO 1 I=1,3	RIN10160
	TEMP=TEMP.AND.(NDX(I).EQ.NDXOLD(I))	RIN10170
	TEMP=TEMP.AND.(NDP(I).EQ.NDPOLD(I))	RIN10180
1	CONTINUE	RIN10190
	IF(TEMP)RECALC=.FALSE.	RIN10200
	END IF	RIN10210
	ALOLD =AL	RIN10220
	EPSOLD=EPS	RIN10230
	EL10LD=EL1	RIN10240
	DO 2 I=1,3	RIN10250
	NDXOLD(I)=NDX(I)	RIN10260
	NDPOLD(I)=NDP(I)	RIN10270
2	CONTINUE	RIN10280
	RETURN	RIN10290
	END	RIN10300
		-

-	SUBROUTINE CONST(H0,H1,PF)	RIN10310
C>		-RIN10320
С		RIN10330
C		RIN10340
С	FUNCTION - CALCULATE CONSTANTS RK,RC,R1,R2,XCAV,ICAV	RIN10350
С	FOR SLIDER BEARIN PRESSURES	RIN10360
С		RIN10370
С	RESTRICTIONS -	RIN10380
С	· · · · · · · · · · · · · · · · · · ·	RIN10390
С	REMARKS - CALLED BY SUBROUTINE EVAL	RIN10400
С	NOTE OTHER VARIABLES PASSED IN COMMON	RIN10410
С		RIN10420
С	EXTERNAL REFERENCES - DABS, DSQRT	RIN10430
С		RIN10440
С	ARGUMENT DEFINITION:	RIN10450
С	NAME DESCRIPTION	RIN10460
С	HO FILM THICKNESS AT PSI=0	RIN10470
С -	H1 FILM THICKNESS AT PSI=1	RIN10480
С	PF RESERVOIR PRESSURE	RIN10490
С		RIN10500
С		RIN10510
C>		-RIN10520
	IMPLICIT REAL*8 (A-H,O-Z)	RIN10530
يەرى 1949-يەرى	COMMON/BCOEFF/RK,RC,R1,R2,XCAV,ICAV	RIN10540
	COMMON/BINT /IELAS, IBACK, IPR	RIN10550
	R0=H1+H0	RIN10560
	R1=H0	RIN10570
	R2=H1-H0	RIN10580
	IF(IBACK.EQ.0)THEN	RIN10590
	RK=2.*H0*H1/R0*(1H0*H1*PF)	RIN10600
	RC=1./RO*(1.+H1**2*PF)	RIN10610
	XCAV=0.	RIN10620
	ELSE IF(IBACK.EQ.1)THEN	RIN10630
	ALF=H1*(-R2)*PF	RIN10640
	RK=H1*(1.+ALF+DSORT(DABS(ALF**2+2.*ALF+1.E-7)))	RIN10650
	IF(DABS(R2), GT, 1, D-10)THEN	RIN10660
	XCAV = (RK - H1)/R2 + 1	RIN10670
	ELSE	RIN10680
	XCAV=1.0	RTN10690
	END IF	RTN10700
	LF((RK, LE, HO, AND, TCAV, NE, O), OR, TCAV, FO, 1) THEN	RTN10710
	RC=1./2./RK	RIN10720
	ELSE	RTN10730
	RK=2,*H0*H1/R0*(1,+H0*H1*PF)	RTN10740
	BC=1./R0*(1H1**2*PF)	RTN10750
		DIN10760
	FND TR	DIN10770
	DETION	
		RINIU/OU
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	SUBROUTINE CONST2(H0,H1,PF)				
C>		RIN10810 -			
С		RIN10820 [~]			
С		RIN10830			
С	REMARKS - SEE CONST	RIN10840			
С		RIN10850 ·			
С		RIN10860			
C>		RIN10870			
	IMPLICIT REAL*8 (A-H,O-Z)	RIN10880			
	COMMON/BCD /XLOC(100),C(100),D(100),NDX(3),NDP(3),DX(3),DP(3)	RIN10890			
	COMMON/BCOEFF/RK,RC,R1,R2,XCAV,ICAV	RIN10900			
	COMMON/BINT /IELAS, IBACK, IPR	RIN10910.			
	RO=H1+HO	RIN10920			
	R1=HO	RIN10930			
	R2=H1-H0	RIN10940			
	CTEMP = (-1) * * (IBACK+1)	RIN10950			
	RK=2.*H0*H1/R0*(1.+CTEMP*H0*H1*PF)	RIN10960			
	RC=1./RO*(1CTEMP*H1**2*PF)	RIN10970			
	XCAV=0.	RIN10980			
	IF(IBACK.EQ.1)THEN	RIN10990			
С	IF(IPR.EQ.1)WRITE(4,*)''	RIN11000			
	PMIN=100.	RIN11010			
	DO 10 $I=1,NDP(2)+NDP(3)$	RIN11020			
С	IF(IPR.EQ.1)WRITE(4,*)P(XLOC(I))	RIN11030			
	<pre>PMIN=DMIN1(PMIN,P(XLOC(I)))</pre>	RIN11040			
10	CONTINUE	RIN11050			
	IF(PMIN.GE.O.DO)RETURN	RIN11060			
		RINI1070			
		RINIIO80			
	$HCAV = H1 + H11 \times (XCAV - 1.)$	RINI1090			
		RINIIIOU			
20		RINIIIU			
		KIN11120			
	FHCAV = PF+1./H11*(-1./H1+HCAV/2./H1**2+1./2./HCAV)	RINIII30			
	FIHCAV=1./H11*(1./2./H1**2-1./2./HCAV**2)	KIN11140			
		RINIIIO			
0	$X \cup AV = (H \cup AV - H \cup / H \cup H \cup H \cup H)$	RINIIIOU			
C	IF(IPK,EQ,I)WKIIE(4,*)XCAV $IF(IPK,EQ,I)WKIIE(4,*)XCAV$	RINIII/U			
	IF(ICUUNI.LI.IU.AND.DABS(MCAV-MCVULD).GI.I.D-//GUIU 20 DV-UCAV	KINIIIOU			
	RK = RUAV	KINIII90			
		RINIIZUU			
	LNV LC .	RINIIZIU DINII220			
	KETAKN				
	ENV	KINII23U			

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	SUBROUTINE	DFN1(X,Y,I))	RIN11240
C>			، به خدم خدمیا که همان که به بنده نوخ می نوح و نوح و با می تو او که بر	RIN11250
C				RIN11260
C				RIN11270
C	FUNCTION		- DERIVATIVE ROUTINE USED BY RUK	RIN11280
C			(NO HYDRODYNAMICS)	RIN11290
С		•		RIN11300
C	RESTRICTI	ONS	-	RIN11310
C				RIN11320
C	REMARKS		- NOTE VARIABLES PASSED IN COMMON	RIN11330
C				RIN11340
C	EXTERNAL	REFERENCES	-	RIN11350
C				RIN11360
C	ARGUMENT	DEFINITION	L	RIN11370
C	NAME	DESCRIPT	FION	RIN11380
0	X	VALUE (OF X FOR DERIVATIVES	RIN11390
3	Y	VALUES	OF INDEPENDENT VARIABLES	RIN11400
3	D	VALUES	OF DERIVATIVES	RIN11410
3				RIN11420
3				RIN11430
C>			****	RIN11440
	IMPLICIT R	EAL*8 (A-H,	,0-Z)	RIN11450
	DIMENSION	Y(4),D(4)		RIN11460
	COMMON/BPA	R /AL,BET,	,PO,EPS,PF,S,U,DT	RIN11470
	D(1)=Y(2)			RIN11480
	D(2)=Y(3)			RIN11490
	D(3)=Y(4)			RIN11500
	D(4) = -Y(1)	/AL	· · · · · · · · · · · · · · · · · · ·	- RIN11510
	RETURN			RIN11520
	END			RIN11530

SUBROUTINE DFN2(X,Y,D) **RIN11540** -----RIN11550 C> C **RIN11560** C **RIN11570** С - DERIVATIVE ROUTINE USED BY RUK FUNCTION **RIN11580** С (HYDRODYNAMICS INCLUDED) **RIN11590** С **RIN11600** С RESTRICTIONS **RIN11610** С **RIN11620** С REMARKS - NOTE VARIABLES PASSED IN COMMON **RIN11630** С **RIN11640** С EXTERNAL REFERENCES - P RIN11650 С RIN11660 С **ARGUMENT DEFINITION: RIN11670** С NAME DESCRIPTION **RIN11680** С X VALUE OF X FOR DERIVATIVES **RIN11690** С Y VALUES OF INDEPENDENT VARIABLES RIN11700 С D VALUES OF DERIVATIVES RIN11710 С **RIN11720** С **RIN11730** C>-----RIN11740 IMPLICIT REAL*8 (A-H,O-Z) RIN11750 DIMENSION Y(4), D(4)RIN11760 COMMON/BPAR /AL.BET.PO.EPS.PF.S.U.DT RIN11770 COMMON/BFLAG /IFLAG, IPLOAD RIN11780 D(1)=Y(2)RIN11790 D(2)=Y(3)RIN11800 D(3)=Y(4)**RIN11810** H=0RIN11820 IF(IPLOAD.EQ.1)H=P0 **RIN11830** IF(X.GT.0.)H=H-P(X)RIN11840 H=H*BET **RIN11850** D(4) = (H - Y(1)) / ALRIN11860 RETURN **RIN11870** END RIN11880

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	SUBROUTINE D	FN3(X,Y,I) ,				 -	RIN11890
C								RIN11900
с с	FUNCTION		- DERIVA	TTVE ROU	TINE USE			RIN11920
č			(HYDRO	DYNAMICS	INCLUDE	ED, NO PREL	DAD PO)	RIN11940
C	, . 1 .		·. ·		• * .			RIN11950
C	RESTRICTION	S	-				,	RIN11960
C C	REMARKS		- NOTE V	ARTARIES	PASSED	IN COMMON		RIN11970
c	KLINKKO			ANIADULO	TAJJED	IN COMMON		RIN11980
С	EXTERNAL RE	FERENCES	- P			,		RIN12000
С								RIN12010
C C	ARGUMENT DE	FINITION	TON					RIN12020
c	X	VALUE (DF X FOR	DERIVATI	VES	2		RTN12030
C	Ŷ	VALUES	OF INDEP	ENDENT V	ARIABLES	3		RIN12050
C	D	VALUES	OF DERIV	ATIVES				RIN12060
C								RIN12070
с С>								RIN12080
0.	IMPLICIT REA	L*8 (A-H,	,0-Z)	۰.		-		RIN12090
	DIMENSION Y(4),D(4)					•	RIN12110
	COMMON/BPAR	/AL,BET,	PO,EPS,P	F,S,U,DT				RIN12120
	COMMON/BINI D(1)=V(2)	/IELAS, I	BACK, IPR					RIN12130
	D(2)=Y(3)						•	RIN12140 RIN12150
	D(3)=Y(4)		. •			• •.		RIN12160
	H=BET*P0							RIN12170
	D(4) = (H - Y(1)))/AL		-			• •	RIN12180
	END				•			RIN12190 RIN12200
		4					· · ·	
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	SUBROUTINE ELAS		RIN12210
C>			-RIN12220
С			RIN12230
С			RIN12240
С	FUNCTION	- DETERMINE ELASTIC SOLUTION	RIN12250
С	· · ·	(NO HYDRODYNAMICS)	RIN12260
С		HELAS, H1ELAS, H2ELAS, H3ELAS, FORCE	RIN12270
С			RIN12280
С	RESTRICTIONS	-	RIN12290
С			RIN12300
С	REMARKS	- NOTE VARIABLES PASSED IN COMMON	RIN12310
С		••	RIN12320
С	EXTERNAL REFERENCES	- NONE	RIN12330
С	• •		RIN12340
С		· · · · · · · · · · · · · · · · · · ·	RIN12350
C>			-RIN12360
	IMPLICIT REAL*8 (A-H	,0-2)	RIN12370
	DIMENSION YO(4)		RIN12380
	COMMON/BPAR /AL, BET	,PO,EPS,PF	RIN12390
	COMMON/BCD /XLOC(10	D0),C(100),D(100),NDX(3),NDP(3),DX(3),DP(3)	RIN12400
	COMMON/BELAS /FORCE.	HELAS, H1ELAS, H2ELAS, H3ELAS, W1(4), W2(4)	RIN12410
	COMMON/BFLAG /IFLAG	IPLOAD	RIN12420
	YO(1)=0.		RIN12430
	YO(2)=0.		RIN12440
	YO(3)=0.		RIN12450
	YO(4)=0.		RIN12460
	WRITE(6,1009)		RIN12470
1009	FORMAT(5X.1HX.8X.1HH	.9X.2HH'.7X.3HH''.7X.4HH'''.6X.4HPRES	RIN12480
	S.8X.5HFORCE)	,,	RIN12490
	IF(IFLAG.EO.1)THEN	· · ·	RIN12500
	IMIN=NDP(2)+1		RIN12510
	IMAX=NDP(2)+NDP(3))	RIN12520
	ELSE IF(IFLAG.EO.2)T	HEN	RIN12530
	IMIN=1		RIN12540
	IMAX=NDP(2)		RIN12550
	ELSE IF(IFLAG.EO.3)TH	IEN	RIN12560
	IMIN=1		RIN12570
	IMAX=NDP(2)+NDP(3))	RIN12580
	ELSE IF(IFLAG.EO.4)TH	IEN	RIN12590
	IMIN=1	· ·	RIN12600
	IMAX=NDP(1)+NDP(2)		RIN12610
	END IF		RTN12620
	DO 600 I=IMIN.IMAX		RTN12630
	YO(1) = YO(1) + C(1)		RIN12640
	YO(2) = YO(2) + D(1)		RTN12650
600	CONTINUE		RIN12660
	YO(1)=YO(1)*PO*BET		RTN12670
•	YO(2) = YO(2) * PO * BET		RTN12680
	HELAS=1YO(1)		RIN12690
	H1ELAS=-YO(2)		RIN12700
	H2ELAS = -YO(3)		RTN12710
	H3ELAS=-YO(4)		RTN12720
	WRITE(6, '(FR_4_SF10_)	S.F13.5) 1. HELAS HIELAS HOFLAS HOFLAS O	RTN12720
	FORCE=0.D0	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	RTN12740
	IF(YO(1).GT.1.)THEN		RIN12750

	CHI=YO(1)-1.0	RIN12760					
	YO(1)=1.0	RIN12770					
	B=CHI/(W2(3)*W1(1)/W1(3)-W2(1)) A=-B*W2(3)/W1(3)						
	YO(2) = A * W1(2) + B * W2(2) + YO(2)	RIN12800					
	YO(3)=0.	RIN12810					
	YO(4)=A*W1(4)+B*W2(4)	RIN12820					
	FORCE=YO(4)*AL/BET	RIN12830					
	HELAS=1.0-YO(1)	RIN12840					
	H1ELAS = -YO(2)	RIN12850					
	H2ELAS=-YO(3)	RIN12860					
	H3ELAS = -YO(4)	RIN12870					
	WRITE(6,'(F8.4,5F10.5,F13.5)')1.0,HELAS,H1ELAS,H2ELAS	RIN12880					
	\$,H3ELAS,O.,FORCE	RIN12890					
	END IF	RIN12900					
	RETURN	RIN12910					
	END	RIN12920					
	SUBROUTINE ERRMSG	RIN12930					
C>-		RIN12940					
C		RIN12950					
С		RIN12960					
С	FUNCTION - PRINT ERROR TERMS UPON EXIT FROM *ZSCNT*	RIN12970					
С		RIN12980					
С	RESTRICTIONS - CALLED ONLY IF IER.NE.0 FROM *2SCNT*	RIN12990					
С	•	RIN13000					
С	REMARKS - FINAL VALUES OF X AND F FROM EVAL	RIN13010					
С	ARE PRINTED	RIN13020					
С		RIN13030					
С	INPUT/OUTPUT:	RIN13040					
С	UNIT DESCRIPTION	RIN13050					
С	4 TERMINAL OUTPUT	RIN13060					
C	6 OUTPUT FILE	RIN13070					
С		RIN13080					
C		RIN13090					
C>-		RIN13100					
	IMPLICIT REAL*8 (A-H.O-Z)	RIN13110					
	COMMON/BLAST /X1.X2.F1.F2	RIN13120					
	WRITE(4,'(8X,''W(1)'',10X,''W(2)'',10X,''F(1)'',10X,''F(2)''	RIN13130					
	+ ./)')	RIN13140					
	WRITE(4, '(1X,4(2X,E12.5))')X1,X2,F1.F2	RIN13150					
	WRITE(6,'(8X,''W(1)'',10X,''W(2)''.10X,''F(1)''.10X,''F(2)''	RIN13160					
	+)')	RIN13170					
•	WRITE(6.'(1X.4(2X.E12.5))')X1.X2.F1.F2	RIN13180					
	RETURN	RIN13190					
	END	RIN13200					

