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# SOLAR VENTILATION AND AIR-CONDITIONING SYSTEM INVESTIGATION USING THE FINITE ELEMENT METHOD

by

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# VOLUME TWO

A Doctoral Thesis submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of the Loughborough University of Technology

March 1985

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# CHAPTER 7

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## 7.1.1 Introduction

The finite element coding for solving the Navier Stokes, continuing, and general energy equations may be subdivided into a number of subroutines each of which may be further reduced into subsections. Before discussing the code details on a subroutine basis, the overall solution strategy may be seen in the skeleton flow chart of Figure 2.2. The actual code comprises many local loops/branches, however these are highlighted by comment statements in the program listings.

## 7.1.2 Master (Main) Segment

This is the program master segment and is used to call the various subroutines in the relevant order.

# 7.2 Subroutine DATAG

This subroutine is called from the MASTER segment and is primarily intended for initialising control variables and arrays. Input and the associated variable name has received detailed coverage in user report, Ref. (1), however knowledge of the following variables is important.

ND1(=4) declared channel for eliminated equations, appears and used in FRUNT, FRONTA and BACSUB, BACSUBA, RESOL NTR the iteration counter 35

ومنهمات المراقبة المراقبة الموالية المسلمان المراقب المعادين والمراقب والمراقب والمحارب والمراقب والمحارب والمراقب والمحارب والمراقب والمحارب والمراقب والمحارب والمحارب والمراقب والمحارب والمحار والمحارب والمحا NTRA coded 1 on first entry to FRONT, Ø after - used to code nodal number negative on last appearance in the mesh

MWGA a non-zero value indicates a single nodal degree of freedom for single equation solution; zero indicates multiple degrees-of-freedom for coupled solution in FRONT, FRONTA.

#### Vectors

NOPP(I) the vector NOPP holds the location in the solution vector (VARI) of the first degree-of-freedom for the node I, typically. NOPP(4) holds the location in VARI of  $U_4$  in {u p v} calculations. When used in conjunction with the vector MDF(I) the location of  $P_i$ ,  $v_i$  etc. may be found in VARI, generally in the program the procedure in {u p v} solution is

M1 = NOPP(I) M2 = M1+1 M3 = M1 + MDF(I) - 1 M1 = NOPP(I) M3 = M1 + MDF(I) - 1 at midside nodes M3 = M1 + MDF(I) - 1

then

U <sub>i</sub>	11	VARI(M1)
P <sub>i</sub>	11	VARI(M2)
۷i	=	VARI(M3)

TEMP(I) the vector of nodal temperatures in uncoupled solution, TEMP(I) holds the temperature at node I.
LPR(I) holds the side code for gradient boundary evaluation associated with element I, this is used in VARCALC in calculating the vector of right hand sides
VARI(I) the solution vector which holds the calculated field and is set up after solution in VARCALC
VARA(I) may be used to hold a relaxed field for accelerating solution convergence rates.

# 7.3 Subroutine DIAG1<sup>(7)</sup>

This subroutine checks the overall control parameters which govern the number of nodes, number of elements, initial conditions, and boundary conditions for the problem being investigated. If an error is detected it is associated with a specific number NEROR, and an appropriate message is output. Since control parameters are mnemonic, the errors appearing in the program listing are selfexplanatory. Error Number

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JEROR

#### Type of Error

If total number of nodes, (NH), is specified as less than or equal to zero.

If the number of data lines referring to nodal points coordinates, (NNP) is less than or equal to zero or greater than total number of nodal points (NH).

If total number of elements, (NE), is less than or equal to zero.

If the total number of node points, (NH), is greater than the product of the total number of elements and the number of nodes per element. If the number of essential type boundary conditions to be specified, (NB), is greater than the total number of possible degrees of freeom. If the total number of initial conditions, ICOND, to be specified is greater than the total number of possible degrees of freedom for MARK#3. If the number of elements which contain a gradient type boundary condition, (NRT), is greater than the total number of elements, (NE). If the number of gradient type boundary conditions, (IRT), is greater than the total number of possible degrees of freedom (variables), (NP). Local error indicator.

Vectors

NECHO(80) Array used to store remaining data temporarily. NEROR(8) Error indicating array.

If any check fails the data which had not been read to that point will be read and printed.

# 7.4 Subroutine $DIAG2^{(7)}$

1.

If the checks on the control data prove to be satisfactory then the remaining data is checked using this subroutine. The main sources of error are usually associated with either the coordinates or in defining element topology i.e. (geometric data errors). NEROR is used again as an indicator for particular checks.

## Error Number

9	If the fluid density or the fluid molecular
•	viscosity is less than or equal to zero.
10	If there are two or more nodal points with
< .>##	identical coordinates.
11	If a node number appears more than once in any element.
12	If a node number is outside the permissible
	bounds.
13	If the number of initial conditions specified
	as input is greater than the total number of
	variables for MARK=3.

The variable JEROR, and the vectors NECHO and NEROR are exactly the same as in subroutine DIAG1. Similarly, should any check fail, the data which had not been read to that point will be read and printed.

# 7.5 Subroutine CORDGEN

This is called from the routine DATAG and is primarily intended to set up element geometry.

NBN(=8)	holds the number of element nodes
NCN	holds the total degrees of freedom (dof) per
	element (20 for upv, 28 for upv $\theta$ )
NDF	holds the dof at corner nodes (3 for upv,
	4 for upvθ)

Vectors

17.

MDF(I)	holds the degrees of freedom associated with
9	node I and a
NDN(I)	holds the number of nodes associated with
 4	element I
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# 7.6 Subroutine ELGEN<sup>(8,9)</sup>

Subroutine ELGEN can be called from CORDGEN and is used for mesh generation using the isoparametric concept. It can deal with mesh generation for domains with complex shapes and for multiplyconnected domains. This routine is self-explanatory in the listing.

NXL	Number of elements in the ( $\xi$ ) direction
NYL	Number of elements in the $(n)$ direction
NN	First node number
ND	Direction parameter
	= 0, elements are numbered sequentially along
	lines of constant (n)
	= 1, elements are numbered sequentially along
	lines of constant (ξ)

Vectors

XM(8)	holds X-coordinates of master nodes
YM(8)	holds Y-coordinates of master nodes
XPT(I)	total number of X-coordinate points in the mesh
YPT(I)	total number of Y-coordinate points in the mesh
NS(I)	stores a list of node numbers of $(\xi = -1)$ for
	all mesh points
SHP(8)	shape functions for $(\xi, \eta)$ coordinates of each
	generated node for each element
XX(8)	(ξ) coordinate of the master nodes
YY(8)	(n) coordinate of the master nodes

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#### 7.7 Subroutine WRITELP

This routine is generally called from VARCALC and is used for printing the initial state and the iteration results. Where output is large this routine may only be called every i.nth iteration and on convergence of the solution.

#### 7.8 Subroutine DATAK

Subroutine DATAK is called from the MASTER segment and is used to read in and assign coding to the boundary condition vectors.

NBV

this holds the number of constrained values in coupled solution where care must be taken not to duplicate boundary value prescription, the variable is used in BACSUB, the backsubstitution routine.

#### Vectors

NCOD(I) given a code l for constrained dof I where I is calculated using NOPP and MDF vectors, typically let v<sub>4</sub> be a constrained value, then M3 = NOPP(4) + MDF(4) - 1 NCOD(M3) = 1 NCOD is zero for an unknown global value and is used in FRONT BC(I) is the prescribed value associated with NCOD(I) as defined above NODV(I)can be used to hold the global location in NCODof the ith (as read in) dof typically if v4 wasthe lOth constrained value read thenNODV(10) = M3this can be used where solution requires iterationbetween coupled and single equations where vectorsNCOD, BC are also set to hold the constrainedvalues in the single equation solution.VALV(I)the boundary value in association with NODV(I).

# 7.9 Subroutine VARCALC

This is the routine called from the MASTER segment which is used for setting up the vector of right hand sides (RHS) to which the element vectors q (see Section 2.3) contribute and also in calling the solution routine, testing for convergence and printing results.

ERA	sets the convergence tolerance on the velocity
	field for successive iterations
RMAX	the greatest relative change in any computed
	velocity, thus RMAX less than ERA denotes satis-
	factory convergence
ITERNAN	a marker for uncoupled solution global iteration.

Vectors

R2(I) this is used in PRESCR to set up the vector of RHS where prescribed gradient values are supplied as input to the program this holds the problem solution as returned from the frontal solution procedure FRONT where 'I' is as defined for the vector NCOD AVARI(I) holds a relaxed value of the solution field, for the case shown as under relaxation, over relaxation may be used too, typically in the loop DO 15  $AVARI(I) = \alpha SK(I) + (1-\alpha) VARI(I)$ where  $\alpha(>1)$  is an over-relaxation constant. In this work  $\alpha = 0.5$ . UPVBC(I) holds the boundary condition values for (u,p,v)in the uncoupled solution for the next global iteration solving (N-S) equations holds the coded (dof) as boundary conditions for NCODV(I) (u,p,v) in the uncoupled solution for the next global iteration, solving (N-S) equations holds the boundary condition values for tempera-TBC(I) ture  $(\theta)$  in the uncoupled solution for the next global iteration, solving the energy equation NCODT(I) holds the coded (dof) as boundary conditions for temperature  $(\theta)$  in the uncoupled solution for the next global iteration, solving the energy equation

# 7.10 Subroutine TEMPCAL

This routine is called from VARCALC and is used to control solution of the temperature equations, notably it is used for reading in boundary conditions, setting up vectors NCOD and BC and in extracting the solution for storage in the vector TEMP.