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		_
	SUBROUTINE EVAL(X.F.N.PAR)	RTN13210
C>	JUDKOVIING LYKD(X;I;N;IAK)	
C		RIN13220
c		RIN13240
C C	RINCTION - DEFINES FOUNTIONS FOR H AND H ¹ WHICH ARE	DIN13250
c	SOLVED BY SECANT METUOD #75CNT*	RIN13230
c	SOLVED BI SECANI MEINOD "ZSCNI"	
C C		RINI3270
	RESIRICITONS	RIN13280
	DEMARKO - NOTE MARIE DAGGED IN COMON	RIN13290
	KEMARKS - NOIE VARIABLE PASSED IN COMMON	RINISSUU
C		RIN13310
C	EXTERNAL REFERENCES - CONST	RIN13320
C		RIN13330
С	INPUT/OUTPUT:	RIN13340
С	UNIT DESCRIPTION	RIN13350
С		RIN13360
С	ARGUMENT DEFINITION:	RIN13370
С	NAME DESCRIPTION	RIN13380
С	X X(1) IS DISPLACEMENT AT 1	RIN13390
С	X(2) IS X' AT 1	RIN13400
С	F EQUATIONS (2) FOR H AND H'	RIN13410
С	N NO. OF EQUATIONS (N=2)	RIN13420
С	PAR NOT USED	RIN13430
C		RIN13440
J		RIN13450
C>		RIN13460
	IMPLICIT REAL*8 (A-H,O-Z)	RIN13470
	DIMENSION X(N), F(N), PAR(1)	RIN13480
	COMMON/BPAR /AL, BET, PO, EPS, PF	RIN13490
	COMMON/BCD /XLOC(100), C(100), D(100), NDX(3), NDP(3), DX(3), DP(3)	RIN13500
	COMMON/BCOEFF/RK.RC.R1.R2.XCAV.ICAV	RIN13510
	COMMON/BINT /IELAS.IBACK.IPR	RIN13520
	COMMON/BLAST /X1LAST.X2LAST.F1LAST.F2LAST	RTN13530
	COMMON/BPROF /C1	RTN13540
	COMMON/BFLAG /IFLAG.IPLOAD	RTN13550
	$H_1=1.0-X(1)$	RIN13560
	$H_1 = C_1 - X(2)$	RTN13570
		RIN13580
	CALL CONST(HO, H1, PF)	DIN13500
	SIM1 = Y(1)	DTN13600
		DIN12610
		RINIJOIU DINI2620
5		RIN13020
5		RINISCSU
	INDEX-INDEX-I	RIN13640
	IF(IFLAG, EQ, 1, AND, INDEX, GI, NDP(2))GOTO (RINI365U
	IF(IFLAG.EQ.2.AND.INDEX.GI.NDF(2)/GUIU 0	RINI366U
	IF(XLUG(INDEX).LI.DMINI(IEPS,XCAV)/GUIU 5	RINI3670
		RIN13680
	PKES=U	RIN13690
		RIN13700
	PRES=P(XLOC(INDEX))	RIN13710
	END IF	RIN13720
_	IF(XLOC(INDEX).GT.1EPS) PRES=PRES-PO	RIN13730
7	CONTINUE	RIN13740
	SUM1=SUM1+C(INDEX)*PRES*BET	RIN13750

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	SUM2=SUM2+D	RIN13760	
	GOTO 5	المراجعة الم	RIN13770
6	CONTINUE		RIN13780
	F(1)=SUM1		RIN13790
	F(2)=SUM2		RIN13800
	X1LAST=X(1)		RIN13810
	X2LAST=X(2)		RIN13820
	F1LAST=F(1)		RIN13830
	F2LAST=F(2)		RIN13840
	RETURN	$(x,y) \in [x^{n+1}, \dots, x^{n+1}]$	RIN13850
	END		RIN13860
			· · · ·

						•		
	SUBROUTINE	EVAL3(X,F,	, N , P	AR)				RIN13870
C>								-RIN13880
С								RIN13890
С								RIN13900
С	FUNCTION		- D	EFINES EQUATION	S FOR H	AND H' WHICH	ARE	RIN13910
С			S	OLVED BY SECANT	METHOD	*ZSCNT*		RIN13920
С	•						· ·	RIN13930
С	RESTRICTIO	ONS	-					RIN13940
С								RIN13950
С	REMARKS		- N	OTE VARIABLE PA	SSED IN	COMMON		RIN13960
С								RIN13970
С	EXTERNAL H	REFERENCES	- C	ONST				RIN13980
С								RIN13990
С	INPUT/OUT	PUT:		·				RIN14000
Ċ	UNIT	DESCRIPT	TION					RIN14010
c								RIN14020
c	ARGUMENT I	DEFINITION	:					RIN14030
č	NAME	DESCRIPT	- TTON					RTN14040
c c	Y	¥(1) T		SDIACEMENT AT 1				RIN14040
c c	А	x(2) = x(2)		AT 1				RIN14050
c c	P	FOUATT	אפ	ע מאא שמאים ביים (2) בטס ע אאה ש	1			DIN14000
	Г N	NO	FOIL	(2) FOR I AND I				RIN14070
		NO. UP	EQU. PD	ATTONS $(n-2)$				RIN14000
	PAR	NOT 051	cŋ					RIN14090
C a								RINI4100
C								RIN14110
C>				 \				-RIN14120
	IMPLICIT KI	EAL*8 (A-H	,U-Z)				RIN14130
	DIMENSION 2	X(N),F(N),I	PAR	1)				RIN14140
	COMMON/BPA	R /AL,BET,	, PU ,	EPS,PF			- (-)	RIN14150
	COMMON/BCD		00),	C(100),D(100),N	DX(3), NL	P(3), DX(3), DI	2(3)	RIN14160
	COMMON/BCOI	EFF/RK,RC,E	R1,R	2,XCAV,ICAV				RIN14170
	COMMON/BIN:	r /IELAS,	IBAC	K,IPR				RIN14180
	COMMON/BLAS	ST /XILAST,	,X2L	AST,F1LAST,F2LA	ST			RIN14190
	COMMON/BPRO	OF /C1						RIN14200
	COMMON/BFL	AG /IFLAG,	I PLO	AD				RIN14210
	H1=1.0-X(1))						RIN14220
	H11=C1-X(2))						RIN14230
	HO=H1-H11							RIN14240
	CALL CONST	(HO,H1,PF)						RIN14250
	SUM1=X(1)							RIN14260
	SUM2=X(2)							RIN14270
	INDEX=0							RIN14280
5	CONTINUE							RIN14290
	INDEX=INDEX	X+1						RIN14300
	IF(INDEX.G	T.NDP(2)+NI	DP(3))GOTO 6				RIN14310
	IF(XLOC(INI	DEX).LT.DM	IN1(1EPS.XCAV))GO	TO 5			RIN14320
	TF(XLOC(INI	DEX).LT.XCA	AV)T	HEN				RIN14330
	PRES=0		, .					RIN14340
	ELSE							RTN14350
•	DDFC=D()	TUCC TNDEY))					RTN14360
	FND TP		,,					DTN1/270
	DDEG-DDEG-1	Þ٨				· •	÷	DTN1/200
7	CONTINUE							RIN1430U
'				DET				RTN14730
	SUM1=SUM1+(CITNDER)*PI	223×	DGL				
	SUMZ=SUMZ+1	UT INDEX)*P	KEST	DEL		•		KIN14410

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	GOTO 5	RIN14420
6	CONTINUE	RIN14430
	F(1)=SUM1	RIN14440
	F(2)=SUM2	RIN14450
	X1LAST=X(1)	RIN14460
	X2LAST=X(2)	RIN14470
	F1LAST=F(1)	RIN14480
	F2LAST=F(2)	RIN14490
	RETURN	RIN14500
	END	RIN14510

FILE: RING FORTRAN L4 MTI MON 01/20/86 14:39:26 PAGE 33 OF 38 SUBROUTINE EVAL4(X,F,N,PAR) RIN14520 C> -RIN14530 С **RIN14540** С **RIN14550** С - DEFINES EQUATIONS FOR H AND H' WHICH ARE FUNCTION RIN14560 С SOLVED BY SECANT METHOD *ZSCNT* **RIN14570** С RIN14580 С RESTRICTIONS **RIN14590** С RIN14600 С - NOTE VARIABLE PASSED IN COMMON REMARKS **RIN14610** С RIN14620 С EXTERNAL REFERENCES - CONST RIN14630 С **RIN14640** С INPUT/OUTPUT: RIN14650 С UNIT DESCRIPTION **RIN14660** С **RIN14670** С **ARGUMENT DEFINITION:** RIN14680 С NAME DESCRIPTION RIN14690 С Х X(1) IS DISPLACEMENT AT 1 RIN14700 С X(2) IS X' AT 1 **RIN14710** С F EQUATIONS (2) FOR H AND H' RIN14720 С N NO. OF EQUATIONS (N=2) RIN14730 С PAR NOT USED RIN14740 С **RIN14750** С RIN14760 -----RIN14770 C> IMPLICIT REAL*8 (A-H,O-Z) **RIN14780** DIMENSION X(N), F(N), PAR(1) RIN14790 COMMON/BPAR /AL,BET,PO,EPS,PF **RIN14800** COMMON/BCD /XLOC(100),C(100),D(100),NDX(3),NDP(3),DX(3),DP(3) **RIN14810** COMMON/BCOEFF/RK,RC,R1,R2,XCAV,ICAV RIN14820 COMMON/BINT /IELAS, IBACK, IPR RIN14830 COMMON/BLAST /X1LAST,X2LAST,F1LAST,F2LAST RIN14840 COMMON/BPROF /C1 **RIN14850** COMMON/BFLAG /IFLAG, IPLOAD RIN14860 H1=1.0-X(1)RIN14870 H11=C1-X(2)RIN14880 H0=H1-H11 RIN14890 CALL CONST(H0,H1,PF) RIN14900 SUM1=X(1)RIN14910 SUM2=X(2)RIN14920 INDEX=0 RIN14930 5 CONTINUE **RIN14940** INDEX=INDEX+1 **RIN14950** IF(INDEX.GT.NDP(1)+NDP(2))GOTO 6 **RIN14960** IF(XLOC(INDEX).LT.DMIN1(1.-EPS,XCAV))GOTO 5 **RIN14970** IF(XLOC(INDEX).LT.XCAV)THEN RIN14980 PRES=0 **RIN14990** ELSE RIN15000 PRES=P(XLOC(INDEX)) RIN15010 END IF **RIN15020** PRES=PRES-PO **RIN15030** 7 CONTINUE RIN15040 SUM1=SUM1+C(INDEX)*PRES*BET RIN15050 SUM2=SUM2+D(INDEX)*PRES*BET RIN15060

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	COTO 5			RTN15070		
6	CONTINUE		· · · · ·	DIN15090		
v	$\mathbb{E}(1) - \mathbb{E}[\mathbb{E}(1)]$			RIN15000		
	F(1) = SUM2			RIN15100		
	F(2) = SUM2	• • •		DINISIIO		
	XILASI = X(1)					
	$\frac{X}{2} \frac{X}{2} \frac{X}$					
	$F_{1} = F_{1} = F_{1$			RINIJIJU DINISIAO		
	PZLASI-P(Z)					
	END					
	END			KINIJIOU		
	FUNCTION P(PST)			RTN15170		
C>						
C	۰.			RIN15190		
č	• • •			RIN15200		
c	FUNCTION	- RETURN HYDRODYNAMIC PRE	SSURE AT PSI	RIN15210		
Č				RIN15220		
C	RESTRICTIONS	-		RIN15230		
C				RIN15240		
С	REMARKS	- NOTE VARIABLES PASSED I	N COMMON	RIN15250		
С	·		· · · · ·	RIN15260		
С	EXTERNAL REFERENCES - DABS					
C				RIN15280		
С	ARGUMENT DEFINITION	:		RIN15290		
С	NAME DESCRIP	TION	· .	RIN15300		
С	PSI VALUE	OF X WHERE PRESSURE IS DES	IRED	RIN15310		
С				RIN15320		
C			· ·	RIN15330		
C>			و به ه به به به به مرجو ورود که به به به به	RIN15340		
	IMPLICIT REAL*8 (A-H	,0-Z)	• ·	RIN15350		
	COMMON/BCOEFF/RK,RC,	R1,R2,XCAV,ICAV		RIN15360		
	COMMON/BINT /IELAS,	IBACK, IPR		RIN15370		
	H=R1+R2*PSI			RIN15380		
	HINV=1./H			RIN15390		
	P=0.		· · ·	RIN15400		
	IF(PSI.GE.XCAV.AND.D	ABS(R2).GT.1.D-10)THEN	· · · ·	RIN15410		
	P=1./R2*(HINV*(-1	.+RK/2.*HINV)+RC)		RIN15420		
	END IF			RIN15430		
	IF(IBACK.EQ.1)THEN			RIN15440		
	P=-P			RIN15450		
	END IF			RIN15460		
	RETURN			RIN15470		
	END			RIN15480		

FILE: RING FORTRAN L4 MTI MON 01/20/86 14:39:26 PAGE 35 OF 38

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C - C - C - USING DISPLACEMENTS, CONVERT TO FILM C - USING DISPLACEMENTS, CONVERT TO FILM C - THICKNESSES AND PRINT OUT C - C - C - C - C - C - C - C - C - C -	RIN15500 RIN15510 RIN15520 RIN15530 RIN15540 RIN15550 RIN15550 RIN15570 RIN15580
C RESTRICTIONS - C REMARKS - C REMARKS - C EXTERNAL REFERENCES - P	RIN15550 RIN15560 RIN15570 RIN15580
C REMARKS - C C C EXTERNAL REFERENCES - P	RIN15570 RIN15580
C EXTERNAL REFERENCES - P	
	RIN15590 RIN15600
C INPUT/OUTPUT:	RIN15610 RIN15620
C UNIT DESCRIPTION C ITERM OUTPUT UNIT	RIN15630 RIN15640
C ARCIMENT DEFINITION:	RIN15650 RIN15660
C NAME DESCRIPTION C X DIMENSIONLESS LENGTH VARIABLE	RIN15670 RIN15680
C Y DISPLACEMENT AND ITS DERIVATIVES C ITERM OUTPUT UNIT	RIN15690 RIN15700
C C	RIN15710 RIN15720
	RIN15730
COMMON/BINT /IELAS,IBACK,IPR COMMON/BPROF /C1	RIN15740 RIN15750 RIN15760
DIMENSION Y(4) H=1Y(1)+C1*(X-1.)	RIN15770 RIN15780
H1=G1-F(2) H2=-Y(3) H3=-Y(4)	RIN15790 RIN15800
PRES=0. $IF(IELAS,E0.0,AND,X,CE.0.)PRES=P(Y)$	RIN15820 RTN15820
WRITE(ITERM,5)X,H,H1,H2,H3,PRES 5 FORMAT(F10.4,5F12.5)	RIN15850 RIN15850
EIUKN END	RIN15860 RIN15870

FILE: RING FORTRAN L4 MTI MON 01/20/86 14:39:26 PAGE 36 OF 38

	SUBROUTINE PRTOUT(XX)	RIN15880
C>		-RIN15890
С		RIN15900
С		RIN15910
С	FUNCTION - PRINT FILM THICK., PRES., ETC.	RIN15920
С	· · · · · ·	RIN15930
С	RESTRICTIONS -	RIN15940
С		RIN15950
С	REMARKS - NOTE VARIABLES PASSED IN COMMON	RIN15960
С		RIN15970
С	EXTERNAL REFERENCES - DFN1, DFN2, DFN3, PRT, RUK	RIN15980
С		RIN15990
С	INPUT/OUTPUT:	RIN16000
С	UNIT DESCRIPTION	RIN16010
С	6 OUTPUT FILE	RIN16020
С		RIN16030
С	ARGUMENT DEFINITION:	RIN16040
С	NAME DESCRIPTION	RIN16050
С	XX(2) DISPLACEMENT, SLOPE OF DISPLACEMENT	RIN16060
С		RIN16070
С		RIN16080
C>		-RIN16090
	IMPLICIT REAL*8 (A-H,O-Z)	RIN16100
	COMMON/BINT /IELAS,IBACK,IPR	RIN16110
	COMMON/BELAS /FORCE,HELAS,H1ELAS,H2ELAS,H3ELAS,W1(4),W2(4)	RIN16120
	COMMON/BCD /XLOC(100),C(100),D(100),NDX(3),NDP(3),DX(3),DP(3)	RIN16130
	COMMON/BFLAG /IFLAG, IPLOAD	RIN16140
	DIMENSION XX(2),YO(4),YT(4),DJ(4),CKJ(4,4)	RIN16150
	EXTERNAL DFN1, DFN2, DFN3	RIN16160
С		RIN16170
	XNN=1.0	RIN16180
	YO(1)=XX(1)	RIN16190
	YO(2)=XX(2)	RIN16200
	YO(3)=0.	RIN16210
	YO(4)=0.	RIN16220
	IF(IBACK.EQ.1.AND.FORCE.GT.1.D-8)THEN	RIN16230
	WRITE(6,1009)	RIN16240
	WRITE(6,'(F8.4,5F10.5,F13.5)')1.0,HELAS,H1ELAS,H2ELAS	RIN16250
	\$,H3ELAS,O.,FORCE	RIN16260
	RETURN	RIN16270
	ELSE	RIN16280
	WRITE(6,1007)	RIN16290
	IF(IPR.EQ.1)THEN	RIN16300
	WRITE(6,'(''@'')')	RIN16310
	ELSE	RIN16320
	WRITE(6,'('' '')')	RIN16330
	END IF	RIN16340
	CALL PRT(XNN,YO,6)	RIN16350
	END IF	RIN16360
	IF(IPR.EQ.1)THEN	RIN16370
	IF(IFLAG.EQ.2.OR.IFLAG.EQ.4)GOTO 111	RIN16380
	IPLOAD=1	RIN16390
	CALL RUK(-DX(3)/2.,-DP(3)/2.,XNN,XNN,YO,YO,4,DFN2,YT,DJ,CKJ,4)	RIN16400
	CALL PRT(XNN, YO, 6)	RIN16410
	DO 9 $JJ=2,NDP(3)$	RIN16420
	164	

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	I = NDP(3) + 1 - II	RTN16430
	CALL $RUK(-DX(3), -DP(3), XNN, XNN, YO, YO, 4, DFN2, YT, DJ, CKJ, 4)$	RIN16440
	CALL $PRT(XNN, YO, 6)$	RIN16450
9	CONTINUE	RIN16460
-	CALL RUK(-DX(3)/2.,-DP(3)/2.,XNN,XNN,YO,YO,4,DFN2,YT,DJ,CKJ,4)	RIN16470
	CALL PRT(XNN, YO, 6)	RIN16480
111	CONTINUE	RIN16490
	IF(IFLAG.EQ.1)THEN	RIN16500
	IPLOAD=0	RIN16510
	ELSE IF(IFLAG.EQ.2)THEN	RIN16520
	IPLOAD=1	RIN16530
	ELSE IF(IFLAG.EQ.3)THEN	RIN16540
	IPLOAD=1	RIN16550
	ELSE IF(IFLAG.EQ.4)THEN	RIN16560
	IPLOAD=1	RIN16570
	END IF $(a)/(a)/(a)/(a)$ and $(a)/(a)/(a)$ when we we denote the set $(a)/(a)$	RIN16580
	CALL RUK $(-DX(2)/2., -DP(2)/2., XNN, XNN, YO, YO, 4, DFN2, YT, DJ, CKJ, 4)$	RIN16590
	CALL PKI(ANN, IU, 0)	RINIGOUU
	$\frac{1}{1-1} \frac{1}{1-1} \frac{1}$	RINICOIU
	J = MP(2) + I = JJ CALL $P(I) = D(2) + MN + MN + MN + D(2) + D(2)$	RIN16620
	CALL $PRT(YNN YO 6)$	RIN16640
8	CONTINUE	RIN16650
Ŭ	CALL RUK $(-DX(2)/2, -DP(2)/2, XNN, XNN, YO, YO, 4, DFN2, YT, DJ, CKJ, 4)$	RIN16660
	CALL PRT(XNN.YO.6)	RIN16670
	IF(IFLAG.EO.1.OR.IFLAG.EO.2)THEN	RIN16680
	WRITE(6,'(''@'')')	RIN16690
	RETURN	RIN16700
	END IF	RIN16710
	DO 7 $J=1,NDP(1)$	RIN16720
	IF(IFLAG.EQ.4)THEN	RIN16730
	CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN3,YT,DJ,CKJ,4)	RIN16740
	ELSE	RIN16750
·	CALL RUK(-DX(1),-DP(1),XNN,XNN,YO,YO,4,DFN1,YT,DJ,CKJ,4)	RIN16760
	END IF	RIN16770
-	CALL PRT(XNN,YO,6)	RIN16780
/	CUNTINUE	RIN16790
	END IF	RINI6800
		RINI681U
c	KEIUKN	RIN16820
1007	FORMAT(7Y 14Y 10Y 144 11Y 244' OF 244' OF AUTIL OF AUTIL OF AUTORS)	N10000
1007	FORMAT(5Y 1HY SY 1HH GY 2HH ¹ 7Y 2HH ¹ 7Y AHH ¹¹ AY AHDDEC	RINICO4U
1003	S.8X. SHFORCE)	RINIERO
С	¥ , 0 , 2 0 ,	RTN16870
-	END	RIN16880

FILE: RING FORTRAN L4 MTI MON 01/20/86 14:39:26 PAGE 38 OF 38 A MATTER AND A STATE AND A MATTER • • • • . SUBROUTINE RUK(DX, DP, XO, XN, YO, YN, NO, DFN, YT, D, CK, ID) **RIN16890** ______ C> ----RIN16900 С **RIN16910** . . . С **RIN16920** C FUNCTION - RUNGE-KUTTA INTEGRATION RIN16930 RIN16940 С С RESTRICTIONS **RIN16950** С **RIN16960** С - REMARKS **RIN16970** С **RIN16980** С EXTERNAL REFERENCES - DFN **RIN16990** С RIN17000 С ARGUMENT DEFINITION: **RIN17010** С NAME DESCRIPTION **RIN17020** С **RIN17030** С **RIN17040** C> ----RIN17050 IMPLICIT REAL*8 (A-H.O-Z) **RIN17060** DIMENSION YO(ID), YN(ID), D(ID), YT(ID), CK(4.ID) **RIN17070** N=DP/DX+.001**RIN17080** XN=XO **RIN17090** DO 2 J=1.NO **RIN17100** 2 YN(J)=YO(J)RIN17110 DO 5 I=1.N **RIN17120** CALL DFN(XN,YN,D) **RIN17130** DO 6 J=1,NO RIN17140 CK(1,J)=D(J)*DX**RIN17150** 6 YT(J)=YN(J)+CK(1,J)/2. **RIN17160** CALL DFN(XN+DX/2.,YT,D) **RIN17170** DO 7 J=1,NO **RIN17180** CK(2,J)=D(J)*DX**RIN17190** 7 YT(J)=YN(J)+CK(2,J)/2. RIN17200 CALL DFN(XN+DX/2.,YT,D) RIN17210 DO 8 J=1.NO RIN17220 CK(3,J)=D(J)*DX**RIN17230** 8 YT(J)=YN(J)+CK(3,J)**RIN17240** CALL DFN(XN+DX,YT,D) RIN17250 DO 9 J=1.NO **RIN17260** CK(4,J)=D(J)*DXRIN17270 YN(J)=YN(J)+(CK(1,J)+2.*(CK(2,J)+CK(3,J))+CK(4,J))/6.**RIN17280** 9 CONTINUE RIN17290 5 XN=XN+DX RIN17300 RETURN RIN17310 END. **RIN17320**

c	SUBROUTINE	ZSCNT	(F	CN,NSIG,N,ITMAX,PAR,X,FNORM,WK,IER)	ZSC00010
	THE DECEM	SHOLIT	-	COMPTIED IN FORTRAN ((FORTUY)	2500020
	THIS PROGRAM	240050	DL	COMPTLED IN FORTRAN 4 (FORTRA)	25000030
C					2500040
C	CONDUMED				2500050
C	COMPUTER		-	I BM/ DOUBLE	2500060
C					ZSC00070
C	LATEST REVISI	LON	-	JUNE 1, 1980	ZSC00080
C					ZSC00090
C	PURPOSE		-	SOLVE A SYSTEM OF NONLINEAR EQUATIONS	ZSC00100
C					ZSC00110
C	USAGE		-	CALL ZSCNT (FCN, NSIG, N, ITMAX, PAR, X, FNORM,	ZSC00120
C				WK,IER)	ZSC00130
C		-			ZSC00140
С	ARGUMENTS	FCN	-	THE NAME OF A USER-SUPPLIED SUBROUTINE WHICH	ZSC00150
С				EVALUATES THE SYSTEM OF EQUATIONS TO BE	ZSC00160
С				SOLVED. FCN MUST BE DECLARED EXTERNAL IN	ZSC00170
С				THE CALLING PROGRAM AND MUST HAVE THE	ZSC00180
С	. · · · · ·			FOLLOWING FORM,	ZSC00190
С				SUBROUTINE FCN(X,F,N,PAR)	ZSC00200
C				DIMENSION $X(N), F(N), PAR(1)$	ZSC00210
C				F(1)=	ZSC00220
C				-	ZSC00230
С				F(N) =	ZSC00240
C				RETURN	ZSC00250
C				END	ZSC00260
C				GIVEN X(1)X(N), FCN MUST EVALUATE THE	ZSC00270
C				FUNCTIONS $F(1) \dots F(N)$ WHICH ARE TO BE MADE	ZSC00280
C				ZERO. X SHOULD NOT BE ALTERED BY FCN. THE	ZSC00290
C				PARAMETERS IN VECTOR PAR (SEE ARGUMENT	ZSC00300
C				PAR BELOW) MAY ALSO BE USED IN THE	ZSC00310
C		NATA		CALCULATION OF F(1)F(N).	ZSC00320
C		NSIG	-	THE NUMBER OF DIGITS OF ACCURACY DESIRED	ZSC00330
C				IN THE COMPUTED ROOT (INPUT).	ZSC00340
C		N	-	THE NUMBER OF EQUATIONS TO BE SOLVED AND	25000350
		T 7777 4 37		THE NUMBER OF UNKNOWNS (INPUT).	25000360
C C		LIMAX	-	THE MAXIMUM ALLOWABLE NUMBER OF ITERATIONS	25000370
		DAD		(INPUT).	25000380
		PAR	-	PAR CUNIAINS A PARAMETER SET WHICH IS	25000390
				PASSED IN THE USER SUPPLIED FUNCTION FON.	2500400
C.				PAR MAI BE USED TO PASS ANI AUXILIARI	25000410
				THE FUNCTION FON (INDUT)	25000420
C C		v	_	A VECTOR OF LENGTH N (INPUT)	25000430
C C		Λ	-	Y IS THE INITIAL ADDOXIMATION TO THE DOOT	25000440
Č				A 15 THE INITIAL APPROXIMATION TO THE ROOT.	2500430
č				THE DOOT FOUND BY ZECNET	23000400
č		ENOPM	_	ON OUTDUT FNODM IS FOUNT TO	25000470
Č		FNORM	-	F(1) $r = F(1)$ $r = F(1)$	25000480
č		WK	_	U_1 U_2 U_2 U_3 U_2 U_3	75000500
č		TEP	-	FRROR PARAMETER (OUTPUT)	75000510
c		TEN	-	TERMINAL FRROR	25000510
C				IER = 129 INDICATES THAT 2SONT FAILED TO	ZSC00520
C				CONVERGE WITHIN ITMAY ITERATIONS THE	28000530
Ċ				USER MAY INCREASE ITMAY OR TRY A NEW	28000540
~				JUAN HALL MONGHOD LITHUS ON ANT A HLM	200000000

С		INITIAL GUESS.	ZSC00560
c		IER = 130 INDICATES THE ALGORITHM WAS	ZSC00570
č		UNABLE TO IMPROVE ON THE RETURNED VALUE	ZSC00580
ĉ	·	OF X THIS SITUATION ARISES WHEN THE	ZSC00590
č		SOLUTION CANNOT BE DETERMINED TO NSIG	25000590
c		DIGITS DUE TO EPROPS IN THE EUNCTION	25000000
C C		VALUES IT MAY ALSO INDICATE TUAT THE	75000620
		POLITING IS TRADED IN THE ADDA OF A	2500020
		LOCAL MINIMUM THE HEED MAY TRY A NEW	28000640
с С		LUCAL MINIMUM. INE USER MAI INI A NEW	25000640
C C	-	INITIAL GOESS.	28000650
	PPRCISION (ILLOPULADE	CINCLE AND DOUDLE (122	25000680
C	PRECISION/HARDWARE	- SINGLE AND DOUBLE/H32	25000670
		- SINGLE/R30,R40,R00	25000680
6	PEOP INGL DOUTINES	STARTE (COUNTS TEAMOR TURAME TURENE TURENE	25000300
U a	REQU. IMSL ROUTINES	- SINGLE/GOUBFS, LEQI2F, LUDAIF, LUELMF, LUKEFF,	25000700
C		UERSET, UERTST, UGETTU, ZSCNU	ZSC00/10
C		- DOUBLE/GGUBFS, LEQTZF, LUDATF, LUELMF, LUREFF,	ZSC00720
C		UERSET, UERTST, UGETIO, VXADD, VXMUL, VXSTO,	ZSC00730
C		ZSCNU	ZSC00740
С			ZSC00750
С	NOTATION	- INFORMATION ON SPECIAL NOTATION AND	ZSC00760
С		CONVENTIONS IS AVAILABLE IN THE MANUAL	ZSC00770
С		INTRODUCTION OR THROUGH IMSL ROUTINE UHELP	ZSC00780
С			ZSC00790
С	COPYRIGHT	- 1980 BY IMSL, INC. ALL RIGHTS RESERVED.	ZSC00800
С			ZSC00810
С	WARRANTY	- IMSL WARRANTS ONLY THAT IMSL TESTING HAS BEEN	ZSC00820
С		APPLIED TO THIS CODE. NO OTHER WARRANTY,	ZSC00830
С		EXPRESSED OR IMPLIED, IS APPLICABLE.	ZSC00840
С			ZSC00850
C			-ZSC00860
С			ZSC00870
С	SUBROUTINE ZSCNT	(FCN,NSIG,N,ITMAX,PAR,X,FNORM,WK,IER)	ZSC00880
С		SPECIFICATIONS FOR ARGUMENTS	ZSC00890
	INTEGER	IER,ITMAX,N,NSIG	ZSC00900
	DOUBLE PRECISION	FNORM, PAR(1), WK(1), X(N)	ZSC00910
С		SPECIFICATIONS FOR LOCAL VARIABLES	ZSC00920
	INTEGER	I1, I2, I3, I4, I5, LNEW, LOLD, N1	ZSC00930
	EXTERNAL	FCN	ZSC00940
С		FIRST EXECUTABLE STATEMENT	ZSC00950
	N1=N+1		ZSC00960
	I1 = N1 * N1 + 1		ZSC00970
	I2 = I1 + N*N1		ZSC00980
	I3 = I2 + N1		ZSC00990
	I4 = I3 + N1		ZSC01000
	15 = 14 + N1		ZSC01010
	CALL UERSET(0,LOL	D) ·	ZSC01020
	CALL ZSCNU(X,N,FC	N,NSIG,N1,WK(1),WK(I1),WK(I2),WK(I3),WK(I4)	ZSC01030
	* ,WK(15),ITMAX,PA	R,IER)	ZSC01040
	CALL FCN(X,WK,N,P	AR)	ZSC01050
	FNORM = 0.0D0		ZSC01060
	DO 5 I = $1.N$		ZSC01070
	FNORM = FNORM	+ WK(I)*WK(I)	ZSC01080
	5 CONTINUE		ZSC01090
	CALL UERSET(LOLD.	LNEW)	ZSC01100
	· - ,	-	

IF (IER.EQ.0) GO TO CONTINUE CALL UERTST(IER,6H) RETURN END	ZSC01110 ZSC01120 ZSC01130 ZSC01140 ZSC01150	
FUNCTION GGUBFS (D	SEED)	ZSC01160
DOUBLE PRECISION	DSEED	ZSC01170
DOUBLE PRECISION	D2P31M, D2P31	ZSC01180
DATA	D2P31M/2147483647.D0/	ZSC01190
DATA	D2P31 /2147483648.D0/	ZSC01200
DSEED = DMOD(16807)	.DO*DSEED,D2P31M)	ZSC01210
GGUBFS = DSEED / D	2P31	ZSC01220
RETURN		ZSC01230
END		ZSC01240
	IF (IER.EQ.0) GO TO CONTINUE CALL UERTST(IER,6H RETURN END FUNCTION GGUBFS (DO DOUBLE PRECISION DOUBLE PRECISION DATA DATA DATA DSEED = DMOD(16807 GGUBFS = DSEED / D RETURN END	IF (IER.EQ.0) GO TO 9005 CONTINUE CALL UERTST(IER,6HZSCNT) RETURN END FUNCTION GGUBFS (DSEED) DOUBLE PRECISION DSEED DOUBLE PRECISION D2P31M,D2P31 DATA D2P31M/2147483647.DO/ DATA D2P31 /2147483648.DO/ DSEED = DMOD(16807.DO*DSEED,D2P31M) GGUBFS = DSEED / D2P31 RETURN END

. •

	SUBROUTINE LEQT2F (A,M,N,IA,B,IDGT,WKAREA,IER)	ZSC01250
	DIMENSION A(IA,1),B(IA,1),WKAREA(1)	ZSC01260
	DOUBLE PRECISION A, B, WKAREA, D1, D2, WA	ZSC01270
	IER=0	ZSC01280
	JER=0	ZSC01290
	J = N*N+1	ZSC01300
	K = J + N	ZSC01310
	MM = K+N	ZSC01320
	KK = 0	ZSC01330
	MM1 = MM-1	ZSC01340
	TT=1	ZSC01350
	$D_0 \leq T = 1 N$	ZSC01360
	DO 5 L=1, R	75001370
	$\frac{1}{1}$	75001380
	$\mathbf{W}_{\mathbf{A}\mathbf{A}\mathbf{C}\mathbf{B}}(\mathbf{J}\mathbf{J}) - \mathbf{A}(\mathbf{I},\mathbf{D})$	25001300
-		25001590
2	CONTINUE CALL LUDATE (UVADEA(1) A N N IDET DI DO UVADEA(1) UVADEA(V)	25001400
-	UNLERD	25001410
·]	$\frac{1}{100} (\text{TER} \text{ CT} 100) = 0.05$	25001420
	$\frac{11}{120} (1007 - 100 - 00 - 100 $	23001430
	IF (IDGI .EQ. U .OR. IER .NE. U) $KK = I$	25001440
	$DU = 1, \Pi$	28001430
	CALL LUELTE (A,B(I,I),WKAREA(J),N,N,WKAREA(MM))	25001460
	$\frac{11}{1000} (KK \cdot NE \cdot U)$	25001470
2	CALL LUREFF (WKAREA(I), B(I,I), A, WKAREA(J), N, N, WKAREA(MM), IDGT,	25001480
7	WKAREA(K), WKAREA(K), JER)	ZSC01490
	DO 10 11=1,N	28001500
	B(11,1) = WKAREA(MM1+11)	25001510
10	CONTINUE	ZSC01520
	IF (JER.NE.0) GO TO 20	ZSC01530
15	CONTINUE	ZSC01540
	GO TO 25	ZSC01550
20	IER = 131	ZSC01560
25	JJ=1	ZSC01570
	DO 30 J = 1, N	ZSC01580
	DO 30 I = 1, N	ZSC01590
:	A(I,J)=WKAREA(JJ)	ZSC01600
	JJ=JJ+1	ZSC01610
30	CONTINUE -	ZSC01620
	IF (IER .EQ. 0) GO TO 9005	ZSC01630
9000	CONTINUE	ZSC01640
	CALL UERTST (IER,6HLEQT2F)	ZSC01650
9005	RETURN	ZSC01660
	END	ZSC01670

ŧ

	SUBROUTINE LUDATE (A,LU,N,IA,IDGT,D1,D2,IPVT,EQUIL,WA,IER)	ZSC01680
	DIMENSION	A(IA,1),LU(IA,1),IPVT(1),EQUIL(1)	ZSC01690
	DOUBLE PRECISION	A.LU.D1.D2.EOUIL.WA.ZERO.ONE.FOUR.SIXTN.SIXTH.	ZSC01700
4		RN WREL BIGA BIG. P. SUM. AT. WI. T. TEST. O	2SC01710
	ከልፕል	7FRO ONE FOUR SIXTN SIXTH/O DO 1 DO 4 DO	25001720
J	-	16 DO 0(25DO/	25001720
	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	10.00,.002500/	23001730
	IER = 0		2201/40
	RN = N		ZSC01750
	WREL = ZERO	• •	ZSC01760
	D1 = ONE		ZSC01770
	D2 = ZERO		ZSC01780
	BIGA = ZERO		ZSC01790
	DO 10 I=1,N		ZSC01800
	BIG = ZERO		ZSC01810
	DO_5 $J=1$ N		ZSC01820
	P = A(T T)		75001830
	$\frac{1}{1} = \frac{1}{2} $		75001840
	D = DABS(D)	·	25001840
	P = DABS(P)		25001850
-	IF (P.GT.BI	G) BIG = P	25001860
5	CONTINUE		ZSC01870
	IF (BIG .GT. BIG	(A) BIGA = BIG	ZSC01880
	IF (BIG .EQ. ZER	10) GO TO 110	ZSC01890
	EQUIL(I) = ONE/B	IG	ZSC01900
10	CONTINUE		ZSC01910
	DO 105 J=1,N		ZSC01920
	JM1 = J - 1		ZSC01930
	IF (JM1 .LT. 1)	GO TO 40	ZSC01940
	DO 35 I=1IM1		ZSC01950
	SIM = LII(T T)		75001960
	$IM1 = I_{-1}$	· · ·	75001970
	INI - I I IF (IDCT FO	0) CO TO 25	25001970
	$\frac{11}{1001} = \frac{1001}{1000} = \frac{1000}{1000}$		23001980
	AI = DABS(SUM)	1)	23001990
	$WI = \Delta ERU$	1) 50 50 00	25002000
	IF (IMI .LT.	1) GO TO 20	ZSC02010
	DO 15 $K=1, IMI$		ZSC02020
	T = LU(I, K)	()*LU(K,J)	ZSC02030
	SUM = SUM	-T	ZSC02040
	WI = WI + DA	ABS(T)	ZSC02050
15	CONTINUE		ZSC02060
	LU(I,J) = SUM	1	ZSC02070
20	WI = WI + DABS((SUM)	ZSC02080
	IF (AI .EO. 2	ZERO) AI = BIGA	ZSC02090
	TEST = WI/AI		ZSC02100
	IF (TEST GT.	WREL) WREL = TEST	ZSC02110
	GO TO 35		25002120
25	TE (IMI IT	1) CO TO 35	75002120
20	DO 20 V - 1 TM1		25002150
	30 30 K - 1, 1H		25002140
<u>~</u>	SUM = SUM	-TO(I'V)~TO(V')	23002130
30	CUNTINUE	,	25002160
• -	LU(1,J) = SUN	1	25002170
35	CONTINUE		ZSC02180
40	P = ZERO		ZSC02190
	DO 70 I=J,N		ZSC02200
	SUM = LU(I,J)		ZSC02210
	IF (IDGT .EQ	. 0) GO TO 55	ZSC02220
	•		