NBT	holds the total temperature boundary conditions
	and is used in the routine BACSUB
NF	provides temporary storage for NP the total
	degrees of freedom for upv calculation
NV	provides temporary storage for NDF
LQ	provides temporary storage for NCN

NP, NDF and NCN are then assigned values (NH, 1, NBN respectively) in readiness for solving the energy equation using FRONT with MWGA=-1. Before returning to VARCALC, NP, NDF and NCN are reassigned. Further should it be necessary to solve the uncoupled equation iteratively then directory vectors need to be set up to hold boundary values, here UPVBC(I), NCODV(I), TBC(I) and NCODT(I) are used as explained in Section 7.9.

# 7.11 Subroutine HCOEF

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A routine called from either VARCALC or TEMPCAL where boundary temperature gradients require evaluation subsequent to obtaining a converged solution. TESTX ) these are used to test integration and for an edge integration TESTX and TESTY should nearly TESTS ) reflect the change in X and Y over the side of the element, TESTS =  $\sqrt{(TESTX^2 + TESTY^2)}$ ELX the cosine of the angle between the outward pointing normal on the element side and the x

axis (see the figure below)



as ELX but in the Y direction

Arrays

ELY

B(1,I) the gradient  $\partial N_i / \partial X$  at node I evaluated at the gaussian point IG (IG = 1 to 3) B(2,I) the gradient  $\partial N_i / \partial y$ 

7.12 Subroutine PRESCR

This routine is called from VARCALC when non-zero boundary prescriptions need evaluation. The routine integrates over the element sides/faces and assembles the elemental vectors {q} into a

global RHS vector R2. Further the routine may be developed and called iteratively to update non-zero gradient/stress boundary conditions, see Section 7.33.

# 7.13 Subroutine SURFINT

Subroutine SURFINT is called from PRESCR and HCOEF and is used for integration over an element side/face according to the variable NSID/NFACE (see Refs. 1, 7, 12).

GPG = -1.0	this corresponds to the element side/face at the
	parametric coordinate $\xi = -1.0$ integration is
	carried out in the direction $n(GPH(I)$ where I=1
	to NGAUSS) the number of gaussian points for
	integration.
	Similarly GPG = 1.0 corresponds to $\xi$ = + 1.0
	while GPH = 1.0 or -1.0 refers to edges at
	$\eta = \pm 1.0$ and integration in direction $\xi(GPG(I))$ ,
	I = 1 to NGAUSS).
DETJ	this is the determinant of the Jacobian matrix [J]
·	and is used for obtaining [J] <sup>-1</sup> to form the global
	shape function derivatives <sup>(2)</sup>
DX ]	these are the components of elemental edge
DY	increments over which integration has occurred,
DS	then when the second
	i = NGAUSS TESTX = $\sum_{i=1}^{NGAUSS} DX_i$ etc.

# Arrays

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CJ(1,1)	this is the contribution $\partial x/\partial \xi$ to the Jacobian
	matrix
CJ(1,2)	the contribution ay/ag
CJ(2,1)	the contribution ax/an
CJ(2,2)	the contribution ay/an
CJI(1,1)	the inversion ∂x/∂ξ
CJI(1,2)	the inversion <code>@x/@n</code>
CJI(2,1)	the inversion ay/ag
CJI(2,2)	the inversion ay/an
DEL(1,I)	the element shape function derivative $\partial N_i/\partial \xi$
DEL(2,I)	the derivative ƏN <sub>i</sub> /Ən

These in conjunction with the inversion CJI(L,M) are used to form the elemental shape function derivatives with respect to the global coordinate systems which are stored in vectors B(L,M) as defined in Section 7.11. To save on computer space many of these arrays associated with forming shape function derivatives are equivalenced to the SK vector (primarily used in the solution routine) and thus inter-routine data transfer economically effected.

## 7.14 Subroutine DIRECS

The purpose of this routine is to evaluate the direction cosines ELX, ELY and is called from routine SURFINT. The values of the array CJ are also generated in this routine as they are necessary in calculating ELX, ELY.

## 7.15 Subroutine ABFIND

This routine is called from FRONT and is used for calling the appropriate element matrix assembly procedure.

## 7.16 Subroutine DERIV

This routine is called from the MASTER segment and from VARCALC when upwind weighting is employed. The function of the routine is to calculate nodal shape functions at the integration Gauss points for each element and to store these on peripheral storage in readiness to assemble the elemental stiffness matrices.

NGAUSS

the number of integration Gauss points in one direction

#### Vectors

XG(I) I=1,3 CG(I) I=1,3 DDA(I) the parametric coordinate of the Gauss point the associated integration weight coefficient the area increment (analogous to DX, DY) associated with the Gauss point where a variable TESTDA may be used such that for an element

 $TESTDA = \sum_{i=1}^{i=NGauss^2} DDA(I)$ 

then TESTDA should closely represent element area and is useful for debugging as this checks out the entire shape function-derivative routines the value of the shape function at node I evaluated at the Gauss point

as for P(I) except for the upwind shape function the vector containing all the P(I) for the element which is written onto peripheral store through channel 10

as DP(I) for upwind shape functions, but written to channel 8

as DP(I) for superparametric element, stored on channel 10.

P(I) WP(I) DP(I) DWP(I)

CP(I)

## Arrays

WDEL(I,J)	the derivative of the upwind shape function at
	node J with respect to $I(I=1=\xi, I=2=\eta)$ and
	evaluated at the Gauss point
DB(L,I)	this contains all the arrays B(L,J) evaluated
	at Gauss points and is written to storage
	through channel 10
DWB(L,I)	as DB(L,I) but for upwind shape functions,
	written for channel 8
CB(L,I)	as DB(L,I) for the superparametric element,
	stored on channel 10.

# 7.17 Subroutine ABFORM1

This is called by ABFIND (called by FRONT) and is the assembly routine for the element stiffness matrix (for normal velocity gradients). The procedure is that element shape functions and derivatives are read off channels 10 (and 8 where appropriate) and the elemental matrices are formulated where with the exception of body force terms all matrix contributions occur on the left hand side (LHS), and even those can be taken to the LHS.

#### Vectors

AT1(I)	holds the RHS evaluation of q <sub>1</sub> at element node I
AI2(I)	holds the RHS evaluation of q <sub>3</sub> at element node I
PP(I)	holds the superparametric shape function for
	weighting the continuity equation at node I
	(=1,3,5,7).

## Arrays

BB(I,J)	holds the derivatives of the superparametric
	element (I=l =x etc) at node J and is used in
	evaluating pressure gradient terms in the
	momentum equations
AA(I,J)	holds the element stiffness matrix and is
	equivalenced to ESTIFM for transfer of data to
	the global assembly procedure in FRONT, FRONTA.

# 7.18 Subroutine ABFORM2

This is called by ABFIND and is the assembly routine for stress boundary prescription. The structure is identical to ABFORM1.

# 7.19 Subroutine EFVISC

This routine evaluates effective viscosity, effective conductivity by first calculating the length scale and kinetic energy of turbulence.

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ZLX1, ZLX2	distances of a point from the parallel wall to
	the x-direction respectively
ZLY1, ZLY2	distances of a point from the parallel walls
	perpendicular to the y-direction respectively
ZPT1, ZPT2	distances of a point from the parallel walls
	perpendicular to the z-direction respectively
ZLLX	length scale of turbulence $(\iota\mu)$ for the part
	of the domain under consideration

TINS	turbulence intensity in the part of the domain
	being considered
UV	absolute, normalised velocity vector
SQK	$\sqrt{K}$ , is square root of kinetic energy of
· · ·	turbulence
VKIN	holds original value of kinematic viscosity ( $v$ )
VKON	holds original value of thermal conductivity (K)
IWTS	holds original value of upwinding choice indi-
· ,	cator (IUPWIN)

VKINM(I)	holds original laminar kinematic viscosity for
	each element in the mesh
VMUDYN(I)	holds original laminar molecular viscosity for
÷	each element in the mesh
VCOND(I)	holds original laminar thermal conductivity for
	each element in the mesh
EMUT(8)	holds current element nodal turbulent dynamic
й г У Т	viscosity
EMUE (8)	holds current element nodal effective dynamic
· · · · · · · · · · · · · · · · · · ·	viscosity
CONDFT(8)	holds current element nodal turbulent thermal
	conductivity
CONDFE(8)	holds current element nodal effective thermal
	conductivity

Vectors

Vectors UU(I), VV(I) and the array DIS(3,I) are fully explained in WYSET (7.25).

# 7.20 Subroutine TLSKIN

Is called from EFVISC to store and transfer via COMMON/TLSKIN1/, TLSKIN2/, the element nodal values of length scale of turbulence, turbulent kinetic energy, turbulent viscosity and turbulent conductivity. These are printed by VARCALC after solution convergence.

Vectors

TLS(I)	holds length scale of turbulence value for each
17 a 19	point in the mesh
EKE(I)	holds kinetic energy of turbulence value for
•	each point in the mesh
TRMU(I)	holds turbulent dynamic viscosity value for each
	point in the mesh
TRCOND(I)	holds turbulent thermal conductivity value for
	each point in the mesh.

7.21 Subroutine FVPROP<sup>(10,11)</sup>

This routine evaluates the molecular and kinematic  $(\mu, \nu)$  viscosity, thermal conductivity (K), coefficient of thermal expansion ( $\beta$ ), specific heat capacity for constant pressure (CP) and the nodal fluid density ( $\rho$ ) on the basis of variable property constants dependent on the temperature (<sup>O</sup>K). It has to be called for each element for laminar flow only, in a similar manner as calling EFVISC.