•

	AI = DABS(SUM)		ZSC02230
	WI = ZERO		ZSC02240
	IF (JM1 .LT. 1) GO TO 50	•	ZSC02250
	DO 45 $K=1.JM1$		ZSC02260
	T = LU(I,K)*LU(K,J)		ZSC02270
	SUM = SUM - T		ZSC02280
	WI = WI + DABS(T)		ZSC02290
45	CONTINUE		ZSC02300
<i></i>	LU(T, I) = SUM	•	ZSC02310
50	WI = WI + DABS(SUM)		ZSC02320
50	TF (AT EO ZERO) AT = BTGA		ZSC02330
	TEST = WI/AI		25002350
	IF (TEST GT, WREL) WREL = TEST	· .	ZSC02350
•	GO TO 65	· · ·	ZSC02360
55	IF (IM1 LT 1) GO TO 65		20002300
	$DO = 60 \ \text{K} = 1 \ \text{M}$		25002380
	SIM = SIM - UI(I K) + UI(K I)		25002300
60	CONTINUE		25002550
. 00	$UU(1, 1) \simeq SUM$		25002400
65	D(1,3) = SON $O = FOUTL(1) * DARS(SUM)$	•	75002410
05	$\mathbf{Q} = \mathbf{E}(\mathbf{Q} \mathbf{T} \mathbf{U}^{T}) + \mathbf{E}(\mathbf{U} \mathbf{U}$		75002420
	P = 0		25002450
	r - Q IMAY = T	· · ·	25002440
70	CONTINUE		25002450
. /0	TE (DN + D E O DN) CO TO 110		25002400
	$\frac{11}{11} (\mathbf{M}^{+1} \cdot \mathbf{E}\mathbf{Q} \cdot \mathbf{M}) = 0 = 10 = 110$	· · ·	25002470
	11 (0.100, 100, 00.100)	۰.	25002480
	DI = -DI $DO = 75 K = 1 N$		25002490
	D - TH(TMAY R)	· · ·	75002510
	F = DO(THAX, K)		23002310
	II(IK) = P		75002520
75	CONTINUE	·	25002550
/ 5	FOUTL(IMAX) = FOUTL(I)		23002540
80	IQUIN(INRK) = IQUIN(U) IPUT(I) = IMAY		25002550
00	$D1 = D1 \div U(T T)$		25002500
85	$\frac{DI}{DI} = \frac{DI}{DI} $		75002570
. 05	$D1 = D1 \times SIXTH$		25002500
	$D_1 = D_1 \text{ SIMM}$ $D_2 = D_2 + FOIR$		25002590
	GO TO 85		25002000
90	IF (DABS(D1) GE SIXTH) GO TO 95		ZSC02620
	$D1 = D1 \times SIXTN$		25002620
	$D_2 = D_2 - FOUR$		ZSC02640
	GO TO 90	- *	ZSC02650
95	CONTINUE		ZSC02660
	JP1 = J+1		ZSC02670
	IF (JP1 ,GT, N) GO TO 105		ZSC02680
	P = LU(J,J)		ZSC02690
	DO 100 I=JP1.N		ZSC02700
	LU(I,J) = LU(I,J)/P		ZSC02710
100	CONTINUE		ZSC02720
105	CONTINUE		ZSC02730
	IF (IDGT .EQ. 0) GO TO 9005		ZSC02740
	P = 3*N+3		ZSC02750
	WA = P*WREL		ZSC02760
	IF (WA+10.D0***(-IDGT) .NE. WA) GO TO 9005		ZSC02770
	IER = 34	ZSC02780	
------	---	----------	
	GO TO 9000	ZSC02790	
110	IER = 129	ZSC02800	
	D1 = ZERO	ZSC02810	
	D2 = ZERO	ZSC02820	
9000	CONTINUE	ZSC02830	
	CALL UERTST(IER, 6HLUDATF)	ZSC02840	
9005	RETURN	ZSC02850	
	END	ZSC02860	
	SUBROUTINE LUELMF (A, B, IPVT, N, IA, X)	ZSC02870	
	DIMENSION $A(IA, 1), B(1), IPVT(1), X(1)$	ZSC02880	
	DOUBLE PRECISION A.B.X.SUM	ZSC02890	
	DO 5 I=1,N	ZSC02900	
5	X(I) = B(I)	ZSC02910	
	IW = 0	ZSC02920	
	DO 20 I=1,N	ZSC02930	
· .	IP = IPVT(I)	ZSC02940	
	SUM = X(IP)	ZSC02950	
	X(IP) = X(I)	ZSC02960	
	IF (IW .EQ. 0) GO TO 15	ZSC02970	
	IM1 = I - 1	ZSC02980	
	DO 10 J=IW,IM1	ZSC02990	
	SUM = SUM-A(I,J)*X(J)	ZSC03000	
10	CONTINUE	ZSC03010	
	GO TO 20	ZSC03020	
15	IF (SUM .NE. 0.DO) $IW = I$	ZSC03030	
20	X(I) = SUM	ZSC03040	
	DO 30 IB=1,N	ZSC03050	
	I = N+1-IB	ZSC03060	
	IP1 = I+1	ZSC03070	
	SUM = X(I)	ZSC03080	
	IF (IP1 .GT. N) GO TO 30	ZSC03090	
	DO 25 J=IP1,N	ZSC03100	
	SUM = SUM-A(I,J)*X(J)	ZSC03110	
25	CONTINUE	ZSC03120	
30	X(I) = SUM/A(I,I)	ZSC03130	
	RETURN	ZSC03140	
	END	ZSC03150	

	SUBROUTINE LUREFF (A,B,UL, IPVT, N, IA, X, IDGT, RES, DX, IER)	ZSC03160
	DIMENSION $A(IA, 1), UL(IA, 1), B(1), X(1), RES(1), DX(1), IPVT(1)$)ZSC03170
	DIMENSION ACCXT(2)	ZSC03180
	DOUBLE PRECISION A.ACCXT, B.UL, X.RES, DX.ZERO, XNORM, DXNORM	ZSC03190
	DATA ITMAX/75/.ZERO/0.D0/	ZSC03200
	TER=0	25003210
	XNORM = ZERO	25003210
	DO 10 T=1 N	25003220
	XNORM = DMAX1(XNORM DABS(X(T)))	25003250
10	CONTINUE	25003240
10	TE (YNORM NE ZERO) CO TO 20	25003250
	11° (AROAL .RE. 22RO) 30 10 20	25003200
	1001 - 50	28003270
20	$\frac{10}{10} \frac{10}{100}$	25003200
20	$\frac{100 45 11 \text{ER}}{11 \text{ER}}$	25003290
	$DU \ 3U \ 1=1, N$	25003300
	ACCXI(1) = 0.000	28003310
	AU(XI(2) = 0.000	ZSC03320
	CALL VXADD(B(1), ACCXT)	ZSC03330
	D0 25 J=1,N	ZSC03340
	CALL VXMUL(-A(I,J),X(J),ACCXT)	ZSC03350
25	CONTINUE	ZSC03360
	CALL VXSTO(ACCXT, RES(I))	ZSC03370
30	CONTINUE	ZSC03380
	CALL LUELMF (UL,RES,IPVT,N,IA,DX)	ZSC03390
	DXNORM = ZERO	ZSC03400
	XNORM = ZERO	ZSC03410
	DO 35 I=1,N	ZSC03420
	X(I) = X(I) + DX(I)	ZSC03430
	DXNORM = DMAX1(DXNORM, DABS(DX(I)))	ZSC03440
	XNORM = DMAX1(XNORM, DABS(X(I)))	ZSC03450
35	CONTINUE	ZSC03460
	IF (ITER .NE. 1) GO TO 40	ZSC03470
	IDGT = 50	ZSC03480
	IF (DXNORM .NE. ZERO) IDGT = -DLOG10(DXNORM/XNORM)	ZSC03490
· 40	IF (XNORM+DXNORM .EQ. XNORM) GO TO 9005	ZSC03500
45	CONTINUE	ZSC03510
	IER = 129	ZSC03520
9000	CONTINUE	ZSC03530
	CALL UERTST(IER, 6HLUREFF)	ZSC03540
9005	RETURN	ZSC03550
	END	ZSC03560
· 1		
l	SUBROUTINE UERSET (LEVEL, LEVOLD)	ZSC03570
	INTEGER LEVEL, LEVOLD	ZSC03580
	LEVOLD = LEVEL	ZSC03590
	CALL UERTST (LEVOLD,6HUERSET)	ZSC03600
	RETURN	ZSC03610
	END	ZSC03620

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	SUBROUTINE UERTST (IER, NAME)			ZSC03630
	INTEGER IEO			ZSC03640
	INTEGER*2 NAME(3) NAMSET(3) NAMEO(3)			ZSC03650
	DATA NAMSET/2HIE 2HRS 2HET/			25003660
				26003670
	DATA $NATEQ/2\pi$, 2π , 2π /			23003670
	DATA LEVEL/4/, IEQDF/0/, IEQ/IH=/			25003680
	1F (1ER.GT.999) GO TO 25			ZSC03690
	IF (IER.LT32) GO TO 55			ZSC03700
	IF (IER.LE.128) GO TO 5			ZSC03710
	IF (LEVEL.LT.1) GO TO 30			ZSC03720
	CALL UGETIO(1,NIN,IOUNIT)	o		ZSC03730
	IF (IEODF.EO.1) WRITE(IOUNIT.35) IER.NAMEO.IEO.NAME			ZSC03740
	IF (IEODF.EO.O) WRITE(IOUNIT.35) IER.NAME		١	ZSC03750
	GO TO 30			ZSC03760
5	IF (IER LE 64) GO TO 10			ZSC03770
	$\frac{11}{11} (11000 \pm 10) = 00 = 10 = 10$			75003780
	CATT UCETTO(1 NIN TOUNIT)			25003700
•	TE (IEODE EO 1) UDITE (IOUNIT (O) IED NAMEO IEO NAME			23003790
	IF (IEQDF.EQ.I) WRITE(IOUNIT,40) IER, NAMEQ, IEQ, NAME			23003800
	IF (IEQDF.EQ.0) WRITE(IOUNII,40) IER,NAME			25003810
				25003820
10	IF (IER.LE.32) GO TO 15			ZSC03830
	IF (LEVEL.LT.3) GO TO 30			ZSC03840
	CALL UGETIO(1,NIN,IOUNIT)			ZSC03850
•	IF (IEQDF.EQ.1) WRITE(IOUNIT,45) IER,NAMEQ,IEQ,NAME			ZSC03860
	IF (IEQDF.EQ.0) WRITE(IOUNIT,45) IER,NAME			ZSC03870
•	GO TO 30			ZSC03880
15	CONTINUE			ZSC03890
	DO 20 I=1,3			ZSC03900
	IF (NAME(I).NE.NAMSET(I)) GO TO 25			ZSC03910
20	CONTINUE			ZSC03920
	LEVOLD = LEVEL			ZSC03930
	LEVEL = IER			ZSC03940
	IER = LEVOLD			ZSC03950
	IF (LEVEL.LT.0) LEVEL = 4			ZSC03960
	IF (LEVEL.GT.4) LEVEL = 4			ZSC03970
	GO TO 30			ZSC03980
25	CONTINUE			ZSC03990
	IF (LEVEL LT 4) GO TO 30			25004000
	CALL DEFTIO(1 NIN TOUNIT)			25004010
	IE (IFODE EO 1) WEITE (IOUNIT SO) IER NAMEO IEO NAME			25004010
	IF (IEQDE EQ.I) WRITE (IOUNIT, 50) IER, MAILE, IEQ, MAIL IF (IEQDE EQ. 0) WRITE (IOUNIT 50) IER NAME			25004020
30	$\frac{11}{100} = 0$			23004030
20		50	•14 · ·	25004040
25	RETURN		••	25004050
22	FORMAT(19H *** TERMINAL ERROR, TOX, $/H(1ER = , 13, 12)$	53		25004060
	1 20H) FROM IMSL ROUTINE , 3A2, A1, 3A2)	•1		ZSC04070
40	FORMAT (36H $\pi\pi\pi$ WARNING WITH FIX ERROR (1ER = ,13,	•		ZSC04080
	1 20H) FROM IMSL ROUTINE , 3A2, A1, 3A2)			ZSC04090
45	FORMAT(18H $\pi\pi\pi\pi$ WARNING ERROR, 11X, 7H(IER = ,13,			ZSC04100
	1 20H) FROM IMSL ROUTINE , 3A2, A1, 3A2)			ZSC04110
50	FORMAT(20H **** UNDEFINED ERROR,9X,7H(IER = ,15,			ZSC04120
-	1 20H) FROM IMSL ROUTINE ,3A2,A1,3A2)			ZSC04130
55	IEQDF = 1			ZSC04140
_	DO 60 I=1,3			ZSC04150
60	NAMEQ(I) = NAME(I)			ZSC04160
65	RETURN			ZSC04170

	END	ZSC04180
	SUBROUTINE UGETIO(IOPT,NIN,NOUT)	ZSC04190
	INTEGER IOPT, NIN, NOUT	ZSC04200
	INTEGER NIND, NOUTD	ZSC04210
	DATA NIND/5/,NOUTD/6/	ZSC04220
	IF (IOPT.EQ.3) GO TO 10	ZSC04230
	IF (IOPT.EQ.2) GO TO 5	ZSC04240
	IF (IOPT.NE.1) GO TO 9005	ZSC04250
	NIN = NIND	ZSC04260
	NOUT = NOUTD .	ZSC04270
	GO TO 9005	ZSC04280
5	NIND = NIN	ZSC04290
	GO TO 9005	ZSC04300
10	NOUTD = NOUT	ZSC04310
9005	RETURN	ZSC04320
	END	ZSC04330
	SUBROUTINE VXADD(A,ACC)	ZSC04340
	DOUBLE PRECISION A, ACC(2)	ZSC04350
	DOUBLE PRECISION X,Y,Z,ZZ	ZSC04360
	X = ACC(1)	ZSC04370
	Y = A	ZSC04380
	IF (DABS(ACC(1)).GE.DABS(A)) GO TO 1	ZSC04390
	X = A	ZSC04400
	Y = ACC(1)	ZSC04410
1	Z = X + Y	ZSC04420
	ZZ = (X-Z)+Y	ZSC04430
	ZZ = ZZ + ACC(2)	ZSC04440
	ACC(1) = Z + ZZ	ZSC04450
	ACC(2) = (Z - ACC(1)) + ZZ	ZSC04460
	RETURN	ZSC04470
	END	ZSC04480

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SUBROUTINE VXMUL	(A,B,ACC)	ZSC04490
DOUBLE PRECISION	A,B,ACC(2)	ZSC04500
DOUBLE PRECISION	X,HA,TA,HB,TB	ZSC04510
INTEGER	IX(2),I	ZSC04520
LOGICAL*1	LX(8),LI(4)	ZSC04530
EQUIVALENCE	(X, LX(1), IX(1)), (I, LI(1))	ZSC04540
DATA	1/0/	ZSC04550
X = A		ZSC04560
LI(4) = LX(5)		ZSC04570
IX(2) = 0		ZSC04580
I = (I/16) * 16		ZSC04590
LX(5) = LI(4)		ZSC04600
HA=X		ZSC04610
TA=A-HA		ZSC04620
X = B		ZSC04630
LI(4) = LX(5)		ZSC04640
IX(2) = 0		ZSC04650
I = (I/16) * 16		ZSC04660
LX(5) = LI(4)		ZSC04670
HB = X		ZSC04680
TB = B-HB		ZSC04690
$X = TA \star TB$		ZSC04700
CALL VXADD(X,ACC)		ZSC04710
X = HA*TB		ZSC04720
CALL VXADD(X,ACC)		ZSC04730
X = TA*HB		ZSC04740
CALL VXADD(X,ACC)		Z\$C04750
X = HA*HB		ZSC04760
CALL VXADD(X,ACC))	ZSC04770
RETURN		ZSC04780
END		ZSC04790
SUBROUTINE VXSTO	(ACC,D)	ZSC04800
DOUBLE PRECISION	ACC(2),D	ZSC04810
D = ACC(1) + ACC(2))	ZSC04820
RETURN		ZSC04830
END		ZSC04840

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	SUBROUTINE ZSCNU	(X,N,FCN,NDIGIT,N1,A,Z,Y,XNORM,B,WK,	ZSC04850
	MAXIT, PAR, IER)		ZSC04860
	INTEGER	IER,MAXIT,N,NDIGIT,N1	ZSC04870
	DOUBLE PRECISION	A(N1,1),B(1),PAR(1),WK(1),X(1),XNORM(1),	ZSC04880
	1.	Y(1), Z(N, 1)	ZSC04890
	INTEGER	I, IBMAX, IBNORM, IDGT, IEVAL, ITER, J, JER, JI, JS,	ZSC04900
	1 .	MI , NRS , NSTART	ZSC04910
	DOUBLE PRECISION	BIG, BNORM, CFACT, DX, EPS, HALF, HLMAX, RACC, REPS,	ZSC04920
	1	RRX,RX,SFACT,SMALL,TEST,TN,TR	ZSC04930
	DOUBLE PRECISION	DSEED	ZSC04940
	DATA	SMALL/Z341000000000000/	ZSC04950
	IER = 0		ZSC04960
	DSEED = 12345.0D0		ZSC04970
	CFACT = 0.99D0		ZSC04980
	BIG = 5.0D5		ZSC04990
	SFACT = 0.1D0		ZSC05000
	IBMAX = 50		ZSC05010
	NRS = 2		ZSC05020
	RACC = DMIN1(DMAX)	l(SMALL,10.0D0**(-NDIGIT)),0.1D0)	ZSC05030
	REPS = DSQRT(SMALI	(L	ZSC05040
	HLMAX = 3.0D0	<i>,</i>	ZSC05050
	ITER = 0		ZSC05060
	IEVAL = 0		ZSC05070
	NSTART = 0		ZSC05080
	IBNORM = 0		ZSC05090
	RX = 1.0D0		ZSC05100
	RRX = 0.0D0		ZSC05110
	EPS = 0.0D0		ZSC05120
	DO 5 I=1,N		ZSC05130
	B(I) = 0.D0	·	ZSC05140
	A(N1,I) = 1.000) .	ZSC05150
	Z(I,N1) = X(I)		ZSC05160
5	CONTINUE		ZSC05170
	B(N1) = 1.D0		ZSC05180
	A(N1,N1) = 1.0D0		ZSC05190
	JI = N1		ZSC05200
	IEVAL = IEVAL+1		ZSC05210
	CALL FCN (Z(1,N1),	A(1,N1),N,PAR)	ZSC05220
	BNORM = 0.0D0		ZSC05230
	DO 10 I=1,N		ZSC05240
	BNORM = BNORM + A	A(I,N1)*A(I,N1)	_ZSC05250
10	CONTINUE		ZSC05260
	XNORM(N1) = BNORM		'ZSC05270
15	IF (NSTART.EQ.NRS)	EPS = EPS*10.0D0	ZSC05280
	IF (NSTART.EQ.0) F	PS = DMIN1(RX, REPS)	ZSC05290
	IF (EPS.GT.BIG) GO	D TO 120	ZSC05300
	NSTART = MOD(NSTAR)	RT,NRS)+1	ZSC05310
	DO 30 J=1,N	•	ZSC05320
	DO 25 I=1,N		ZSC05330
20	TR = (GGUBFS)	S(DSEED)-0.5D0)*2.0D0	ZSC05340
	IF (DABS(TR)).LT.0.1D0) GO TO 20	ZSC05350
	Z(I,J) = X(I)	L)+DMAX1(DABS(X(I)),0.1D0)*TR*EPS	ZSC05360
25	CONTINUE		ZSC05370
	IEVAL = IEVAL+1		ZSC05380
	. CALL FCN $(Z(1, J))$	J), $A(1, J)$, N , PAR)	ZSC05390

178

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30 CONTINUE ZSC05400 DO 35 J=1,N ZSC05410 XNORM(J) = 0.D0ZSC05420 DO 35 I=1,N ZSC05430 XNORM(J) = XNORM(J)+A(I,J)*A(I,J)ZSC05440 **35 CONTINUE** ZSC05450 40 JI = N1ZSC05460 JS = JIZSC05470 DO 45 J=1,N ZSC05480 IF (XNORM(J).GT.XNORM(JS)) JS = J ZSC05490 IF (XNORM(J), LT, XNORM(JI)) JI = J ZSC05500 45 CONTINUE ZSC05510 IF (XNORM(JI).EQ.0.D0) GO TO 125 ZSC05520 IF (XNORM(JI).GT.SFACT*BNORM) GO TO 50 ZSC05530 BNORM = XNORM(JI)ZSC05540 IBNORM = ITERZSC05550 50 IF ((ITER-IBNORM).GT.IBMAX) GO TO 120 ZSC05560 ITER = ITER+1ZSC05570 IF (ITER.GE.MAXIT) GO TO 115 ZSC05580 DO 55 MI=1,N1 ZSC05590 Y(MI) = B(MI)ZSC05600 55 CONTINUE ZSC05610 IDGT = 0ZSC05620 CALL LEQT2F (A,1,N1,N1,Y,IDGT,WK,JER) ZSC05630 IF (JER.NE.0) GO TO 85 ZSC05640 DO 65 I=1,N ZSC05650 DX = 0.0D0ZSC05660 DO 60 J=1,N1 ZSC05670 DX = DX + Y(J) * Z(I,J)ZSC05680 CONTINUE ZSC05690 60 X(I) = DXZSC05700 65 CONTINUE ZSC05710 HALF = 0.D0ZSC05720 70 IEVAL = IEVAL+1 ZSC05730 CALL FCN (X,Y,N,PAR) ZSC05740 ZSC05750 TN = 0.D0DO 75 I=1,N ZSC05760 TN = TN+Y(I)*Y(I)ZSC05770 **75 CONTINUE** ZSC05780 IF (TN.LT.XNORM(JS)) GO TO 95 ZSC05790 HALF = HALF+1.DOZSC05800 IF (HALF.GT.HLMAX) GO TO 85 ZSC05810 DO 80 I=1,N . ZSC05820 X(I) = (X(I)+HALF*Z(I,JI))/(HALF+1.0D0)ZSC05830 **80 CONTINUE** ZSC05840 GO TO 70 ZSC05850 85 IF (JI.EQ.N1) GO TO 15 ZSC05860 XNORM(N1) = XNORM(JI)ZSC05870 DO 90 I=1,N ZSC05880 Z(I,N1) = Z(I,JI)ZSC05890 A(I,N1) = A(I,JI)ZSC05900 **90 CONTINUE** ZSC05910 GO TO 15 ZSC05920 95 IF ((HALF.NE.0.D0).OR.(ITER.EQ.1)) GO TO 105 ZSC05930 RX = SMALLZSC05940

	DO 100 I=1,N	ZSCO	5950
	RX = DMAX1(RX, DABS(X(I)-Z(I, JI))/DMAX1(DABS(X))	(I)),0.1D0)) ZSCO	5960
100	CONTINUE	ZSCO	5970
	RRX = DMAX1(-DLOG10(RX), 0.0D0)	ZSCO	5980
	IF (RX.LE.RACC) GO TO 125	ZSCO	5990
105	IF (TN.LT.CFACT*XNORM(JI)) NSTART = 0	ZSCO	6000
	XNORM(JS) = TN	ZSCO	6010
	DO 110 I=1,N	ZSCO	6020
	Z(I, JS) = X(I)	ZSCO	6030
	A(I, JS) = Y(I)	ZSCO	6040
110	CONTINUE	ZSCO	6050
	GO TO 40	ZSCO	6060
115	IER = 129	ZSCO	6070
	GO TO 125	ZSCO	6080
120	IER = 130	ZSCO	6090
125	DO 130 I=1,N	ZSCO	6100
	X(I) = Z(I, JI)	ZSCO	6110
130	CONTINUE	ZSCO	6120
	RETURN	ZSCO	6130
	END	ZSCO	6140

APPENDIX C







	Т	ABLE	C-1	R	MPING	Rinsh 8	ESKN	A-1-A-1 -	Sma	LL CIARAN	ز ب	CT SAS	TD BAB	STT-	SAE -11	. STROKE	: = 2 in
DATA	Frequery	آ - ` ,	 . • !	OIL I	DLAT Phands	CLANP	of busin	Rump	no Phase	e Rus	000		-				
POINT	+12			ĉ	(*;)	MP.	(11/2)	MA.	. (11/13) 9/	hus			ļ	· ·	()	
	10			47.8	(116)	8.62	(1250)	8.81	287		0				1	· ·	
				41.2	(117)			7.51	(1060	2	1 IP				1		
				47.8	(118)			4.79	1695	3.	40				1		
				47.8	(118)			2.09	1303) 3.	45						
	· · · ·			47.8	(118)			0.04	16	3	57			<u>, </u>	1		
																1	·
2	. 35			50.0	(122)	8.62	(1250)	9.18	1332		$\overline{\mathbf{s}}$						
				50.0	(122)			8.51	1235	1	3.6				!		
		·		50.0	(122)			7.58	(1100	1	2.2					1	
			·	50,0	(122)			5.52	1800	<u>) </u>	8.8				:	i	
				489	(120)	┝╌┠──	┝╼╄╼═╄	2.76	(400	1 20	0.4						
ļi				47.8	(118)	└ +		0.21	(30)	2	0.8			1	1		
			ļ				<u> </u>		1								
3	60			48.9	(120)	842	(1250)	9.10	1320	<u>и </u>	<u></u>	I		·	1		
			·	49.4	(121)	└─┟──	┟╾╂──┤	8.81	(127e	33	13				1		
				50.0	(122)	└──┨───	┝╌┦╌┤	6.23	11005]] 31	3.4				1		
			L	48.9	(120)	┝──┠───	┝╌┠╌╴┤	5.52	11800	<u>14</u>	0.3	[l			
			·	48.9	(120)	┝╾ <u></u> ┟──	┟╾╂──╏	2.76	1400	4	2.5			1	1	ļ	L
				49.4	121)	Ψ	+	0.33	148		3.0			l <u>.</u>			L
			 	·		ļ			4								
4	10			47.B	(118)	6.89	11000)	7.25	4052	yc	2	I		L			
			·	47.8	(118)	└─↓ ──	┟╌╻┥	6.40	1929	13	.2 🔟					<u> </u>	
l			! 	47.8	(116)			5.19	1 (844	3	. 5	I]	L			
			· · ·	47.8	(118)	┝╌┨╌╌	┟╌┠╌┨	3.47	1(504	-↓4	.0						
	····	l		47.8	11181		╞╼╧┤	-0-	10	¥ <u> </u>	3			l		ļ	L
			ļ			1			+	J				L		Į	
_5	35		L	47.8	(118)	6.89	1(1000)	7.36	1068	<u>}</u>	2			l	<u> </u>	l	
			I	478	(118)	┞──┠───	┝╌┠╶┨	6.76	1 (980	<u> Л К</u>	1.8	[ļ		ļ	
				478	(118)	⊢∔	+ + +	5.52	1180	2 2	1.5	I	 	<u> </u>			
				47.2	(117)	└──└ ──	↓_↓	1.38	120	2	<u>4.C</u>			L		<u> </u>	
			l	46.7	(116)			0.12		71	4.9∏						
	} }-		┞━━━━━┓┫	┞i	┞	 	┟┈───┤			-]		ļ	+		
CHARGE		Incorrect	L L	L	L	L				_ _				L	<u> </u>	L	L
		FRUJEC				ENG.	INEEM:		DAT	E: N	UTES:						MTI

CALCULATION SHEET

STROKE = 2 m

		TABLE C-	-1 CastilD	RUMPING RI	NG DE	ESIGN - A	1.A.I	SMALL GRARAUKE	HAT'L:	TID BASED	BASSITT (S	AE -11)	
DATA	FR1Q.	On	JULT-	amp	Why Pors	Rumpe	Peru	Rumper					
POIDT	Hr	°C	("F)	MR	(14/3)	ИFL	(16/15)	A/m.s					
<u> </u>	60	50	0.0 (122)	6.89	(1000)	7.39	(1072)	10					
		49	.4 (121)	<u> _</u>		4.89	(1000)	42.0			·		
		49	4 (121)			4.12	(100)	46.0					
		49	<u> </u>	·-		2.15	(399)	49.4					
		50	0 (122)	<u>↓</u>	<u> +</u>	0.14	(20)	<u></u>					
η	19	41	8 (118)	3.45	(500)	3.85	(558)	0					
		47	8 (118)		1	3.41	1/4951	3.02					
		47	8 (11B)			2.44	(354)	397					
		47	18 (118)			1.38	(200)	2.92					
		41	8 (118)	↓		-0-	101	3.83					
8	35	48	3 (119)	345	(500)	384	1560						
		4	1.9 /120)	-= <u></u> -		1335	(AAL)	709					
		50	.0 (122)			2.37	1310	917					
		44	.4 (121)			1.38	(200)	266		1 7 0			
		50	.0 (122)	÷	+	0.10	(14)	28.0		<u>Š</u>			
				<u> </u>		 	<u> </u>	·III	····	7 -			
_2	60	48	9 (120)	3,45	(500)	3.19	(SSO)						
		مک	.0 (122)			3.45	(500)	41.2		S			
		41	4 (121)			2.07	(300)	512		F			
		46	19 (120)			1.38	(200)	54.2		P			
		. 46	3.9 (120)	•	+	6.18	(26)	59.0					
10	10	47	.8 (118)	8.62	(1260)	8.62	(1250)	2.47		_ <u>_</u>			
		41	8 (118)	6.89	(1000)	6.89	(1000)	3.15					
		47	2 (117)	5.52	(800)	5.52	(800)	3.05					
		41	2 (117)	4.31	(625)	4.51	1625	2.00					
		47	.8 (118)	1.35	(193)	1.33	(193	0					
				↓		<u> </u>	<u> </u>						
			·	<u> </u>		<u>}</u> }	-{	┨──┨───┨─					
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ALCULATION S	HEET			·									(3-70)

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		·												+
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		48.9	(120)	+	•	1,21	(176)	7.43	1					ļ
		48.9	(120)	·		2.76	(400)	7.26						1
		500	(122)			4.96	(120)		72540	1.0012.	Smoke		1	1
		48.9	(120)		111201	8,60	(1748)	492	7				<u> </u>	+
14	60	41.8	(118)	847	(120)	9 19	(122)	<u>`</u>						+
			(140)	· · · · · · · · · · · · · · · · · · ·	─▼	1.08	(156)	6.7-1	<u>,</u>		┠			
		60.0			┝─ <u></u> ╂─╂─	2.76	(400)	<u> </u>	}		 		{	╉───
		60.6	(141)		┝╼╉╼╉╼╸	4.96	(720)	6.43	12540	m (1.001	b.)Srace	٤	\	1
		58.9	(138)		┝━╍┠╼╍┠╼╍	7.45	(1080)	5,45	1	Ļ			 	_
13	60	59.4	(139)	8.67	(1250)	8.69	(1261)	-0-					·	
		49.4	(121)	0,35	(51)	0.35	(51)	33.6					1	
		489	(120)	1.40	(203)	1.40	(203)	34.8					1	1
		48.9	(120)	2.76	(400)	2.76	(400)	40.6					1	1
		48.9	(120)	4.22	(612)	4.72	((17)						i	1
		48.9	(120)	5,1	(67)	517	(497)	<u>0,1</u>			<u>├</u>		<u> </u>	
- <u>'</u>		<u> </u>	(134)	<u> </u>	(02)	8.65	(12(4)	33.8						
12	-+		7		1000						┣			}
		50.0	(122)	0,29	(42)	0,29	(45)			L	<u> </u>		<u> </u>	_
<u>_</u>		0.0	(122)	1-31	(200)	1.58	(200)	17.0						
		50.0	(122)	8.76	(400)	2.76	(400)	19.0						
		50.0	(122)	4.11	(620)	4.21	(670)	23.2						
		48.9	(120)	5.62	(84)	5.62	(816)	24.3						
		49.4	(121)	6.99	(1014)	6.99	(1014)	21.7						
11	35	49.4	(121)	8.64	(120)	QLG	11212	179						
DOIDT	H	TEM	Prest	MR	(1)(3)	UD L	18442	Rew					l	
TATO	The	OILIN	hr	(Lamo)	Deer	D	D	Bunner				1		
				MPING KIL	SG UESIC	$\frac{1}{2}$	<u></u>		MA	1.1.1			r	r

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MT1-4 (3-70)

		TABLE	C-2	۹ ۲	RUMPIN	og Ru	<u>34</u> 7	DESIGN	_ Ä •:	2-A-1	LARGE	GIARA	xe, HA	דינ: זה	BASED	BABBI	n (sae	· II)
DATA	TELQ.		OILIN	LTT D		(Lamo)	L Par	5	RIMPER	Peru		Rumpers						
POIDT	Hr	 [r	(F)		MR	(16/13	hl	MPL.	(16/15)		A/n.J		1				
┝┻╋		II	41.8	(118)		10.3	1(150		10,5	(1517)		-0-						
┝		╏	47.B	(118)					8.64	(1254)		2.08				•		
			47.8	(118)					7.51	(1099)		2.46						
		┣───┤	47.8	(116)					4.82	(700)		2.85						
		 -	47.8	(118)		+	+		-0-	(0)		3.05						
	. 25	┠──┼	6	(100)				<u></u>		<u> </u>				ļ	l			
		-+	50.0	(122)		10.3	1050	2)	10.8	(1572)		-0-		 				
		┠╍╍╌┠	30.0	(122)			┠Ң		8.62	(1220)		16.8						
		┠────┼	48.5		<u> </u>		┝──╁	_	1.78	(1128)	ļ	17.5		ļ	·			
		┠───╁	47.8	118					4.14	(600)	l	18.6		<u> </u>	ļ			
		┝	41.8	1101		.			0.14	(20)		18.5		ļ				
3	60	┠╸╴╴╸┠	49.0	(12)		10.3	1	. 		() and	·			<u> </u>	↓			
	~		10.9	(120)		10.5	11200	2 <u>1 f</u>	10.8	(15/)		-0-	-	<u> </u>	}			
		┟───╁	<u>40.1</u>	(120)			┨──┨─		10.2	(1488)		214			 			
		├{-	50.0	(199)	·		+		7.06	(13)		340		 	I			
			<u>CII</u>	(124)			╂──╂─		2.12	(852)		35.6		ł				
				(122)		-1	}		244, 44	(446)	}	55.	<u> </u>		┨────		 	
			2010	218-1					- MC-TH	(221		32.4			<u> </u>	ļ	<u> </u>	
4	10		48.9	(120)		8.62	(1250		8.79	(1275)		- 0-	<u></u>				<u> </u>	┨
			489	(120)		1	1	1	7.58	(100)		2.92		<u> </u>			1	<u> </u>
			48.9	(120)					SSI	(900)	·	311			<u>↓</u>		t	[
			48.9	(120)					2.11	(390)	l	311			[[1
			48.3	(119)			14		-0-	103		271		<u> </u>	t	<u> </u>	<u> </u>	<u>├</u> ───
														1	<u>↓ </u>			
5	35		48.9	(120)	,	8.62	1250		8.98	(1302)		-0-		1	1	1	1	<u> </u>
		T	48.9	(120)		1	1		8.35	(1224)	1	18.8		1	1	1	1	1
			48.9	(120)					6.76	(980)	[20.2		1	1	· .	1	1
			48.9	(120)					3.45	(500)		21.4		1	1	<u> </u>	1	1
	· .		48.3	(119)		4	+		0.23	(34)		21.8		1	1	1	1	1
_ <u>_</u>														1	1	 	t	
									·						1	<u> </u>		
HARGENO			1		<u> </u>		L											I
		PROJECT	IITLE:			ENG	NEER:	•		DATE:		NOTES:						MTI