Tøinitial or fluid bulk reference temperatureVectorsDVISC(8)holds newly formed current element nodal mole-<br/>cular viscosityEKFON(8)holds newly formed current element nodal ther-<br/>mal conductivitySTEMP(3)holds the current element nodal temperature<br/>values (<sup>0</sup>K) from last iteration

The above routine can be used with both coupled and uncoupled solutions.

# 7.22 Subroutine ABFORM5

Again called by ABFIND contains the formulation for free or mixed convection.

#### Vector

Al3(I) this holds the elemental RHS contribution q<sub>4</sub> at element node I and comprises contributions from the Newton-Raphson algorithm.

## 7.23 Subroutine TEMPM

Called from ABFIND, this routine assembles the elemental matrix entries for the decoupled energy equation.

## 7.24 Subroutine SFR

SFR is called by either DERIV or SURFINT and contains the elemental shape functions and derivatives for both parabolic and linear elements, the latter used to assemble the superparametric element for pressure interpolation. The routine also contains the upwind weighting functions and their derivatives.

# 7.25 Subroutine WYSET

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This routine is called by DERIV and SURFINT and evaluates the optimised parameters  $\alpha$  and  $\beta$  for the upwind weighting functions.

A1	=	αı	′(see	Reference	ces l,	3,	4,	9	and	12)
AA 1	=	βl		3						
A2	=	<sup>α</sup> 3								
AA2	Ħ	<sup>β</sup> 3	°, ") , }	44 A	na T N a					
B1	=	α2	,	÷	j., ,	, <b>-</b>				
BB1	=	<sup>₿</sup> 2	,	يە مورىپ		×				
B2	=	α <sub>4</sub>								
BB2	=	β <sub>4</sub> .		ه ۱ م						
			p `	s. * .	<b>*</b> : •					
Vent	• ~ ~									

Vectors	
UAVE(1)	average velocity along element side 3,1 (= $U_{31}$ )
UAVE(2)	= U <sub>57</sub>
VAVE(1)	= V <sub>53</sub>
VAVE(2)	= V <sub>71</sub>
UU(I)	= u velocity component at current element node I
VV(I)	= v velocity component at current element node I

#### Arrays

DIS(1,I)	the u component of velocity at node 1
DIS(2,I)	the v component of velocity at node 1
DIS(3,I)	(T) - temperature at node I

#### 7.26 Subroutine FRONT, FRONTA

This is the global matrix assembly and elimination routine and is called by VARCALC, TEMPCAL, PSICALC and WCALC. Details of the structure of this routine may be found in Ref. (5). However the present version is more efficient due to implementation of work done by Walters in Ref. (6). Three errors regarding NCRIT and NMAX sizes, and element matrix singularity or ill-conditioning are self-explanatory once they occur.

## 7.27 Subroutine BACSUB, BACSUBA

This is a backsubstitution routine and is called by FRONT subsequent to completing the elimination phase of solution.

# 7.28 Subroutine RESOL<sup>(5)</sup>

This routine provides a re-solution facility, where it can compute corrections to the equations system depending on their residuals.

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# 7.29 Subroutine PSICALC<sup>(1,12,13)</sup>

This subroutine calculates stream function ( $\psi$ ) from a known velocity field.

IAUTO -	= 0, specify stream function values at every
	node on the boundaries
	= 1, subroutine AUTOBC called to compute stream
₹ · · · · · · · · · · · · · · · · · · ·	function values at the boundaries
NB	total number of boundary nodes
NOD	node number for boundary conditions
VAL	stream function boundary condition value.
Vectors	· _* ·
PSI(I)	holds each nodal ( $\psi$ ) value in the mesh
NODP(I)	holds boundary node numbers in the mesh

VALP(I) holds boundary node  $(\psi)$  value in the mesh

.

Certain temporary variables storage similar to Section 7.10 is necessary before their original values are reassigned. This is straightforward and can be followed very easily in the listing.

# 7.30 Subroutine WCALC<sup>(1,12,13)</sup>

.

This subroutine calculates vorticity ( $\omega$ ) field from a known velocity field.

	/AL similar as in Section 7.	.29
--	------------------------------	-----

Vectors

NODW(I)	holds each nodal ( $\omega$ ) value in the mesh
VALW(I)	holds boundary node numbers in the mesh
R2(I)	holds boundary node ( $\omega$ ) value in the mesh

# 7.31 <u>Subroutine AUTOBC</u>(1,12)

This routine determines boundary values for the stream function field (Cartesian coordinates only).

KINL	number of elements on inlet boundary
KOUT	number of elements on outlet boundary
PSIF	( $\psi$ ) value on fixed boundary (specified as
	datum boundary)
NLB	total number of boundary nodes on fixed boundary
NOD	node number
NUB	total number of boundary nodes not on fixed
	boundary

Vectors

ALEN(I)	holds length of elements side for inlet boundary
BLEN(I)	holds length of elements side for outlet boundary
KINZ(I)	holds element numbers for inlet boundary
KOUZ(I)	holds element numbers for outlet boundary

# 7.32 Subroutine ABFORM6<sup>(1,12)</sup>

Element assembling routine to be called from the frontal solution routine for stream function or vorticity.

The vectors have the same meanings as in Section 7.17 as well as the overall structure.

# 7.33 Procedure for Updating Nonzero Gradient/Stress Boundary Prescriptions

The routine PRESCR is used to assemble non-zero gradient/stress boundary conditions into the global RHS vector. It may also be used with little modification to update unknown gradient/stress values during each iteration of calculation. This may be achieved in the manner outlined below:

- i) Call PRESCR iteratively from VARCALC with the appropriate NSID/NFACE code
- ii) For gradient values form in loop DO20 (see Appendix II) the appropriate linearised values  $\frac{\partial \overline{u}}{\partial x}$ ,  $\frac{\partial \overline{v}}{\partial x}$  etc. which may be achieved typically at the edge Gauss points G1=0.0 G2=0.0 D0 20 L=1, NBN

```
NN=IABS(NOP(NELL,L))
M1=NOPP(NN)
M3=M1+MDF(NN)-1
G1=G1+VAR1(M1)*B(1,L) (au/ax)
G2=G2+VAR1(M3)*B(1,L) (av/ax)
20 CONTINUE
```

- iii) For stress values a similar procedure may be used except p is evaluated from the superparametric interpolation
  - iv) The gradient/stresses, evaluated at the edge Gauss points may then be assembled into the RHS vector in the loop DO 60 which needs small changes, typically

 $R2(M1)=R2(M1)+H1*V* \begin{vmatrix} \frac{\partial \overline{U}}{\partial x} & DY + \frac{\partial \overline{U}}{\partial y} & DX \end{vmatrix}$ 

 $R2(M3)=R2(M3)+H1*V* \quad \begin{vmatrix} \frac{\partial V}{\partial X} & DY + \frac{\partial V}{\partial y} & DX \end{vmatrix}$ 

etc.

## 7.34 References

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# APPENDIX I

i.

t a data transfer

# PROGRAM DIMENSIONING AND USERS INSTRUCTIONS

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# AI.1 Introduction

The following are program instructions in full details, reporting the problem types which may be tackled using the two dimensional and axisymmetric version option. Hence this can be regarded as an instruction manual for running the program.

The finite element algorithms utilise the eight-noded, quadrilateral, isoparametric elements (Serendipity family) and are structured to solve four different problem types:

Isothermal - (laminar),

2. Forced convection - (laminar),

3. Free or mixed convection - (laminar), and

4. Buoyant, recirculating free or mixed convection (turbulent or mixed).

For problem types 1 and 2, formulations are included for solving the Navier Stokes equations (see Schlichting, reference 1) in both Cartesian (x-y) and axisymmetric (r-z) form. Further, for these two equation sets, the algorithm caters for boundary conditions of the following form:

- a) prescribed
- b) normal velocity gradients (n.v.g)
- c) stress (see reference 1).

The nondissipative energy equation (see reference 1) is also solved for problems of category 2 after having first obtained a
converged velocity field. However such a procedure is only acceptable where fluid properties are largely independent of temperature. Solution of the uncoupled equations in both Cartesian and axisymmetric form is effected only for prescribed values and zero temperature gradients on the domain boundary.

Natural convection occurs when density changes occur in the fluid. For this reason, the energy equation is linked to the right hand side of the Navier-Stokes equations for the uncoupled solution, where each time the Navier-Stokes equations are solved, the resulting velocities are used to solve the energy equation until overall convergence is achieved. Another formulation for this problem type is included where the energy equation is coupled into the velocity field calculation and solution for temperature differences with respect to a reference value effected through the domain. This procedure is subject to both prescribed and gradient boundary conditions.

## AI.2 Implementation on Different Computer Systems

This program is written to conform to the American National Standard FORTRAN 77 (ansi 77) and is set up to run on the Honeywell Multics (DPS8/M) operating system. Different computers have different operating systems and thus some guidance on implementation is warranted.

Input to the program is effected through channel NCR (=5) whereas line printer output is directed to channel NLP (=9).

The program may also require two further channels for input/output. Channel NCP (=1) - (file CPØ), for dumping or reading in initial conditions (e.g. extrapolated values) and channel (2) - (file edl), which is used for dumping data for use in restart should there be insufficient time available to complete the computer run in one attempt. Further, working space is required by the program in order that excessive storage is not consumed. For this purpose, scratch discs need to be assigned to channels 10, 8 and 4, the former two are used in assembly of the element stiffness matrices and appear in subroutines

> DERIV ABFORM1 ABFORM2 ABFORM5 ABFORM6 TEMPM

and

The discs are written to/read from SEQUENTIALLY and having been read from require REWIND. However not all compilers feature these instructions and may require conversion of these files to DIRECT ACCESS form, the declaration of which depends on the computer operating system.