MT14 (3-70)

		TABLE C-2	Cont'd T	RUMPING RIN	34 Di	تدارى	– A·	2-A-1	LARGE CLIARADCE	HATL	Tis BA	DED BAB	BITT (SA	(11.5
]									1		
DATA	herd.		fr	(LAMPL)	h Hasss		RUDEL	Pesu	Kunper					•
THIOD	H	2	(°F)	MPL	(16/3)		MPL.	(16/15)	8/m.3					
6	60	48.3	(119)	8.62	(1250)		9.13	(1324)	-0-					
		49.4	(121)		•		8.77	(1272)	31.8					
		50.0	(171)				7.80	(1131)	36.3					
		50,0	(122)				6.02	(874)	31.7					
		48.9	(120)				3.45	(500)	41.8					
		49.4	(12)	•	*		0.14	(20)	41.9		1	1	1	
7	10	500	(122)	689	(1000)		6.99	(1014)	-0-			ľ	1	
		48,9	(120)			·	6.13	(889)	3.50					
		48.9	(120)				4.81	((98)	4.32			I		
		48.9	(120)				2.13	(396)	4.58					·
		48,9	(120)		+		0	-0-	4.49					
			·											
8	35	478	(118)	6.89	(1000)		1.24	(1050)	-0-					
		48.9	(120)				6.43	(933)	23.2			•		
		48.9	(120)				6.33	(918)	20.8					
		<u></u>	(122)				6.02	(873)	22.4					
		48.3	(119)				3.45	(500)	23.5					
		478	(118)				0.10	(14)	ZL.2					
<u> </u>						, , , , , , , , , , , , , , , , , , ,		•						
<u> </u>	60	48.9	(120)	6.81	(1000)		1.25	(1052)	-0-					
		48.9	(120)				7.20	(1044)	37.1					
		48.9	<u>(120)</u>				6.09	(884)	44.2					1
	l	49.4	(121)				3.45	(500)	49.5	·				
		48.9	(120)				21.0	(22)	50.6					
			-, 											
10	10	48.9	(120)	10.3	(1500)		10.3	(1500)	1.10				-l	<u> </u>
		48.9	(120)	8.41	(12-49)		8.61	(1249)	1.84					
		48.3	(119)	6.91	(1001)		6.91	(002)	4.25					<u> </u>
		47.8	(118)	4,84	(702)		4.84	(702)	6.34					
		48.3	(119)	2.76	(400)		2.76	(400)	5.16					
ł		48.3	(119)	1,38	(200)	T	1.38	(200)	4.70					
		47.8	(118)	0.10	(14)		0.10	(14)	7.96					<u> </u>
manue N	U.	IPROJECT TITLE:	•	ENGI	NEER:			DATE:	NOTES					MTI
ALCULATIO	N SHEET	······································		······					<u>I</u>		•			NTI 4 (3-70)

		TABLE	6-21	CONA'D T	RUMPIN	x Ru	36 Dr	ESIGN	- A	·2·A-1			MA	5'L:				
DATA	FRIQ.		OIL JU	.ът" Р		(LAMPIN MR	h Parss		RIMPEL	Pers		Rompite Row						
	35	┟╼╼╾╂	<u> </u>	(170)		101	11500		10.2	(ISON)		2/11/0						
[1		╏───┼		(118)		8 98	(1303)		8 GY	(1203)	┟╌───┤	17.6						
				(119)		7 (8	(1100)		7.0	(1,00)	<u>}</u> −−−−-	20.0						
		-		7100		620	(900)		6.70	(9m)		27 8			f		<u> </u>	
				(120)		4.85	(103)		485	(203)		27 1						
				(171)		3.45	(500)		341	(((((10 %					· · · ·	
				(12.0)		2.07	(300)		201	(300)		19.9				— i		
				(120)		0.69	(100)		OLA	(100)		18.6			i	<u> </u>		
				(120)		023	(34)		0.23	(34)		18.3			1			
						K.,				1211								
12	60			(118)		10.3	(1500)		10.3	(1500)		341	· · · · · · · · · · · · · · · · · · ·			. 1		
				(1)9)		8.99	(1304)		8,99	(1304)		40.2						
				(120)		7.58	(1099)		7.58	(1099)		45.2						
				(121)		6.29	(912)		6.79	(9.2)		.52.1			·			
				(119)		4.84	(102)		4.84	(702)		55.6						1
				(119)		3.45	(500)		3.45	(500)		51.7		[
				(10)		2.07	(300)		2.07	(300)	·	44.0						
				(120)		0.61	(97)		0.17	(97)		43.1						•
				(122)		0.42	(60)		0.42	(60)		40.7						l
	60			(138)		8.62	(1250)		9.33	(1314)		-0-	h					
				(137)					8.60	(1248)		571						
				(131)					4,96	(720)		7.50	25.4 m	m (1.00	ba) Sma	K9_		
		 		(136)					2.76	(400)		7.60						
				(138)		4			0,83	(120)		1.51	1					L
																		L
																		· · ·
										<u></u>								L
							<u> </u>											L
								[
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HARGE		PROJECT	TITLE.				l			L			l	I	<u>i</u>	[]	L	L
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MTI-4 (3-70)

		TABLE	C-3	•	PUMPING	Dir	in De	SIGN	- A-	1-6-1	SHORT	LENGTH	HA	רינ: -	Tio Bas	ED BA	TT 189	(SAE·II)
DATA	TRIQ		OILIN	. г т Р	a	AmPia	4 Parss		RIMPET	PEELS		Rumped						
POIDT	H ₂		<u> </u>	(°F)	 	112	(16/2)		MHL	(10/2)		g/mis						
	10		47.8	(118)	{{ } } {!	0.3	(1500)		9.00	(130[]	 	-0-			<u> </u>	<u> </u>		
			48.3	(119)					6.97	(982)	· · ·	.659		·		L		
			48.3	(IId)					4.49	(651)		1.14						
	i		41.3	(114)			!		2.26	(323)		1.62						1
		·	4.1	015)		4	•		0.02	(4)	<u> </u>	239		. <u></u>	<u> </u>	<u> </u>		
2	35		49,4	(121)		D.3	(1500)		9.82	(1424)		-0-			1	<u> </u>		·{
			50.0	(122)		1			7.39	(1072)		6.55			1	1	İ	
			50.0	(In)					491	(712)		10.3			1	İ	İ .	
			49.4	(12)					2,48	(360)	1	12.9			1	i		<u> </u>
			49.4	021)	ļ ļ	+	•	•	0.04	(6)		15.1					1	ŀ
3	60		526	(123)	1	0.3	(1500)		11.5	(1659)		-0-				<u> </u>	<u> </u>	
			.906	(123)		1			8.60	(1248)	[22.9			1		<u> </u>	
			49.4	(121)					5.23	(831)	l	28.1			1	<u> </u>		-
			48.9	(120)					2.91	(422)	1	32.1						
			50.6	(123)		+	+		0.09	(13)		31.7						
				(10)	,	90		<u> </u>	1.00	6	 				- 	 	 	_
4	1_10		414	(12)	<u> </u>	<u> </u>	(1000)		6.45	N008)		-0-			·		 	
			50.0	(120)	┨		┝╼┨╼╌┨		5.20	tuză)	 	1.42				·	 	
			50.0	(122)	 				3.47	(503)		1.98				ļ	ļ	
			50.0	(124)	┨-───-┠──		<u>├</u> [1.14	(253)	 	2.30						_
			48.9	(120)	<u>├</u> ──- <u>├</u> ─·	.			0.03	(5)	 	2.74			 			
5	35	`	48.3	(119)	6		(1000)		7.19	6116)		-0-						
			47.2	(11)					5.76	(835)		9.08					1	
			48.9	(120)					3,84	(557)		12.6			1	1	1	1
		•	49.4	(12))					1.93	(280)	1	N.A	·		1	†		
			52.2	(126)		Y	+		0.08	(0)		16.6			1	1	1	1
		_	· · · · · · · · · · · · · · · · · · ·					•									<u> </u>	
			 		 													
					<u> </u>						 				·			
CHARGE N	10.	PROJE	L CT TITLE:	L	LL	ENG	NEER:	L	I	DATE:	I	NOTES:			I	<u>l.</u>	L	l
						<u> </u>				· ·								MTI

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Friq. H ₂ - GO	011 J.3 12 M 34 59.0 59.0 59.0 50.2 50.2 50.2	(12) (12) (122) (123) (123)	(LAMD), MR. 6.89	(16/13) (16/13) (1000)	Rm. 1476	ED PEESS	Rumpad Row Almia					
	२ २ २ २ २ २ २ २ २ २ २ २ २ २ २ २ २ २ २	(°F) (122) (122) (122) (123) (123)	6.89	(1600) (1000)	<u>и</u> В 7,60	(16/13)	£/mij	l l			, i	
	, 59.0 সি.D সি.D সি.D সি.C সি.C সি.C	(122)(122)(122)(123)(123)		(1000)	1.60	11112						Ł
	50.0 50.0 50.0 50.0	(122) (122) (123) (123)				-finel	0					
	50.0 50.0 50.0	(122) (123) (122)			5.10	(835)	22.6	[
	50.6 50.0	(123)		<u> </u>	3,80	(560)	21.8					1
		1 (17 7 1 1		╞╌┠─┦	. 1.9	(280)	32.0					
+	-	1841	•		0.1	(1 b)	34.6					
	51.7	(125)	3.45	(500)	1.72	(250)	0					
	51.1	(12.4)			1.2.	(188)	1.809			i		
	51.7	(125)			0,5	· (125)	2.02			i		
	51.1	(124)			0.4	(.3)	2.78		-			
- · · · ·	52.2	(126)		4	0	0	3,24					
24		(123)	345	(sm)	3.53	(5.0)						
	511	(124)			21.1	(202)						
┼┷╼┯╄	517	(12c)	┝╼╾╼╌┠╌╌┨╼╍	$\left - \right $	1.7	1/7(1)	<u> </u>	<u> </u>	-{}			}
	52.2	(124)		<u> </u>	0.90	(120)						
	51.1	(124)		V	0.08	(12)	18.6					
	E19	(122)	2.5	(500)		KERRY						
	500	(123)		15001	2 10	1250		{				ļ
-{+		(12.1)		╏╌┠┈┨	4/16	19041	190					
╶╂╌╍╌╂		(124)	┝━╍╼┼╼╍╂╼╍	╏╌╏╌╴┨	1,9((611)						l
-{}	582	(120)	┞────┟──┟──			-1956	- 31.0					
		1491			0.11	_ (16)						
10	47.2	(11)	10.3	(1500)	10.3	(1500)	-0-					
	47.2	(U))	8.62	(1250)	8.6	1 (1250)	.693					
	47.2	(117)	6.89	(1000)	6.8	(1000)	1.24				· · · · ·	·
35	47.2	(117)	10.3	(1500)	10.3	(160)	6.08					
	dr9	(120)	× L7	1261	<u> </u>	1/12 (2)			╶╁╌───┤			
	48,3	(119)	6.84	(1000)	6.8	i (1000)	17.B					
<u>_l</u>	PROJECT TITLE:	L	Engi	I] INEER:	· · · ·	DATE:	NOTES:	1	<u> </u>		L	MTI
	35	51.1 51.7 51.7 51.1 52.2 35 51.1 51.7 52.2 51.1 51.7 52.2 51.1 52.2 52.2 52.2 52.2 52.2 52.2 52.2 52.2 52.2 52.2 53.3 10 47.2 47.2 48.3 PROJECT TITLE:	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	51.1 (124) 1.24 51.7 (125) 0.54 51.1 (124) 0.43 52.2 (1124) 0.43 52.2 (124) 0.43 52.2 (124) 0.43 52.2 (124) 0.43 52.2 (124) 0.43 51.1 (124) 0.43 52.2 (124) 0.43 52.2 (121) 0.45 52.2 (121) 0.45 52.2 (121) 0.45 52.4 (123) 1.1 52.4 (123) 1.1 52.2 (124) 0.45 52.4 (123) 1.1 52.2 (124) 0.41 52.2 (124) 0.41 52.4 (120) 4.52 (1250) 47.2 (117) 10.3 (1500) 10.3 48.3 (141) 4.84 1000 6.87 48.3 </td <td>$\begin{array}{c c c c c c c c c c c c c c c c c c c$</td> <td>$\begin{array}{c c c c c c c c c c c c c c c c c c c$</td> <td>$\begin{array}{c c c c c c c c c c c c c c c c c c c$</td> <td>$\begin{array}{c c c c c c c c c c c c c c c c c c c$</td> <td>$\begin{array}{c c c c c c c c c c c c c c c c c c c$</td> <td>$\begin{array}{c c c c c c c c c c c c c c c c c c c$</td>	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $

OF POOR QUALITY

MTI-4 (3-70)

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		-	TABLE	C-3	•	PUMPIN	6 Rin	sh Di	ESIGN	_ /	4.1-8-1	Short	LENGTH	HA	۲٬۲:				
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	PTAG	Friq.		OILIN	LLT"		LAMPIN	4 Passs		RIMPEI	Peeu		Rimpip						
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	POIDT	Hr	I	°C	(F)		MR	(16/2)		MPa	(16/2)		A/mis	1					
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	12	60		48.9	(120)		10.3	<u>(1500)</u>	L	10.3	(1500)		18.5						
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$				49.4	(121)		8.62	(1250)	ļ	8.62	(1210)		30.1						
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$			· · · · ·	<u>50,0</u>	(122)	<u> </u>	6.89	(1000)		6.89	(1000)		38.8					1	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $								ļ	<u> </u>		i	<u> </u>	1	1			1	i	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	13	60		58.3	(137)		8.62	KIZSO)	<u> </u>	7.90	10140		-0-	0		i	1	i	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$				589	(138)					7.03	(1020)		1.4					1	·
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$				58.3	(137)					4.96	(720)		4.68	25.4m	n (1.00 i	6) STACK	t		
Image: Series (13) Image: Series (13) Image: Series (13) Image: Series (13) Image: Series (13) 14 0 51.1 (124) 0 -0- 0 -0- 2.34 Image: Series (14) 1 10 51.1 (124) 0 -0- 0 -0- 2.34 Image: Series (14) 1 25 51.1 (124) 0 -0- 0 -0- 12.1 (4.4) 460 51.1 (124) 0 -0- 0 -0- 11.8 1 15 0 53.3 (120) 0 -0- 0 -0- 4.6 1 10 53.3 (120) 0 -0- 0 -0- 1.1 1 </td <td></td> <td></td> <td></td> <td>57.7</td> <td>(136)</td> <td></td> <td></td> <td></td> <td></td> <td>2.76</td> <td>(4∞)</td> <td></td> <td>5,38</td> <td></td> <td></td> <td></td> <td></td> <td>ł</td> <td></td>				57.7	(136)					2.76	(4∞)		5,38					ł	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				58.3	(137)		+	•	L	0.59	(86)		5.55	J			· · ·		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $								L	<u> </u>								1		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	14	0		51.1	(124)		0	-0-	Ļ	0	-0-		1.42					1	
35. 51.1 (124) 0 -0- 0 -0- 12.1 (2.9) 40 51.1 (124) 0 -0- 0 -0- 11.8 11.8 15 0 53.3 (129) 0 -0- 0 -0- 4.16 10 53.3 (121) 0 -0- 0 -0- 4.16 10.13 35 53.3 (121) 0 -0- 0 -0- 4.16 10.13 35 53.3 (121) 0 -0- 0 -0- 9.14 10.817 P20.170M(400//s) 40 53.3 (123) 0 -0- 0 -0- 11.7 10 10 50.4 (123) 0 -0- 0 -0- 5.81 10.13.87 P20.130 M(120//s) 11 0 -0- 0 -0- 9.0 2.00 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.97 10.13.9		10		<u>SI.I</u>	(124)		0	-0-	ļ	0	-0-		2.34		INAT	P= 0.07	- mr (1	16/121	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$		35		51.1	(157)		<u> </u>	-0-		0	-0-		12.1 (6.9)			1		1
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		60		51.1	(124)		0	-0-		0	-0-		17.8						
15 0 53.3 (120) 0 -0^- 0 -0^- 9.14 IDATT P20.17009 (100/h)*) 35 53.3 (120) 0 -0^- 0 -0^- 9.14 IDATT P20.17009 (100/h)*) 40 53.3 (120) 0 -0^- 0 -0^- 10.7 40 53.3 (120) 0 -0^- 0 -0^- 2.00 11.7 16 0 50.4 (123) 0 -0^- 0 -0^- 2.00 10 50.4 (123) 0 -0^- 0 -0^- 5.99 IDAST P20.13040 (201/h)*) 35 50.0 (122) 0 -0^- 0 -0^- 9.18 40 51.7 (121) 0 $-0^ 0^ -0^ 10^ 10^ 50.0^ 10^ 0^ -0^ 10^ 10^ 10^ 10^ 10^ 10^ 10^ 10^ 10^ 10^ 10^ 10^ 10^-$					ļ_,				L										
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$\begin{array}{c c c c c c c c c c c c c c c c c c c $		10		53,3	(128)		0	-0-		0	-0-		9.14		TINIT	P=0.274	WR (401	15	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		35_		533	(12)		0	-0-	<u> </u>	0	-0-								
$\begin{array}{c c c c c c c c c c c c c c c c c c c $. 60		53.3	(128)		0	-0-		0	-0-		27.4						
16 0 50.6 (123) 0 -0^- 0 -0^- 2.00 Image: Constraint of the state of								<u> </u>											
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	16			50.6	(123)		0	-0-		0	-0-		2.00						
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		10		50.6	(123)		0	-0-		0	-0-		5,99		TUIST	P=0.138	WA (Zol	1.5)	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		35		50,0	(122)		0	-0-		0	-0-		9.88						
I7 O 50.0 (I22) 6.89 (DOO) O -O - - I		6 0		51.7	(130)		0	-0-		0	-0-		20.7				,		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $																		1	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	<u>11</u>	0		50.0	(122)		6.89	(1000)		0	-0-								
3S So.0 (122) 0 -0- 15.0 J.N.ST PE & ISOMR (2016/13) 60 50.6 (123) 7 0 -0- 43.4 1 60 50.6 (123) 7 0 -0- 43.4 1 60 50.6 (123) 7 0 -0- 43.4 1 60 50.6 (123) 7 0 -0- 43.4 1 60 50.6 (123) 7 1 0 -0- 43.4 1 60 50.6 (123) 7 1 0 -0- 43.4 1 60 60 60 60 60 60 60 1 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 60 <td< td=""><td></td><td>10</td><td></td><td>50.0</td><td>(122)</td><td></td><td>_</td><td></td><td>l</td><td>0</td><td>-0-</td><td></td><td>2.69</td><td></td><td></td><td></td><td></td><td></td><td></td></td<>		10		50.0	(122)		_		l	0	-0-		2.69						
GO 50.6 (123) Image: Model Image: Model Image: Model CHARGE NO. PROJECT TITLE: ENGINEER: DATE: NOTES:	L			50,0	(122)					0	-0-		15.0		INLER	P= 0.132	mB (zo	16/132)	
CHARGE NO. PROJECT TITLE: ENGINEER: DATE: NOTES:		60		50.6	(123)		+			0	-0.		43.4						
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DATA		Friq.		OIL IL	12T-		CLAMPIN MR.	6 Pass		Rumper HP	Pers (14/15)		Roman Row						
10				50.0	(122)		1 90	(Jona)		0.03	(5)					[<u> </u>	{
10		10	} -		11721		6.07	Theor	<u> </u>	0.03	$\frac{13}{12}$	- <u>-</u>	7 22		D.			t-nr-	<u> </u>
		1.10	·	50.0	(122)	<u> </u>		┟╌╌╂╼╍╴	<u> </u>	0.00			5.33		JAKST-	P=0,00	mile (B aiples	<u>r)</u>
		33		50.0	14661		├─ <u></u> └─	╎──╁──	{	0,10	(15)		20.8					<u> </u>	
		60	 	1 5):1	1.0531				{	0.12	(16)		41.0				<u> </u>	<u> </u>	<u> </u>
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		TABLE (C-4.	1	BUNDIN	og Ru	sh De	SIGN	<u> </u>	-1-A-Z	CONTOURED	HAT'I		BASED	BAB	ы п- (\$	NE-II)
DATA	Tesq.	0	IL JO	27-		(LAMIPIN MB	4 Perss (16/57)		Rmper	PEELS	Rumper Bow						
1	10		41.8	(118)		8.62	11250	1	8.9R	1302)				+ - +			
			48.3	(119)				1	8.42	(1250)	264						
	1		47.8	(118)					496	(120)	2.52						
			47.8	(118)					2.76	(Dod)	2.401			† – – – †			
		4	478	(118)		•		1	0.43	(60)	2.19			<u> </u>			
							i	1						1			· · ·
2	35	9	50.6	(123)		8.42	(1250)		9.45	(1372)	-0-			1			
		2	50.0	(122)					8.62	(120)	18.0			1		1	
			472	(11)					4.96	(720)	17.2			1			1
<u> </u>		6	48.3	(119)					2.76	(400)	17.3			1			1
			489	(120)		+	ŧ.		0.78	(114)	17.2						
L					•		ļ		<u> </u>					t 1			
3	60	<u></u>	50.6	(123)		8.62	1250		9.51	(1380)	-0-						
		4	48.9	(120)				<u> </u>	8.62	(1250)	39.0						
	 		47.2	(11)					6.70	(412)	38.0						
I			47.2	ŤιυŤ					2.71	(393)	36.8						
	<u> </u>		49.4	(121)		*			1.03	(150)	33.0						
}	}	 		7				<u> </u>									ļ
4	10	4	47.2	()))		6.89	(1000)	L	7.16	(1039)	-0-					<u>.</u>	
·	╏────	4	783	<u>Ulaí</u>		 			6.54	(J A)	1.30	L					L
· · ·		4	18.3	()19)			┞─┠──	ļ	4.96	(720)	1.40						
			<u> 48.3 </u>	1119		_		 	2.76	(400)	1.56						
			38 .8	(120)		+	1	<u> </u>	0.29	<u>(42)</u>	1.60		·······				
		,		ha.		4 80		 		<u> </u>	 			·		· · ·	
			100	$\frac{1121}{1120}$		6.89	(1000)		7.5	<u>nodo</u>)	-D-I.			<u>}</u>]
· · · · · · · · · · · · · · · · · · ·			MI	(120)		├ <u>─</u> ─}	├ ─- ├ ─-	<u> </u>	6.89	1000	18.9			┟╌──┤	·	 	
			AVG	(12.5)			┠──┠──		4.96	(120)	18.6			╏╴╴╴┤		 	}
	<u> </u>		46.9	$\frac{1}{1}$		<u> </u>		<u> </u>	2.53	(370)				┨			<u> </u>
	<u>}</u> }`		46.2	(1141			· ·	l	1.36	(198)	18.9			↓		ļ	ļ
		┟───┟─	·				<u> </u>		 		┝╼┉╼┠╍╍╼┠╴	<u> </u>		╂┠		[Į
	╂	┟	 	· · · ·		·		 	 		┝┣-			<u> </u>		ļ	
	<u> </u>	<u>├</u>						<u> </u>	<u>├</u> ───		╞╌╼╌┠╌╌╌┨╴			┠───┦		<u> </u>	<u> </u>
CHARGE	I I NO.	PROJECT T	ITLE:		L	ENG	I.	l	L	IDATE:		<u> </u>		<u> </u>	·		1
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MT1-4 (3-70)

L		TABLE	<u>c-4</u>	<u> </u>	PUMPIN	og Ru	x De	SIGN	<u> </u>	-1-A-2	- Courto	ULED	HAT'L:	TIS BARED	BABBITT	· (SAE.	11)
DATA	Feiq.	0	IL IN	er-		a ampin	C Parss		Rimper	PEESS	म	unped Row			-		
POIDT		├ ─── ├ ──	<u> </u>	(°E)		MIL	(16/2)	<u> </u>	MHA	(16/2)	┦───┤-	A/mis		_ <u>_</u>			
<u>_</u>	60		50.0	(13)		6.89	11001		1.58	0092)	┠───┼	-0-		<u>_</u>			
			AR a	(126)			i-1	<u> </u>	<u>Le:10</u>	(12)	<u> </u> -	41.2		·			
┝━──┤			<u>10.1</u> <u>17</u> 7	(10)				 	504	(158)	}	48.2					
		<u> </u>		(122)		<u> </u>	-1		6,16	(400)	╂───┼	46.8					
		- ^{\$}	30.0	1631	· · · · · · · · ·	Y	· · · · · ·	<u>}</u>	1.14	(252)	<u>}</u>	45.2					
7	10		49.4	(121)		3.45	500		396	(574)	}	-0-					
			50.0	(122)		1	1		2.90	(420)		407			<u> </u>		
			50.0	(122)				· ·	1.65	(240)		4.00					
			50.0	(122)		ł			0.36	(53)		4.00			1		·
	·													1	1		
B	35		47.8	(118)		3.45	500		4.09	(2 84)		-0-					
			48.9	(120)					3.31	(480)		36.5					
			<u>90.0</u>	(122)					2.07	(300)		38.2					
		<u> </u>	<u>50.0</u>	(122)		+	+		1.65	(240)		38.4					
· · · ·			100				I										
9	60		48.9	(120)		345	500	ļ	430	(624)	┞───┼	-0-					
		┟───┼─	48.9	(120)			4	 	331	(480)	 	80.8		<u></u>	L		· · ·
		┟───┼─					·				-						
	10	├ ─── ├ '	412	<u>(III)</u>		9.10	(1350)	 	9.10	(1320)	ļļ	2416					
		<u>↓</u>	<u>478</u>	<u>(118)</u>		6.89	(1000)	[6.89	(1000)	II	.14	<u>İ</u>				
			418	(118)		2.21	(<u>800</u>)		5.52	(600)	<u>├</u>	2.18					
			<u>41.2</u>	-902		414	(600)	·····	4.14	(600)		4.20			·		
	·	<u> </u>	418	(110)		2.76	(400)	 	2.76	(400)	 	600			ļ		
			178	().0)			(120)			(100.)	<u> </u>						•
		+	<u>414</u>			1.10	(1520)		4.0	(1520)	┟───┟	13.4					
			<u>41.4</u>	(12)		6.01	(1000)		6.61	(1000)	┠┄━━━┫	26.3			<u> </u>		
· · · · · ·		<u>}</u>	47.4			2.11	(100)		5.52	(800)	┠────┤	21.0	<u>`</u>		ļ		
 		<u>├</u>	410	mer	 	7.14	(000)		4.14	<u> </u>	┟───┼	<u>33.2</u>					
	·	┝──┼-	<u>41.6</u>	71117		4.16	• 400]		7.16	400)	┠────┨╸	9.7		<u> </u>			
		<u> </u>									┠────┤						
	· · · · · · · · · · · · · · · · · · ·	<u>├</u> ╎									╏────┤╴		—— —				
CHARGE I	NO.	PROJECT T	IITLE:			ENGI	NEER:	L		DATE:	L	NOTES:	(f	L.,		MTI

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MT1-4 (3-70)

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		TABL	E C-4	· •	PUMPIN	in Riv	34 D	ESIGN		A-I-A	-2	CONTONES	D HK	<u>דינ: </u>	TU BASE	DBACOIT	- (SAE	·m
DATA	Truc	.	OILIN	P.		(LAMPIN	h Plasses	t l	RIMPER	Peass		Rimpid	·					
POIDT	H ₂	<u> </u>	°C	(°E)	├ │ -	MHL	(16/2	<u>) </u>	ИН	(10/2)	<u> </u>	A/mis						
<u></u>	60	2	48.9	(20)	-	9.10	[1320	<u> </u>	9.10	(1320)	<u> </u>	31.2				1.		
			49.4	([2])	-	7.02	1018	¥	1.02	(1018)	ļ	<u> </u>						
ļ			50,0	(122)	-	5.58	(810)	<u> </u>	5.58	(810)	<u> </u>	<u></u>						ł
		<u>_</u>	48.9	(120)	_	4.14	(600)	<u> </u>	4.14	(600)		14.0		· ·				
		·	48.9	(120)		3.07	(446)		307	(445)	· 	95.8			<u> </u>			
13	6	2	51.1	(136)		8.62	(1250	4	9.20	(1335)	-	-0-	<u>`</u>		<u> </u>			·
			58.3	(137)				1	8.60	(1248)	ſ	2.31	1		1			i
			58.3	(137)					496	(720)		2.72	25.4	r (1.00	D Smar	<u>.</u>		· · ·
			58,9	(138)					2.76	(400)		3.85			1			
			51.1	(134)		+	+	1	0.52	(76)		4.29	<u>;</u>		1	<u>i - </u>		
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CHARGE	NO.	PROJ	ECT TITLE:		••	ENG	NEER:			DATE	:	NOTES:		L	.1	I	t ¹	і
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MTI 4 (3-70)

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	TAC	BLE C-5	PUMPING RU	JG DESI	<u>دی</u> – ۱	B-1-A-1	1	HAT'L: Ra	on J	
PTA	Terq.	OIL JULET	(Game)	X Parss	Rumper	PRESS	Rumpin			
0101	Hr		MPL MPL	(16/2)	MPL.	(16/12)	A/mis			
	0	48.3 /119	5.17	(750)	4.42	()14)	-0-			
		<u>478 (116</u>	3)	<u>↓ ↓ </u>	331	(480)	4.08			
		48.9 (12			1.65	(240)	4.48 1			
		48.3 (119	a)		0.83	(120)	4.40			
		48.3 (119			0,13	(19)	4.30		1.	
								·	1	1 1
2	35	47.8 (1)) 5,17	(750)	5.20	(755)	-0-		1	1 1
		47.2 (11)			331	(480)	25.7			1
	<u> </u>	49.4 (12)			1.65	(240)	28.2			1
		48.3 (119)		0 83	(120)	27.8		i	†
·		47.8 (116	3)		0.26	(37)	27.0	1	i	
										1
3	60	489 /120	5.17	(750)	5.18	(51)	-0-			<u>↓</u>
		48.9 (12			5.58	(480)	59.9			
		48.9 (12			145	(240)	45.4			+
		48.3 (1)	a)		0.83	(120)	(3.0	-		+
		463 (1)			0.63	(91)	61.7		—	+
										+
4	10	47.2 (1)7	1 3.45	(500)	311	(578)	- 0-			
-		47.8 (1)			2 18	13601	212			+
		489 (12)			115	(240)				+
		489 (12				(120)	<u> </u>			+
		483 (1)	9		410	(20)				
<u></u>			••†	<u> </u>		/		-{		╉╾╾╌┦╌╌╌╴
5	35	483 /119	345	(500)	3.0	(510)				+
		483 7114			2.48	(240)	220			+
		- AK3 7110		<u> </u>		124011				╉───╁───
		489 /12		<u>+ </u>	1.43	(121)				+
		dk 2 / / / k	<u>ă' </u>	┼╅╌┼╴	012					╉╼╼═╋╼╼═
			* !	┼─╹─┼─		1411	 2]·/- 			╋╍╌╌┠───
		·	╶╴┟─────┥────	┼╍──┼╌		 				· I
<u> </u>				┼───┼─						╂───┟───
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		TABLE C-5	1	RUMPING RI	sh Dr	<u>εςις.) - B</u> -	-A-1		HAT'L:	Ruco	τc		······
DATA	tera.	OIL TO	ч.т	a amai	h Parss	Rmper	Pers	Rumpers					
POINT	Hr	<u> </u>	(•F)	MPL	(16/2)	MAL NA	(16/2)	8/mis					
6	<u> </u>	48.9	(150)	3.45	<u>(500)</u>	3.52	510	-0-					
		48.9	(150)			2.48	360)	77.1			<u> </u>	·	
┞───┼-		49.4	(121)		┦-┨──	.65	(240)	101			<u> </u>		· ·
 		489	(120)		⊢∤	0.83	(120)	113				<u> </u>	
└─── ┼·		50.0	(12)	+		0.51	(74)	89.2			<u> </u>		
\vdash	10	48.9	(120)	1.72	(20)	1.98	(288)				 	<u> </u>	· ·
		48.9	(120)			1.65	(240)	6.38	·	- <u> </u>			
		48.3	(119)			1.24	(180)	7.37		<u> </u>	<u> </u>	j	
i		483	()(9)			0.83	(120)	7.87	· · ·		1	<u>├</u> ───	i
		489	(120)		4	0.30	(43)	11.5			1	I	
			7. 5								·		
	35	41.4	(121)	1.72	(20)	2.08	(301)	-0-		_	<u> </u>	1	
		50.6	(123)		├_ 	1.65	(240)	48.6			<u> </u>		
		44,4	(121)	·	┞──┠───	1.24	(180)	53.7					
}			(121)	 *	.	1.00	(14P)	61.8			_	ļ	ļ
9	60	50.0	(122)	1.72	(250)	2.03	(295)	-0-		-{			{
		48.3	(19)		1	1.65	(240)	4Cu			1	1	1
·		49.4	(121)			1.24	(160)	140			1	<u> </u>	
		48,9	(120)	4	×	1.13	(164)	136	· · · ·				
10		/17	(110)		(1.2)		<u></u>	····			ļ		
			1120	4.14	1600		(600)				 	 	
- ,-		48.2	(110)			24		1.24			<u> </u>	}	
			-111-11		112301		(2 10)	<u> </u>					
11	35	48.9	(120)	4,14	(600)	4.14	(600)	-0-					1
		48,9	(120)	345	(500)	3.45	(500)	8.97			1	1	<u> </u>
		48.9_	(120)	172	(250)	1.72	(256)	43.2					1
					ļ	<u> ·</u>							
12	60	47.8	(118)	314	(550)	3.79	(<u>SD)</u>	-0-					
		94.4	(121)	345	(500)	345	<u>(८००)</u>	16.5					
CHARGE		4/.8	(118)	1.72	(52)	1.72	(250)	105					
CHARGE NU	υ.	FRUJECI IIILE:		ENG	INEER:		DATE	NOTES:					MTI
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MT14 (3-20)

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[TABLE C-5	· · ·	RUMPING RU	yes De	esign	·	B-1-	A-1		HAT	ι:	Rula	۶ <u>۲</u>		······ · ·
DATA	Friq.	On J.	2-2-T-	(Lamp)	A ARESS	ŀ	RIMPEI	PEEUS		Rumper						
THING	H _X	L C	(°E)	MFL	(16/2)	 	MHL	(16/13)		A/mis						
13	60	58.3	<u> (131)</u>	5.17	1(120)	 		(841)		-0-				· `		
		58.9	1138)	╏┉━━━╸┨╼╸┨╼╸	╏╴┨──╴	 		(800)		9.72				<u> </u>		
		59.4	(139)	<u> </u>	┼─┼──			(600)		11.2			<u>.</u>			
		58.9	(138)	┟╍╍╼╌┠╼╍┠╼╸	 	ļ		(396)		0.8			1	<u> </u>		
		583		├ ─── ├ ── ↓	+			(118)	<u> </u>	10.1			<u> </u>	•	!	
14	35	A83	119	0	-0-		0.50	72		927				1	<u> </u>	· ·
		183	1 119	0,34	50	1	0.00	85		10.9		<u> </u>	- 	<u></u>	i	+
		44.1	121	0.69	100		0.81	174		185				1		
		49.4	121	1.03	150	· · · · ·	0.90	130	1	5X 6						
		489	120	1.38	200	<u> </u>	0.98	117		67.8					 -	<u>}</u>
		48.3	119	1.72	250	1	1.11	161		66.6			1	<u> </u>	1	1
		487	119	2.07	300		1.06	154	[72.9					+	
		da.	119	2.4	350		0.18	112	<u> </u>	871						
		48.9	120	2.76	400		0.68	99	t	647					<u> </u>	<u> </u>
		48.9	120	3.10	450		0.63	91	<u> </u>	437					<u> </u>	<u> </u>
		49.4	121	1.72	250		1.17	170		42.1			· [· · · · ·			<u> </u>
		48.9	120	1.38	200	-	1.23	179		63.6						
	•												1	1		
15	35	478	118	0	-0-		0	- 0-		90.9						
		48.3	119	0.34	50			1		76.3					<u> </u>	
		48.9	120	0.69	100				1	87.8					<u> </u>	<u> </u>
		48.9	120	1.03	150					817					 -	<u> </u>
		48.9	120	1.38	200	1				78.9					1	<u> </u>
		48.3	119	I.n.	250					82.4		<u> </u>	-	1		
		45.3	119	2,01	300					86.0				1-'	1	t
		48.9	120	2.41	350					53.7					1	<u> </u>
		48.9	120	276	400		+	8	1	49.4				<u> </u>		<u> </u>
									1							
					1 .				·					1	1	<u> </u>
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	<u>_</u>				<u> </u>	L	L	L								1
CHARGE I	¥U.			ENG	INEER:			DATE		NOTES:					1997 - M.	MTI