Scratch disc 4 is encountered in the solution procedure and holds the reduced equations on channel ND1 (=4), this is also written to in a SEQUENTIAL manner and occurs in subroutines:

#### FRONT, FRONTA

and

,

# BACSUB, BACSUBA

A further feature of the program is the system clock function calling subroutine (TIMER). This function occurs in many places throughout the program and it is suggested that either a dummy routine is inserted or a routine which calls the clock function of the particular operating system using a subroutine such as ours:

, , , <b>,</b> ,	SUBROUTINE TIMER (K1)
· ,	IMPLICIT DOUBLE PRECISION (A-H,O-Z)
, <b>C</b> ,	Call system clock function (in seconds)
••• •••	X=QMILL(I)
	K1=X
, · · · · · · · · · · · · · · · · · · ·	RETURN
. <b>*</b>	END

· . . ·

For the Honeywell Multics system a [PL/1] program had to be written to define the above [QMILL(I)] for the system and to return it in seconds.

AI.3 Arrays and their Dimensioning

AI.3.1 Arrays in COMMON/GEP/

The numbers shown are the ones used in this thesis:

NOP(a,8)	(122,8)	R1(c)	(1553)	NODV(d)	(550)
NDN(a)	(122)	R2(c)	(1553)	VALV(d)	(550)
LPR(a)	(122)	VARI(c)	(1553)		
TEMP(b)	(461)	VARA(c)	(1553)		
CORD(b,2)	(461,2)	NCOD(c)	(1553)		
RSPEC(b,6)	(461,6)	BC(c)	(1553)	4	
NOPP(b)	(461)	AVARI(c)	(1553)		
MDF(b)	(461)				

The value of 'a' must be at least equal to the number of elements in the problem, while entry 'b' needs to be at least the number of nodes in the overall mesh. The value of 'c' must be at least the total number of degrees of freedom (dof) in the mesh, while 'd' must be at least the number of constrained degrees of freedom for the problem. Some knowledge of these values is necessary 'a priori' estimation of which is best illustrated by example as shown in the mesh below, Figure AI.1:

	13		14	, <u>-</u>	15		16	
) 	9	0	10		11		12	0
	5	0	6		7		8	0
	1		. 2	0	3	6	4	

FIGURE AI.1

Clearly there are 16 elements, then a  $\geq$  16, there are 65 nodes, hence b  $\geq$  65. The number of dof requires further calculation. For the velocity and pressure field, velocity is interpolated quadratically while pressure is subject to linear interpolation, thus the x (or z) velocity component 'u', pressure 'p' and y (or r) component 'v' are solved at nodes 'X' while only u and v are solved at nodes 'o'. Thus for the mesh the total degrees of freedom is given by

 $25 \times 3 + 40 \times 2 = 155$ 

thus c≥ 155

× • ·

When the temperature field is solved for a coupled equation set, temperature is quadratically interpolated and thus the variables u, p, v,  $\theta$  are solved at corner nodes and u, v,  $\theta$  at midside nodes. For a particular problem, the number of dof associated with an element is echoed as the variable NCN and the total dof for the problem is output against the name NP.

#### AI.3.2 Arrays in COMMON/GUARD/

The numbers shown are the ones used in this thesis:

SK(p)	(40000)	NMAX = 200
ESTIFM(q,q)	(28,28)	NCRIT = 80
GISH(r)	(600)	
INTEG(s)	(2700)	۰ , ۶

The values of p, r and s are the most difficult to estimate, 'q' must be at least the number of dof associated with each element, when solving for u, p, v,  $\theta - q \ge 28$ . The value of p has a minimum value as in certain subroutines, local arrays are equivalenced to SK to save space, for the present p $\ge$  40000. The maximum value of p, r and s are solely dependent on a developed form of Hood's frontal solution routine (see references 2 and 3) as the global stiffness array is equivalenced to it in the solution procedure, thus some knowledge of solution 'frontwidth' is required.

An estimate of this value may be obtained again with reference to the example mesh, Figure AI.2 below:

	· · · · ·				
	13	14	15	16	
<u>(</u> )	9	10	11	12	
く		6	7	8	7
	1	2	3	4	

FIGURE AI.2

Solution proceeds with ascending element numbers, at a particular solution stage eight elements have been processed resulting in a

front of partially assembled equations as shown (contributions from elements 9 to 12 are required to fully assemble the matrix on the 'front'). The total number of partially assembled equations for u, p, v solution are;

 $5 \times 3 + 4 \times 2 = 23$ 

plus space to assemble the next element

• •

.

•• . .

= 23 + 20 = 43

Therefore for the unsymmetric matrix, the storage required is  $(43)^2$ .

Estimation of the value of NMAX is also subject to boundary prescription and thus its precise value is difficult to evaluate beforehand.

The estimation of NMAX controls the value of 'p' which is now set such that  $p \ge (NMAX)^2$ , whereas  $r \ge NMAX$ . The INTEG array is formed by equivalencing integer arrays in FRONT and BACSUB, FRONTA BACSUBA, these arrays are shown together with the numbers used in this thesis:

	LDEST(x)(28)	LHED(y)(200)
	KDEST(x)(28)	KHED(y)(200)
· • •	NK(×)(28)	LPIV(y)(200)
	EQ(y,y)(200,200)	KPIV(y)(200)
· · · · ·		JMOD(y)(200)

The value of 'x' must be at least the total number of dof for an element (28 for u, p, v,  $\theta$ ), whereas  $y \ge NMAX$ . However, should there be any underestimate of NMAX the solution routine will stop and the appropriate diagnostic message printed.

A further local array which may need redimensioning occurs in subroutines (WYSET) and (EFVISC) under the name DISC(3,e) where e should be chosen to be the same as 'b' in Section AI.3.1 i.e. e = 461 as in this work.

### AI.4 Program Input

**n**, n

The following section describes program input data including the program variable name and the format through which it is read. Reference will be made to data line sets, these may constitute a single line of input or many lines.

1 TITLE (12A6)

TITLE (3) lines of input to describe the purpose of the computer run (2 lines could be left empty).

2 MARK, NAX1, NEWTON, IUPWIN, ITURB, (515)

MARK=1 Normal Velocity Gradients (nvg) boundary specification

MARK=2 Stress boundary specification

- MARK=3 Free or mixed convection formulation, nvg's or u,p,v; gradient or prescribed value on  $\theta$
- MARK=4 Forced or mixed convection, nvg boundary prescription on u,p,v

MARK=5 Forced convection, stress boundary prescription on u,p,v.

NAX1=0 x-y coordinate system

NAX1=1 z-r coordinate system

NEWTON=0 standard iteration procedure

- NEWTON=1 Newton-Raphson iteration procedure (should yield higher convergence rates for laminar flow only)
- IUPWIN=0 no upwinding, i.e. weighting functions equals the shape functions
- IUPWIN=1 upwinding applied to the temperature equation in free or mixed convection problems
- IUPWIN=2 upwind weighting applied on the momentum equations in advection dominated problems

ITURB=0 laminar flow only

ITURB=1 partially turbulent or fully turbulent flows. This calls subroutine (EFVISC) in which effective viscosity and effective conductivity are evaluated for each element. This subroutine should be adjusted for each individual problem.

For isothermal studies proceed to card set 4.

3. CONDF, BETA, CPF (3F20.10)

CONDF = thermal conductivity of the working fluid BETA = coefficient of cubical expansion

CPF = specific heat capacity at constant pressure

- - -

4. EMU, RHO, X, Y (4F20.10)

EMU = dynamic viscosity RHO = density

X = x component of body force

Y = y component of body force

5 NH(I5)

NH = number of nodes in the mesh

· ...,

6 MTRD(15)

MTRD=0 no restart input required on channel (2) namely [edl] file

MTRD=1 input required on channel 2 for restart

7 NCARDS(I5)

NCARDS=0 no output of converged field for post processing

(plotting, extrapolation for restart etc).

NCARDS=1 output of converged velocity-temperature fields on convergence on channel NCP(=1), namely [cp0] file.

8 MTRIT(I5)

MTRIT=0 no dump of unconverged calculations onto channel 2 for restart

MTRIT=1 dump of unconverged calculations onto channel 2 for restart

LTIM = duration of program execution before dump for restart if MTRIT=1, otherwise execution stops, the variable

LTIM is compared against the argument derived from the system clock using SUBROUTINE TIMER.

## 10 NNP(I5)

NNP = the number of nodal points input to the program nodal coordinates need only be supplied at element corners, interpolation of midside nodes occurring automatically where element sides are straight For NNP=0, go to card set 14.

N = node number CORD(N,1) = x(or z) coordinate of the node CORD(N,2) = y(or r) coordinate of the node

There should be 'NNP' lines of data to input the coordinate system.

12 NE (I5)
NE = the number of elements in the mesh

N = element number

NOP(N,1) = global node number corresponding to the 'element'
node number 1 of element N as shown in Figure AI.3
below:

81		82	83
Ī	NOP(4,7)	NOP(4,6)	NOP(4,5)
45	NOP(4,8)	element 4	NOP(4,4) 46
	NOP(4,1)	NOP(4,2)	NOP(4,3)
o- 27	· · · · · · · · · · · · · · · · · · ·	28	29

FIGURE AI.3

Then for element four the input line is

4 27 28 29 46 83 82 81 45

N.B. (a) counterclockwise nodal numbering

, • }

3

(b) there should be NE lines of element data.