		TABLE C-6	<u> </u>	PUMPING RIN	sh De	<u>- (1,21) -</u>	C•1	-A-1		HAT'L: 0	lebow Gr	ZAPNITL	(CNF	·1)
DATA	Friq.	OIL IN	. 1 .Т	(LAMP)	4 Parss	Rur	NPER	PEEUS	Roman					
POIDT	Hr	2	(•F)	Mra	(IPY2)	<u> </u>	Hen.	(16/15)	<u></u>					
┝╾┸╍╍┼	10	489	(120)	6.89	(1000)	<u> </u>	<u>ж</u>	(1022)	- 0-	<u> </u>				
		41.4			\vdash	<u> </u>	62	(461)	<u></u>	· · · · · · · · · · · · · · · · · · ·				
		48.9	(120)			5.	50	(148)	4.27					
· · · ·		44.4	(121)		├ ── ├ ──	2	76	(400)	5.58					·
-		48.9	(120)			··	36	(198)	5.20			i		
		48.9	(120)	¥	+	. 0	31	(54)	5.0		<u> </u>			•
2	35	30.6	(123)	6.89	(1000)	7.	35	(1066)	-0-					
		51.1	(124)			6.9	89	(1000)	AIG					
		48.9	(120)			· S.	50	(798)	13.14					
		49.4	(121)			2.	76	(400)	29.9					
		48.9	(120)				3८	(198)	29.3					
		48.9	(120)	•	+	0.	23	(34)	26.2			· · ·		
							* *			·····	1			
3	60	47.8	(118)	6.89	(1000)	2.	44	(1080)	-0-					
,		47.2	(11)	1	1	L L	.89	(1000)	30.7					
		48.3	(119)			5.	50	(798)	44.6					
		49.4	(121)			2	76	(400)	57.0					·
		49.4	(121)				36	(198)	55.7				·,	1
		44.4	7121)			0	50	(72)	53.					
					<u>-</u>			- <u>) I I I</u> .						
4	10	47.2	(1)	רו ב	(75)	3,	96	(518)	-0-					
		478	(118)			3	12	(540)	4.95					
		48.9	(120)			2.	48	(360)	6.92					[
		48.9	(120)				24	(180)	6.17					
		48.9	(120)	*	+	0.	12	(32)	6.38					
					L									
5	25	48.9	(120)	517	(750)	5.	09	(738)	-0-					1
		50.0	(22)			3	12	(240)	27.8					
		48.9	(120)			2	.07	(300)	35.6		1			
		48.9	(120)				24	(180)	36.0		1			<u> </u>
——————————————————————————————————————		,SD.0	(122)	+	+	0.3	5	(51)	35.6					
CHARGE N	I	PROJECT TITLE:			INEER:	┞		DATE						l
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MTI 4 (3-70)

		TABLE C-6	1	PUMPIN	36 Rin	sh De	ESIGN	<u> </u>	1-4-1		HAT'L: C	ARBON C	DRAPH I	r. (C	4F-J)
DATA	181Q.	On IN	2.T- P		CAMPIN MB.	(ILLS)		Runder MA.	Pesus	Rumpers Row					
			(123)		5.17	(115)		541	(785)	= = = = = =				· · · · · · · · ·	
		5.6	(123)	· · · · · ·	· 1		1	3.72	(540)	546					
		. 49.1	(121)					207	(300)	198		╉───┤		·····	
		494	(121)	·			1	1.24	(180)			+		<u> </u>	
		47.8	(118)			•		0.41	(68)	716		†			
7	10	48.3	(19)		3.45	(500)	· ·	.2.16	(312)	-0-			i		
		48.3	1/119)		1			1.15	(240)	411			<u> </u>		
		48.3	(119)					1.24	(180)	7.00				·	
		48.9	(120)					0.83	(120)	8.08		1 1			
		48.3	(119)		+	+		0,16	(24)	9.23		- <u> </u> i			
8	35	49.4	(121)		3.45	(500)		2.96	(429)	-0-			<u> </u>		
		49.4	(121)		1			2.48	(360)	12.4					
		49.4	(121)					1.65	(240)	26.8	·····				· · · · ·
		48.9	(120)					0.83	(120)	36.0					
		50.0	(122)		+	+		0.41	((0)	38.4		++			
91	60	47.2	(11)		3.45	(500)		3.41	(495)	-D-					
		47.2	1111				1	2.48	(360)	35.2					
		418	(B)					1.65	(240)	640					
		47 %	(IIB)					0.96	(140)	64.0					
								1				1			
10	10		L NOT	SELF	SUST	AIN I									
- 11	36	49.4	(121)		7.38	(070)		7.38	(1070)	10.2					
	•	50.D	(122)		6.89	(1000)		6.89	(1000)	10.4					
		W	LL NO	T SELF	SUSTA	N	t hours	o Pa	55.3019						
														<u> </u>	
12	60	51.1	(124)		7.73	(1121)		7.73	(1121)	24.6	·				
		49.4	(121)		6.89	(1000)	1	- 6.89	(1000)	71.9		┼───┤			
		51.0	(122)		6.20	(900)		6.20	(900)	27.5					├ ────┤
		Y	IL NOT	SELF S	USTAI	DAT	LOWER	Azs85	2294						
CHARGE NO.		PROJECT TITLE:			ENG	INEER:			DATE:	NOTES:	······	------		I	L
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CALCULATION SHEET

MT14 (3-70)

	- 	TABLE C-7	· '	PUMPING RI	sh Di	ESIGN	. D	-1-4-1	(12mm Bose)	HAT'L : TI	D BASED	BABBI	IT (SAE	-11)
PTAG	Terq.	OIL JU	1.T-	annon:	h Perss		RIMPER	Peens	RUMAD					
TOIDT	Hr	<u> </u>	CE)	MAL	(16/2)	ļ	NFL.	(16/12)	A/m.s					
	10	48.3	$\left \left(119 \right) \right $	8.62	(1520)	ļ	9.02	(1308)					•	
		49.4			┨──┨───		7.44	(1080)	1.88		L	<u> </u>		
		48.3	(119)			· · · · · · · · · · · · · · · · · · ·	4.93	(720)	1.82		l			
		48.3	(119)	╏╌╌╌╴╏╴╴┨╌╴	 		3.10	(450)	1.76					
		48.3	[(119_		<u> </u>	·	0.12	(17)	<u> </u>		<u> </u>	l		
			1		1000						<u> </u>			•
2	35	49.4	$\left(\frac{1}{2} \right)$	8.62	11570		9.38	(1341)	-0-					
		50.0	(12)	┟╍╼╍╍╼╼-┨╍╍╼┠╼╼╸		<u> </u>	1.14	(108)	N.L		ļ			
		50.0	(122)	<u> </u>	<u>! </u>		4.93	(72)	14.4					
		48.3	[(j)9)	ļi	 − −−		3.10	(490)	14.2		l			
		48.3	(119)		↓		_0.97	(41)	13.4					
			1,			·	1							
3	60	49.4	(121)	8.62	(1250)		9.31	(350)	-0-					
		48.3	(114)				7.44	(1080)	31.3				·	
		48.3	[(119)_				4.93	(720)	29.7					
		44.4	(121)			<u> </u>	310	(450)	27.6					
		49.4	(121)	<u> </u> ₽	•		0.21	(31)	28.7					
A		10.6	(120)		(1000)		0.15	1077			 	·		
		46.1	111-0	<u><u> </u></u>			5.20	700			 			
				┼━━━━┼━━┼──	┟─┟──		2.30			<u> </u>				
		48.3	11141	╏────┤──┨──			4.14	600	2.60		 	ļ		
· · ·		41.8	111101	╏╼╍╍╍╌╏╌╌┠╼╸	 		1.65	240	2.40				·	
		49.4	11 121 1	<u> </u>	↓ ▼		0.12	- 17	2,30		 	·		
5	35	47.8	(118)	6.89	(1000)		2.51	(1090)	-0-		 			
		48.3	(119)				6.62	(960)						
		50.0	(122)				5.17	(16)						
		483	(114)				310	(46)	11 1		<u> </u>	 	 	
	·····	423	(119)			[0.10	745			 			
				<u> </u>	<u>·</u>	1	V. 10				<u> </u>			
	├ <u>`</u>	<u>†</u>		} ───── ── ────────────────────────────	<u> </u>	!								
		}		<u>├───</u>							- <u>.</u>		<u> </u>	
		1	1		t						<u> </u>			
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MTI-4 (3-70)

		TABLE C	-7	•	RUMPING RI	NG D	ESIGN		D1-	A-1 (12mm Boar)	HAT'L:	Tij Bas	D BABI	BITT (S	AE · 11)
ATAG	Trag.	On	Inte	л	(Lamp	of Parss		Rmper	Pesu	Rumper					
DOIDT	Har			F	MR	(16/3)		MPL	(16/15)	8/00					
6	60	41	.8 (118)	6.89	(1000)	1	17.49	10861	+0-					
		4	1.8 (118)			1	6.20	(900)	40.2			-		
		50	0.0 (122)				4.14	(600)	87.7					
		49	.4 (121)				1.15	(240)	35.1					
		44	4	(121)	+			0.41	(59)	1.25					
7	10	4	33 (1	119)	3.45	(500)		3.12	(540)	-0-					
		48	9 (120)				2.89	(420)	2.88			!		
<u>.</u>		4	<u>8.3 (()</u>	19)				1.65	(240)	8.47			•		
		4	33 (119)	+			0,12	(16)	4.20					
8	35	44	4 0	121)	345	(500)		4.01	(582)	-0-					
		49	4 (121)				2.90	(420)	20.8			!		
		49	14 0	121)				1.65	(240)	21.7					
		44	4 (121)	+	Y		0.30	(43)	72.2					
		ļ													
9	60	50	0 (1	122)	3.45	<u>(5</u> ∞)		4.01	(582)	-0-					
		47	8 (<u> 8)</u>			ļ	2.90	(420)	39.6			·		
		41	8 (1	18)				1.65	(240)	43.0					
		50	0 (1	22)	•	•		0.32	(47)	44.2					
10	<u> </u>	45.	<u>c (1</u>	<u>14</u>)	B.62	(1250)		8.62	(1250)	1.35					
		47.	2 (1	117)	6.89	(1000)	<u>.</u>	6.89	(1000)	1.74					
		48	3 (119)	5.51	(800)		5.51	(800)	2.23					
		48	9 [1	120)	4.14	(600)	L	414	(COO)	2.76					
		48	3 (119)	2.76	(400)	· · · ·	2.76	(400)	3.54		_			
		48	311	1137	1.39	(200)		1.39	(200)	3.80					
		↓ ↓	-+				<u> </u>	L	L						
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		┨────┨───	_+			<u> </u>			Į						
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	: 	PHOJECT TIT	LE:		EN	3INEER:			DATE:	NOTES:				Ľ,	MTI
ALCULATION SHE	ET											····		L	

· 2.,

		TABLE	C-1		Pumpinsh	Russ	Des	14D	D-1-1	1-1 (12	(mm 6021)	Ma	r'L: T.	SBASEL	BABB	и п (S	ve II)	
DATA	Fasq	01	IL INCO	LT"		CLAMPI	y Phases	_	Rumpio	<u>bisson</u>	Run	pro						
POINT	142		2 (•F)		MPA	(16/12-)	MH	(112)	· •	/mid					· ·	ŀ
11	35	4	83 1	19)		8.62	(120)		8.12	(076)	13	.0						
		4	83 (1	10)	· · · · · · · · · · · · · · · · · · ·	6.89	(1000)	l	6.89	(1000)	15				· · ·			
		4	a 7 0	21)		5,51	(800)		5.51	(800)		1.6					•	
	<u>·</u>	4	89 (120)	· · ·	4.14	(600)		4.14	(600)	2	0.0						
		4	<u>a q (</u>	21]_		2.76	(400)	·	2.76	(400)	. 2	1.0						
		4	<u> 84 (</u>	50)		1.39	(200)	·	1.39	(200)	1	9.3		·	 	 		· ·
12	60	4	¥.3 (I	19)		8.42	(20)		842	(1250)	21	1.3	· · ·		┼───	i		<u></u>
	"	4	8.9 (1	20)		6.89	(1000)	· · ·	6.89	(1000)	3	6.1						
		4	78 (118)		5.51	(500)		551	(800)	4	0.6		1	1			1
	·	4	78 ()	IB)		4.14	(600)		4.14	(600)	4	3.2			·	1		1
		4	18 9	18)		2.76	(400)		2.76	(400)	4	0.1	•			1		
			18 (18)		1.39	(200)		1.39	(200)	3	1.2			· · ·			
	·						1.0	· ·						ļ	<u> </u>	· · · · · · · · · · · · · · · · · · ·		
13	<u> </u>	<u> </u>	<u>x3 (1</u>	ЫÚ		8.62	(1210)		9.15	एमर)		으니	<u> </u>				·	<u> </u>
		4		IIBI			┟──╂──		821_	()200)	V	D:4		ļ		<u> </u>		·
			<u>*3 1</u>	lat -					662	(960)		o'l	7 25	4 mm (10012 Pil	oci _		
f	{		0.6.	23			┠─-┠	·	4.14	(600)		1.8		<u> </u>		[
		4	83 (<u>119</u>					2.48	(360)	C	1.0			<u> </u>	·		<u> </u>
			8' π −Ω	21)		Y			0.17	(ম)		<u>8</u> 1_						_
14	60	5	8.9 (1	38)		8.62	1250		9.35	(356)	-	D -	<u>ר</u>	· · · · ·	+			+
		S	9.4 (1	3)				•	8.27	(1201)	7	.71			1			
		6	0.0 (1	40)					662	(940)	7	56	1 15	1	24:20	-		
		5	a.1 ()	39)					4.14	(600)	1	.20		1	P. 107 0		· · · ·	1
		S	9.4 (1	39)					1.48	(360)	6	.73						1
		<u> </u>	0.0 1	40)			+		0.12	(1)	6	•43	,					1
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CHARGE NO. PROJECT TITLE:						ENG	NEER:		•	DATE:	N	OTES:	DTES:					MTI

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MT1-4 (3-70)

TABLE D-1

RUN	MATERIAL	R mm (in.)	C•10 ³ mm (in.)	t mm (in.)	$\begin{array}{c} E \\ MPa \cdot 10^{3} \\ (psi \cdot 10^{6}) \end{array}$; . V	L ₁ mm (in.)	L mm (in.)	e mm (in.)	
I.	Babbitt	9.52 (0.375)	11.43 (0.45)	1.19 (.047)	51.7 (7.5)	0.36	7.56 (0.298)	6.78 (0.267)	2.92 (.115)	
II	Babbitt	9.52 (0.375)	19.05 (0.45)	1.19 (.047)	51.7 (7.5)	0.36	7.56 (0.298)	6.78 (0.267)	2.92 (.115)	AND UN
v	Rulon J	9.52 (0.375)	42.55 (1.675)	2.44 (.096)	1.72 (.25)	0.46	7.56 (0.298)	6.78 (0.267)	2.92 (.115)	CORREC
VI	Carbon	9.52 (0.375)	20.35 (0.80)	1.44 (.056)	21.5 (3.11)	0.29	7.56 (0.298)	6.78 (0.267)	2.92 (.115)	TED TH
VII	Babbitt	6.00 (0.236)	8.89 (0.35)	0.89 (.035)	51.7 (7.5)	0.36	5.59 (0.22)	5.08 (0.2)	1.93 (.076)	EORY

203

*The viscosity used is that corresponding to test temperature plus an assumed 20°F used in the oil film.

FIGURES SHOWING COMPARISON WITH EXPERIMENTAL DATA



Fig. D-1 Performance of Babbitt Pumping Ring (I)



Fig. D-2 Performance of Babbitt Pumping Ring (I)



Fig. D-3 Performance of Babbitt Pumping Ring (I)



Fig. D-4 Performance of Babbitt Pumping Ring (I)



Fig. D-5 Performance of Babbitt Pumping Ring (II)


Fig. D-6 Performance of Babbitt Pumping Ring (II)

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Fig. D-9 Performance of Small Babbitt Pumping Ring (VII)



Fig. D-10 Performance of Small Babbitt Pumping Ring (VII)



Fig. D-11 Performance of Small Babbitt Pumping Ring (VII)



Fig. D-12 Performance of Small Babbitt Pumping Ring (VII)

215

MPa

I.



Fig. D-13 Qualitative Comparisons of Theoretical and Experimental Results



Fig. D-14 Performance of Carbon Pumping Ring







Fig. D-16 Performance of Carbon Graphite Pumping Ring







Fig. D-18 Performance of Rulon Pumping Ring









TABLE D-2

QUALITATIVE SUMMARY OF COMPARISON

BETWEEN ANALYTICAL RESULTS AND TESTS

· · .		(Q _{o THEO} /Q _{o EXP})		(p _{fm THEO} /p _{fm EXP})	
RING		High p _o	Low Po	High p _o	Lów p _o
Babbitt	Small C	2	1	2	1
	Large C	3	1.5	1.5 - 0.5	0.7 - 0.2
	Small R	2	0.5	2	1 - 0.3
Carbon Graphite		2.5	3 - 2	1 - 2	1.5 - 4
Rulon		2.5	2.5	1	1.5 - 0.5

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16 Abstract An analysis, computer pro vide design data for pump to occur in flow predicti that performed well exper	gram and experiment ing rings. Althoug on, a procedure has imentally. A preli	al data have h some disagr been used to minary analys	been generated eement has be design pumpi is has also be	d to pro- en found ng rings een devel-
oped for the prediction o Leningrader seal.	1 film thickness an	d pressure di	stribution in	a pumping
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