If NNP≠0 go to card set 16

14 (i) IMESH(I5)

IMESH=1, Arbitrary or complex mesh generation. Now go to 15 IMESH=0, Equidistance (equispaced) mesh generation. Carry on

(ii) NROWS, NCOLS (215)
 NROWS = number of elements rows
 NCOLS = number of elements columns

- (iii) DX,DY (2F20.10)
  - DX = element X increment DY = element Y increment Go to 16
- 15
- i) NXL, NYL, NN, ND (4110)
  - NXL = total number of elements in the  $(\xi)$  direction
    - NYL = total number of elements in the (n) direction
  - NN = first node number of the mesh

  - ND = 1, sequential number of elements along lines of  $\ldots$  constant ( $\xi$ )
- ii) (XM(I), YM(I), I=1,8) (2F10.3)

. 1

Reads in (8) cards for the x,y coordinates of the master nodes of the mesh, on the basis of 8-noded isoparametric quadrilateral element mesh blocks.

The procedure (15-i)+(15-ii) can be repeated for as many mesh blocks as required, then these mesh blocks are interconnected to form the mesh.

16 ICOND (I10)

.

ICOND=0 pass to card set 18

ICOND = number of initial conditions on u,p,v,(0) which have been extrapolated from previous runs or guessed, these are read off channel NCP(=1)

- 17 L,K,PHI (215, F20.10) in the file assigned for channel (1), namely [cp0].
  - L = node number K = dof number
  - K=1 for u or Vz
  - K=2 for p (only at corner nodes)
  - K=3 for v or Vr
  - K=4 for  $\theta$  (temperature)
  - PHI = magnitude of the DOF
- 18 NRT (I5)
  - NRT = 0 pass to card set 22
  - NRT = number of elements on which gradient/stress boundary prescriptions are applied, however zero gradients are assumed and do not need explicit evaluation.
- 19 LE, NSID (215)

. ., .

- LE = element number
- NSID = element side code (see Figure AI.4 below).



NSID=4

20 IRT (I5)

IRT = total number of gradient/stress boundary prescriptions

L = node number RSPEC(L,1) =  $\partial u/\partial x$  for nvg formulation RSPEC(L,1) =  $\sigma_x$  for stress formulation RSPEC(L,2) =  $\partial u/\partial y$  for nvg formulation RSPEC(L,2) =  $\tau_{xy}$  for stress formulation RSPEC(L,3) =  $\partial v/\partial x$  for nvg formulation RSPEC(L,3) =  $\tau_{yx}$  for stress formulation RSPEC(L,4) =  $\partial v/\partial y$  for nvg formulation RSPEC(L,4) =  $\sigma_y$  for stress formulation RSPEC(L,4) =  $\sigma_y$  for stress formulation RSPEC(L,5) =  $\partial \theta/\partial x$  for free or mixed laminar and/or turbulent convection

RSPEC(L,6) =  $\partial \theta / \partial y$  for free or mixed laminar and/or turbulent convection

In cylindrical coordinate systems

$$\frac{\partial}{\partial x} = \frac{\partial}{\partial z}; \qquad \frac{\partial}{\partial y} = \frac{\partial}{\partial r}; \quad \sigma x = \sigma z;$$
$$\tau_{xy} = \tau_{zr}; \quad \tau_{yx} = \tau_{rz}; \quad \sigma y = \sigma r$$

22 NB (I5)

NB

= number of constrained degrees of freedom, care must be taken to avoid duplication as this affects the solution procedure

- 23 NOD, MDEG, VAL (215, F20.10)
  - NOD = node number

MDEG = dof code (as K of 17)

VAL = prescribed boundary value

For isothermal data, input is now complete. For coupled free or mixed laminar and/or turbulent convection problems, go to card set 28. For uncoupled forced or mixed laminar and/or turbulent convection only, continue.

24 NB (I5)

NOD = node number

VAL = prescribed temperature value

· •.

26 NHEAT (I5)

NHEAT= 0

This ends input data for uncoupled forced or mixed laminar and/ or turbulent convection problems.

NHEAT= number of elements on which heat transfer coefficients need calculating

27 NELL, NSID 215)

NELL = element number

NSID = element side code (see 19)

This completes input data for uncoupled forced or mixed laminar and/or turbulent convection problems. Go to 30.

NB = number of prescribed temperature values, again taking care to avoid duplication

# 28 NHEAT (15)

1.1

Used in coupled free or mixed laminar and/or turbulent convection problems, but has the same function as card set 26. NHEAT = 0 completes input data for free or mixed convection

problems.

Go to 30.

# 29 NELL, NSID (215)

As card set 27 and completes input for free or mixed laminar and/or turbulent convection problems. Go to 30.

30 IPSW (15)

IPSW=0 this indicates that stream function and vorticity values calculations are not required and ends input data for either forced or free convection, or any other case.
IPSW=1 program goes on to calculate stream function and vorticity values from known velocity fields using the (FEM), and hence following data is required.

31 IAUTO (I5)

1.15

• :

IAUTO=0 this means that stream function values at boundary nodes

have to be specified, hence carry on to 32

IAUTO=1 subroutine "AUTOBC" is called to compute stream function

values at boundaries. Go to 34.

32 NB (I5) Total number of boundary nodes for stream functions only.

33 NOD, VAL (I10, F20.10) as many data lines as (NB) in 32 above. NOD = boundary node number VAL = stream function value at this node. Go to 43.

34. KINL (I5) Number of elements on inlet boundary, (for  $\psi$ )

- 35 KINZ, ALEN (I10, F20.10) as many data lines as (KINL) in 34 above. KINZ = element number ALEN = length of element side
- 36 KOUT (I5) Number of elements on outlet boundary.

×. . . . . .

2. ·

- 37 KOUZ, BLEN (I10, F20.10) as many data lines as (KOUT) in 36 above. KOUZ = element number BLEN = length of element side
- 38 PSIF (F20.10) Value of stream function to be specified on datum boundary.

39 NLB (I5) Total number of boundary nodes on fixed boundary, for  $(\psi)$ 

- 40 NOD (I5) Node number, as many data lines as (NLB) in 39 above, for  $(\psi)$
- 41 NUB (15) Total number of boundary nodes not on fixed boundary, for  $(\psi)$

405

- 42 NOD (I5) Node number, as many data lines as (NUB) in 41 above, for  $(\psi)$
- 43 NB (I5) Total number of boundary nodes for vorticity only.
  If (NB=0), this means no vorticity values calculations are required and hence, this ends the input data, otherwise, proceed.
- 44 NOD, VAL (I10, F20.10) NOD = node number VAL = vorticity value

. . .,

As many data lines as (NB) in 43 above.

#### AI.5 Details of the Auto Mesh Generation Features

AI.5.1 Equidistant (Equispaced) Mesh Generation (MESH=0)

This is a simple algorithm for auto generation of a REGULAR finite element mesh (see data set 14(ii), 14(iii) of Section AI.4). Input for this section is best illustrated by example shown below in Figure AI.5.



\* ; · · · · · \*;

For the problem there are 6 rows of elements (NROWS=6) and 4 columns (NCOLS=4), then for the geometry shown

$$DX = \frac{1.0}{4} = 0.25$$
  $DY = \frac{2.0}{6} = 0.67$ 

AI.5.2 Arbitrary or Complex Mesh Generation (MESH=1)<sup>(4)</sup>

This is an algorithm which uses the isoparametric concept to deal with complex domains shapes and multiply connected domains.



FIGURE ALS: CURVED DOMAIN

Using the curved domain in Figure AI.6on the right hand side, it is regarded that the whole domain is one big isoparametric element and defined by the eight master nodes. A suitable mesh is obtained by using lines of constant ( $\xi$ ) and (n), left hand side to divide the "large element" into (n) elements in the ( $\xi$ ) direction and (m) elements in the (n) direction. The coordinates of any point (j) are given as: <sup>(4)</sup>

$$x_{j} = \sum_{i=1}^{8} N_{i} (\xi_{j}, n_{j}) x_{i}$$

$$y_{j} = \sum_{i=1}^{8} N_{i} (\xi_{j}, n_{j}) y_{i}$$
(AI.1)

If grading of mesh is required, weighting factors can be introduced to create unequal dimensions inside a "large element". A simpler

. . ·

way to shift the origin of  $(\xi, \eta)$  axes towards the corner in which a denser mesh is desired is shown in Figure AI.7.





For detailed examples and discussion see References 4 and 5.

## 6.6 References

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# APPENDIX II

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# PROGRAM LISTING

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#### VERSION 4

FETHSOLVAC

PROGRAMMER : Mohammed J. K. Alshatam DATE : 10 . 01 . 1985 TIME : 10:59

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0004:0 444 9995. J 4. Programmer: Mohammed Jassim Alghatam Zizzania ŵ: 3784 J ¥: EOPT C **9** 8838 7 9 8838 7 sk: sk: Ċ Maratal L IMPLICIT DOUBLE PRECISION (A-H, O-Z) COMMON/CONTE/ 1 N. Y. V. COMDE EETA, OPE-RHC, HCGEM, HCGEY, 2 GEE, GEG, GEH, EMU, MG(D), CG(D), DS, DK, DY, 3 NE, NH, NE, YE, NDE, NIM, NEN, JT1, MO1, MTRO 4, NTIME, MARK, NTR, LTIM, MTRIT, NCGRDS, NSID, NAXI 499.4 5, HET. HMGE, HWF. WELL, NTEA, NORUSS, NER, NCR, NLP, NCF E. MCOPC. 36. MG. NEW NET, NEWTON, ITURE, ICOND CCL.MCN/CEF 1 TEMP(4FI), CORD(461.2), RSFEC(461.6) 2, Pl(1530), R2(1550), VARI(1353), VARA(1550), BC(1553) 3, VRLV(560), RVARI(1553), NOP(122, 8), NDN(122), LPR(122) ÷. 1 AF1. AAC A1. A2. R51. EE2 E1. E2. DIS. 1. 461) 3. 17 8. Noelli, gr. uril, go. Jue(2. 72). Dur(72). TT(8) 3. 09(8). 77(9) Urve(1). 78VE(2). TUPAIN, 14T5. VKIN, VKON .... • . . OFEN IUNIT=1.FILE=1c#81.FORM=1FORMATTED1) OFEN IUNIT=2.FILE=1ed11.FORM=1UNFIRMATTED1) DEEN UNIT=2.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) OFEN UNIT=2.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) DEEN/UNIT=3.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) DEEN/UNIT=10.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) DEEN/UNIT=10.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) DEEN/UNIT=10.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) DEEN/UNIT=10.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) DEEN/UNIT=10.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) DEEN/UNIT=10.FORM=1UNFORMATTED1.STATUS=1SCRATCH1) ê î mi N\_7=5 N142 HU741 G-11 (1847-171) 5 NEITEANLE 1000 ASIL TIMERCITEX TIMELECTIEN NEITEANLE 101XITIMEL MEITEANLE 101XITIMEL 1022 ст. Г CALL DATAS

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0100:			END

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FETHSOLVAC (CONT.) P 9 0101 C 0102:0 9 0103 C 1 0104 0 Ņ S 0105:0 0105:0 6 0107:0 ġ! 9**] 01**08:C\* 3 SUBROUTINE DATAG 0109: 0110:C\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* GI 0111:C નુક 0112:0 91 IMPLICIT DOUBLE FRECISION (A-H, 0-Z) 0113: 31 COMMON/CONTP/ 0114 1 Χ.Υ.Υ.Υ.CONDF, BETR, CPF, RHO, HCOFX, HCOFY, 0115. **و**ن 2 GFF. GPG, GFH, EMU, XG(2), CG(3), DS, DX, DY, 0116:<u>Ģį</u> 3 NP, NH, NE, NB, NDF, NCN, NBN, IT1, ND1, MTRD e**D 0**117 : 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI ST 0118: 5, NRT, MWGR, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP 0119: 0 5, NCORD, IG, NG, NEV, NBT, NEWTON, ITURE, ICOND 01200 Ĥ COMMON/GEP/ 0121: Ģ 1 TEMP(461), CORD(461, 2), RSPEC(461, 6)  $0122^{+}$ Ş 2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) 0123: Ê 3, VALV(560), AVARI(1553), NOP(122, 8), NON(122), LFR(122) 0124: 4, NOFP(461), MOF(461), NCOD(1553), NODV(560) 0125: COMMON/GUARD/ 3 0126: 9, 1 SK(40000), ESTIFM(28, 28), GISH(600), INTEG(2700) 0127 COMMON/UPWIN/ 0128: ŝĮ 1 AR1, AR2, A1, A2, EB1, BB2, B1, B2, DIS(2, 461) 0129 2, WP(8), WDEL(2, 8), WB(2, 8), DWB(2, 72), DWP(72), TT(8) 0130: 3, UU(8), VV(8), UAVE(2), VAVE(2), IUPMIN, IWTS, VKIN, VKON 0131: CHARACTER \*120 TITLE 0132: 0133:C 0134:0\*\*\*\*\*\*\*\*\*\*\*\* 0135 0 INITIAL DATA 0136 C\*\*\*\*\*\* 0137 : Č <u>a</u>[ 00 7 IT=1,3 0138: 6 READ(NCR, ((A)))TITLE 0139: WRITE(NLP, 270)TITLE 0140. CONTINUE 7 0141: REWIND 2 0142: REWIND 4 0143: REWIND 10 0144: 5 REWIND 8 *0*145: 0146: ND1 = 4Ðļ NTR=1 0147: 3 NTRA=1 0148: 0149: MWGA=0 0150:C 8

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# FETHSOLVAC (CONT.)

0151	: [****	******
0152	:C RI	EAD IN CONTROL VARIABLES
0153	; C****	******
0154	: C	
0155		READ(NCR/102)MARK,NAXI,NEWTON,IUPWIN,ITURB
0156	:	WRITE(NLP,601)
0157	:	GO TO(20, 22, 24, 26, 28), MARK
0158	: 26	CONTINUE
0159.		IF(NAXI.EQ.0) WRITE(NLP,213)
0160.	•	IF(NANI.EQ.1) WRITE(NLP,217)
0161.		WRITE(NLP,250)
0162.		READ(NCR, 600)CONDF, BETA, CPF
0163.	•	WRITE(NLP, 600)CONDF, BETA, CPF
0164	• •	<u>GO TO 30</u>
0165	: 20	CONTINUE
0166.	•	IF(NAXI.EQ. 0)WRITE(NLF, 212)
0167	•	IF(NHXI, EU. 1)UKITE(NLP, 216)
0168:	· 	GO TU 3V
0169	: 22	CONTINUE
0170	•	IF(NBXI.EU.0)NRITE(NLF,214)
0171	•	IF(NHXI, EU. 1)WRITE(NLP, 215)
0172:		60 TU 30
0173:	: 24	CONTINUE
0174	• •	IF(NHXI.EU.U)WRIJE(NLF,219)
0175:	•	IF (NHXI, EU, 1)MRITE(NLP,221).
0176:	•	WRITE(NLF)250)
0177:	•	REHD(NUR, 600)UUNDF, BETH, CPF
0178:	•	WRITE(NLF, 600) CUNDE, BETH, CFF
0179:		GU TU SU SOUTINUE
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0122.		
0155 134 21 -		WRITEIN R. 201 NH
11155. 11155	,	DR = 18 I = 1. NH
N1 46		DO 18 J=1.2
A197.	18	CORD(I,J) = 0.
0198.		READ(NCR, 102)MTRD
0199		WRITE(NLP, 210)MTRD
0200:		READ(NCR, 102)NCARDS

نمعتا U FETHSOL VAC ٠. 0000 00000  $\mathbf{C}$ 0000000 00000 ナナナ \* READ IN DATA OFF DISC FOR CALCULAT READ IN DATA OFF DISC FOR CALCULATION RESTART \*\* デデチチ \* 下し IF(MTRD\_NE\_0) GO TO 16 DO 12 I=1,NP VARA(I)=0. 12 VARI(I)=0. 15 CONTINUE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 4 12 12 1.-1 -. 70 l'. EHD READ(NCR, 103)ICOND WRITE(NLP, 232) ICON IF(ICOND, EQ. 0)GO TO DO 35 I=1, ICOND READ(NCP, 118)L, K, PH NOPP(1)=1 DO 74 I=2,NH NOPP(I)=NOPP(I-1)+MDF( NP=NOPP(NH)+MDF(NH)-1 WRITE(NLP,100)NP ERD IN INITIAL CONDITIONS 1----DO 13 I=1. TEMP(I)=0. CONTINUE IF(MTRD.NE. DO 12 I=1. IF(MTRD. L READ(2) 1 NP.NTR. REWIND 2 CALL RITE(NLP, 234)NCARDS EAD(NCR, 102)NTRIT RITE(NLP, 230)NTRIT EAD(NCR, 103)LTIN RITE(NLP, 228)LTIN CCONT. CORDGEN 6.9/H r-- $\sim$ m e NH 9 Яù 121 000  $\geq$ 5 DHI TOND 1 1-a 4. [1] 141 140 NP> 2 1 1-2. ¥ \*\*\*\*\*\*\*\* 大田 \*\*\*\* \*\* 000000 000000 7 \* \* \*

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#### FETHSOLVAC (CONT.)

IF(MARK. EQ. 3. AND. MDF(L). EQ. 3. AND. K. EQ. 3) K=2 0251: IF (MARK. EQ. 3. AND. MDF (L). EQ. 3. AND. K. EQ. 4) K=3 0252: IF(MARK. NE. 3. AND. MDF(L), EQ. 2. AND. K. EQ. 3) K=2 0253. IF (MARK: NE. 3. AND. K. EQ. 4) GO TO 34 0254: J=NOPP(L)+K-1 0255: VARI(J)=PHI ···· 0256: GO TO 35 0257: 34 CONTINUE 0258: TEMP(L)=PHI 0259: 35 CONTINUE 0260; WRITE(NLP,200) 0261CALL NRITELP 0262: IF(MARK.LT.4) GO TO 39 0263: WRITE(NLF, 201) 0264: 00 38 I=1,NH 0265WRITE(NLP,246)I,TEMP(I) 0266. 38 CONTINUE 0267: 0268: *39 CONTINUE* WRITE(NLP,227) 0269: 0270: WRITE(NLP,105)(N,NOPP(N),(CORD(N,M),M=1,2),MDF(N),N=1,NH) 0271:C 0273:0 READ IN SPECIFIED STRESS OR NORMAL DERIVATIVE VALUES 0275:C DO 80 L=1,NE 0276 -0277: LPR(L)=0 0278S0 CONTINUE DO 82 L=1,6 0279: D0 82 I=1,NH 0280: RSPEC(I,L)=0. 0281: 82 CONTINUE 83 CONTINUE 0282: 0283: READ(NCR, 102)NRT 0284: WRITE(NLP, 238)NRT 0285: IF(NRT.EQ.0)60 TO 500286: WRITE(NLP, 274) 0287. DO 46 L=1, NRT 0288: PEAD(NCR, 106)LE, NSID 0289: WRITE(NLP, 108)LE, NSID 0250: LPR(LE)=NSID 0291: 46 CONTINUE 0292: WRITE(NLP,242) 0293: READ(NCR, 102)IRT 0294: WRITE(NLP, 120)IRT 0295: WRITE(NLP, 122) 0296: DO 85 JI=1, IRT 0297: 0298: READ(NCR, 246)L, (RSPEC(L, I), I=1, 6) 0299: WRITE(NLP,246)L,(RSPEC(L,I),I=1,6) **85 CONTINUE** 0300:

FETHSOLVAC (CONT. )

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b 0301: 50 CONTINUE 0302: IWTS=IUPWIN 0303: VKIN=V VKON=CONDF 0304: 0305;0 CHECK INITIAL DATA 0307:0 **J** 0308 : C\* 0309 ; C 0310: CALL DIAG1(NB, NRT, NE, ICOND, IRT, NH, NNF, NDF, NF, MARK) 0311:C 0312:0 0314:C CHECK NODAL CONNECTIONS AND COORDINATES 0315:C\* 0316:C CALL DIAG2 9 0317 : 0318:C 0319:0 0320: 100 FORMAT(/4H NP=, I4) 0321: 102 FORMAT(515) 0322: 103 FORMAT(I10) 105 FORMAT(215,2F20.10,15) 0323: 106 FORMAT( 2515) 0324: 108 FORMAT(2110,F20.10) 0325: ) 0325 : 110 FORMAT(13H ELEMENT DATA) 0327: 114 FORMAT(4F20.10) 0328: 118 FORMAT(215,F25.20) 0329: 201 FORMAT(/40H INITIAL CONDITION STATE FOR TEMPERATURE/) 202 FORMAT(/5X, SH NODE, 5X, 12H TEMPERATURE/) 0330 120 FORMAT(/SH IRT=, I5//) 0331: 0332: 122 FORMAT( 5%,5H NODE,3%,6H DU/D%,4%,6H DU/DY,4%,6H DV/D% 0333: 2,4X,6H DV/DY,4X,6H DT/DX,4X,6H DT/DY 0334: 3/14X,3H SX,7X,3H SY/) ,0335. 200 FORMAT(/14H INITIAL STATE/) 204 FORMAT(4H NH=, I3) 0336: 0337 210 FORMAT(6H MTRD=,13) 212 FORMAT(1H 'STEADY STATE-CARTESIAN COORDINATES',/, 0338 - NORMAL VELOCITY GRADIENTS SPECIFIED (/) 0339 213 FORMAT(\* FORCED OR MIXED CONVECTION, CARTESIAN SYSTEM', /, 0340: :"NORMAL VELOCITY GRADIENT BOUNDARY CONDITIONS";#>>--0341. 217 FORMAT(\* FORCED OR MIXED CONVECTION AXISYMMETRIC SYSTEM', // 0342: 0343: . 1 NORMAL VELOCITY GRADIENTS BOUNDARY CONDITIONS()/) -0344: 214 FORMAT<//STEADY STATE-CARTESIAN COORDINATES',/, : SURFACE STRESSES SPECIFIED //> 0345: 215 FORMAT<//STEADY STATE-CYLINDRICAL COORDINATES/,// 0346. 0347: : AXISYMMETRIC SURFACE STRESSES SPECIFIED (//) 0348. 216 FORMAT</\*STEADY STATE-CYLINDRICAL COORDINATES\*/// 0349: : AXISYMMETRIC NORMAL VELOCITY GRADIENTS SPECIFIED //> 0350: 219 FORMAT(\* \*FREE OR MIXED CONVECTION,\*\*\* \*////\*\*\*\*

FETHSOLVAC (CONT.)

7X, CARTESIAN COORDINATE SYSTEM. ()// 0351: "NORMAL VELOCITY GRADIENTS BOUNDARY CONDITIONS(,/) 0352: 221 FORMAT( FREE OR MIXED CONVECTION AXISYMMETRIC FORMULATION', // 0353: : 'NORMAL VELOCITY GRADIENTS BOUNDARY CONDITIONS', // 0354: 222 FORMAT(7H MARK=, 12, 5%, 5HNAXI=, 12, 5%, 7HNENTON=, 12, 5%, 7HIUPWIN=, 12, ···0355: ITURB=, 12) 0356; -5X, SH 0357: 224 FORMAT(4\* FORCED CONVECTION CARTESIAN COORDINATES >\* STRESS BOUNDARY CONDITIONS\*>/> -)0358: Lag ter ter dave u 226 FORMAT(\* 0359: FORCED CONVECTION AXISYMMETRIC COORDINATES' ;; < STRESS BOUNDARY CONDITIONS() /> 0360; · · · · · · 227 FORMAT(/" Y OR R-COORDINATE' NODE NOPP X OR Z-COORDINATE 0361: :/ MDF(,/) . . 0362: 228 FORMAT(6H LTIM=, I5, SHSECS.) -0363: 230 FORMAT(7H MTRIT=, I3) 0364: 232 FORMAT(/7H ICOND=,110) 0365: 234 FORMAT(SH NCARDS=, 12) 0366: 238 FORMAT(SH NRT=, I2) 90367: 242 FORMAT//39H SPECIFIED STRESS OR NORMAL DERIVATIVES/> 0368. 246 FORMAT(I10,6F10.4) 0369: 250 FORMAT(10X,6H CONDF,14X,5H BETA,15X,6H CPF> 0370: 252 FORMATKY VISCOSITY=1,E12.5,7 DENSITY=1,E12.5, 0371: X BODY FORCE=', E12. 5, /; 1H ' Y BODY FORCE=', E12. 5, . 1 0372: KINEMATIC VISCOSITY=1,E12.5,/> 0373: 270 FORMAT(1H + A119) 0374: 274 FORMAT(/8H ELEMENT, 5X, 5H SIDE/) 0375: 600 FORMAT(3F20.10) )0376: 601 FORMAT(2,1H / CONTROL DATA AND PHYSICAL QUANTITIES :///// 0377: 602 FORMAT(7,1H , 'DENSITY=RHO=(ka/m\*\*3)',7,1H , 0378: :"SPECIFIC HEAT CAPACITY FOR CONSTANT PRESSURE=CPF=">//1H > 0379: :/CP=[w/sec/ksK\_(J/ksK)]/>/>1H\_> 0380. :YDYNAMIC VISCOSITY=MU=[ks/m\_sec(N\_sec/m\*\*2)]/,/,1H\_ 0381: :'KINEMATIC VISCOSITY=NU=(m\*\*2/sec)',/,1H ) ... 0382: ;′THERMAL\_CONDUCTIVITY=CONDF=K=(w/mK)/,/,1H , 0383: :/COEFFICIENT OF CUBICAL EXPRNSION=BETA=(m\*\*3/K)/,/,1H > 0384: RETURN 0385: END 0386: 0387:0 0388:0 0389:0 8398:0 0391.0 0392:0 0393:0 0394: 0396:0 SUBROUTINE DIAG1 (NBCON, NEBCN, NELEM, NICON, NNBCN, NPOIN, NRPON, 0397: 0398: -NDF, NP, MARK) 0399:C 

FETHSOLVAC (CONT.)

IMPLICIT DOUBLE PRECISION (A-H, 0-Z) 0401: DIMENSION NECHO(80), NEROR(8) 0402: 0403:0 SCRUTINY OF CONTROL DATA 0404:0\*\*\* 0405:C 37 IF(NRFON. EQ. 0) NRFON=NFOIN-(NELEM\*3) 0406: 0407: DO 10 IEROR=1,S 10 NEROR(IEROR)=0 90408: 0409:C SCRUTINISE CONTROL DATA AND PRINT ERROR MESSAGE 0410:0\*\*\* 0411 : C · · · \* ; > \* IF(NPOIN.LE. 0) NEROR(1)=1 0412: IF (NRPON. LE. 0. OR. NRPON. GT. NPOIN) NEROR(2)=1 0413: NEROR(3)=1 IF(NELEM.LE.0) 0414: IF(NPOIN.GT.NELEM\*8) IF(NBCON.GT.NPOIN\*NDF) NEROR(4)=1**0415**: NEROR(5)=10416: ERNE3=NPOIN+NP 9417: NEROR(6)=1 IF (MARK. NE. 3. AND. NICON, GT. ERNE3) 0418: ---- NEROR(7)=1 IF(NEBCN. GT. NELEM) 0419: IF (NNBCN. GT. NP) 0420: 0421:0 0422:C\*\*\* CHECK ON ERROR-IF UNITY PRINT 0423:0 0424: JEROR=0 - DO 20 IEROR=1,8 8425: IF(NEROR(IEROR), EQ. 0) GO TO 2011 0426: JEROR=1 0427: 0428:0 0429:0\*\*\* WRITE OUT ERROR NUMBER 0430:0 WRITE(9,2000)IEROR 0421: 0432 20 CONTINUE IF(JEROR.EQ.0) RETURN 0433: 0434:0 0435;C\*\*\* LIST DATA REMAINING AFTER CONTROL PARAMETERS 0436:0 WRITE(9,2010) 0437: 30 CONTINUE 0438: READ(5,1000) NECHO 0439: WRITE(9,2020) NECHO 0420: GO TO 30 0441: 1000 FORMAT(80A1) 0142: 2000 FORMAT(/)10X,33HCONTROL PARAMETER ERROR\*\*\*\*ERROR,15) 0443: 0444: 2010 FORMAT(7,10%,42HDATA FOLLOWING ERROR IN CONTROL DATA LINES/) 0445: 2020 FORMAT(10X,80A1) END 0446: 0447:C 0448:C 0449:C 0450 C

FETHSOLVAC (CONT.) 0451:0 0452:C 0453:C 0454: 0456 C 0457: SUBROUTINE DIAG2 **)** 8458 : C . .... IMPLICIT DOUBLE PRECISION (A-H. 0-Z) 0460: COMMON/CONTR/ 0461: 1 X, Y, V, CONDF, BETA, CPF, RHO, HCOFX, HCOFY, **0462**: 2 GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 0463: 3 NP> NH; NE> NB; NDF; NCN; NBN; IT1; ND1; MTRD 0464: 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI 0465: 5, NRT, MNGA, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP 0466: 6, NCORD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND 90467: COMMON/GEP/ 0468: 1 TEMP(461), CORD(461, 2), RSPEC(461, 6) 0469: 2, R1(1552), R2(1553), VARI(1553), VARA(1553), BC(1553) 0470: 3, VALV(560), AVARI(1553), NOP(122, 8), NDN(122), LPR(122) 0471 : 4, NOPP(461), MDF(461), NCOD(1553), NODY(560) 0472: 0473: COMMON/GUARD/ 1 SK(40000),ESTIFM(28,28),GISH(600),INTEG(2700) 0474; 0475: COMMON/UPWIN/ 1 AA1, AA2, A1, A2, BB1, BB2, B1, B2, DI5(3, 461) 0476: 2, WP(8), WDEL(2,8), WB(2,8), DWB(2,72), DWP(72), TT(8) 0477: 2,UU(8),VV(8),URVE(2),VAVE(2),IUPWIN,IWT5,VKIN,VKON 0478: DIMENSION NECHO(80), NERAR(13) 0479: 0480:0 NTOTV=NP 8481: DENSY=RHD 0482: MELEM=NE 0483: MPOIN=NH 0484: NELEM=MELEM 0485: NNODF=NBN 0186: NFOIN=NH 0487: VISCY=EMU 0488: 0489 ·C SCRUTINISE ELEMENT AND NODAL POINT DATA 8498 :0\*\*\* 0491.C 0492:C 0493:0\*\*\* INITIALIZE ERROR ARRAY 0494:C DO 10 IEROR=1,13 0495; NEROR(IEROR)=0 0196: 0497: 10 CONTINUE 0498:C 0499:0\*\*\* CHECK PHYSICAL PROPERTIES 0500:C

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FETHSOLVAC (CONT.) 0501: IF (DENSY, LE. 0. 0. OR. VISCY, LE. 0. 0) NEROR(9)=1. 0502:0 . k CHECK NODAL COORDINATES 0503:0\*\*\* CHECK FOR TWO IDENTICAL COORDINATES 0504:0\*\*\* 0505:C DO 40 IPOIN=2,NPOIN 0506. JP0IN=IF0IN-1 0507: DO 30 KPOIN=1, JPOIN 0508: · . • IF(CORD(IFOIN, 1), NE. CORD(KFOIN, 1), OR. CORD(IFOIN, 2). 0509: -NE CORD(KPOIN, 2)) GO TO 20 0510: NEROR(10)=1 0511: 20 CONTINUE 0512: 30 CONTINUE 0513; 40 CONTINUE 0514 0515:C CHECK ELEMENT NODAL NUMBERS 0516:0\*\*\* A - REPETITION OF A NODE NUMBER IN ONE ELEMENT 0517:0\*\*\* B - NODE NUMBER OUTSIDE PERMISSIBLE BOUNDS 0518:C\*\*\* 0519:C DO 50 IPOIN=1, NPOIN 0520: DO 50 IELEM=1. NELEM 0521: LCONT=0 0522: DO 50 INODE=1, NNODP 0523: IF(NOP(IELEM,INODE) NE.IPOIN) GO TO 50 0524: LCONT=LCONT+1 0525: > IF(LCONT.GT. 1) NEROR(11)=1 0526: 50 CONTINUE 0527: DO 60 IELEM=1, NELEM 0528: DO 60 INODE=1, NNODE 0529: IF(NOP(IELEM, INODE), LE. 0, OR. NOP(IELEM, INODE), GT. NPOIN) 0530: -NEROR(12)=1 0531: 60 CONTINUE 0532: 0533:0 CHECK ON NUMBER OF INITIAL CONDITIONS INPUT 8534:0\*\*\* 0535:0 IF(ICOND. GT. NTOTY. AND. MARK. EQ. 3) NEROR(13)=1 0536. 0537:0 WRITE OUT ERROR NUMBER 0538 . C\*\*\* 0539:0 JEROR=0 0540: DO 70 IEROR=9,13 0541: IF(NEROR(IEROR), EQ. 0) GO TO 70 0542: JEROR=1 0543: NRITE(9,2000) IEROR 0544: 70 CONTINUE 0545: 0546:C DECIDE WHETHER TO CONTINUE OR ECHO DATA 0547.0\*\*\* 0548:0 0549 IF(JEROR.EQ.0) RETURN 0550÷C

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(CONT.) FETHSOLVAC P 0551:0\*\*\* LIST REMAINING DATA 10.00 0552:0 WRITE(9,2010) 0553: 80 CONTINUE 0554: 0555: READ(5, 1000) NECHO WRITE(9,2020) NECHO 0556: GO TO 80 0557 30558 1000 FORMAT(80A1) 2000 FORMAT(/10%,10HDATA ERROR,15) 0559 2010 FORMAT(/10%, 14HREMAINING DATA) 0560: 2020 FORMAT(10%, 80A1) 0561: END 0562: 0563:0 0564 C 0565:C 0566:C €0567:C 0568:C 0569:C Ĺ 0570: SUBROUTINE CORDGEN 0572: 8573 : C\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 0574:C B575:C\* GENERATE COORDINATES Ø576:C '0577:C\* 0578:0 IMPLICIT DOUBLE PRECISION (A-H, 0-Z) 0579: COMMON/CONTR/ 0580: 1 Χ. Υ. Υ. CONDF, BETR, CPF, RHO, HCOFX, HCOFY, 0581: 2 GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 0582: 3 NP, NH, NE, NB, NDF, NCN, NBN, IT1; ND1, MTRD 0583: 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI 0584: 5, NRT, MNGA, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP **\$05**85. 20586 5, NCORD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND ~ COMMON/GEP/ 0587 1 TEMP(461),CORD(461,2);RSPEC(461,6) 0588: 2,R1(1553),R2(1553),VARI(1553),VARA(1553),BC(1553) 0539 -3, VALV(560), AVARI(1553), NOP(122, 8), NDN(122), LPR(122) 0590: 4, NOFP(461), MDF(461), NCOD(1553), NODV(56A) 0591: COMMON/GUARD/ 0592. 0593: 1 SK(40000), ESTIFM(28, 28), GISH(600), INTEG(2700) \$0594 COMMON/UPWIN/ 10525: 1 AA1, AA2, A1, A2, BB1, BB2, B1, B2, DIS(3, 461) 2,WP(8),WDEL(2,8),WB(2,8),DNB(2,72),DWP(72),TT(8) 0596: 3,UU(8),VV(8),UAVE(2),VAVE(2),IUPWIN,IMTS,VKIN,VKON -0597: 0598:0 8599: NBN=80600: NCN=20

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FET	HSOLVA	C (CONT.)
		· · ·
0601	:	NDF=3
0602	:	IF (MHRK. NE. 3) GU TU 71
0603	• •	NUN=28
0604		
0605	: 71	CUNTINUE DEORGNOD ADDANND
0606	•	KERUKNUKI 1027NNF HOTTERNUD DOGENNDD
0607	•	- MRIIELNEFJ2007NNF - 60 70 1-4 NU
00000	. 75	NO FO I-1340 MDE/I)=NDE-1
0007	. re	MRITECNIE, 202)NCN
0610		IF(NNP. EQ. 0)GO TO 72
A612	•	WRITE(NLP, 267)
0613	: C	
0614	· C+++++	*********
0615	· C	READ IN ELEMENT DATA
0616	: C****	******
0617	: C	
0618		DO 16 L=1, NNP
0619		REHD(NUR)103)N;(UURD(N;M);M=1;2)
0620	: 16	CUNTINUE
4621	•	- MR11E(NLF)2047 10500/NCD-400NNF
0622	• • •	REFUNNUES 1027AE BRITEZMER, DARNE
8023		METTERNIE, 22d V
0225		DD 10 1=1.NF
೮೦೭೨ ವರ್ಷದ	•	$\frac{1}{N} \frac{1}{N} \frac{1}$
10020 10627	•	PEAD(NCR.106) N. (NDP(N.M).M=1.NBN)
0021	•	WRITE(NLP, 106)N, (NDP(N, M), M=1, NBN)
0620	10	CONTINUE
A630		GU TU 78
0631	: C	
0632	· C****	***************************************
0633	: C	CALCULATE NODAL DATA FOR A AUTOGENERATING REGULAR MESH.
8624	· C++++	************
0635	:C	na na ku na
0626	: 72	CUNTINUE
0637	•	REHU(NUR)102/18ESH Arcibecu co an co to 77
0638		- 18419238.20.20.00.10.77 - 5500/NFR 400/NEDUC NEDUC
1037. acto		REHUKNURI 1927ARUNDI NUULD Betternie, geenhonie, monie
8040. 11233	•	EFANINER, 114 YAX, AV
0071. DIII:		MRITECNI P. 268)DX. DV
1647		NU=3+NROWS+2
8644	•	NE=NRQWS*NCOLS
0645	•	DO 76 I=1, NROWS
0646		DO 76 J=1, NCOLS
0647.	•	N=NROWS*(J-1)+I
0648.	•	NDN(N)=8
0619	•	NOP(N, 1) = (J-1) * NU + 2 * I - 1
0650.	•	NOP(N,2)=J*NU+I-NROWS-1

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#### FETHSOLVAC (CONT.)

NOP(N, 3)=J\*NU+2\*I-1 0651: NOP(N,4)=J\*NU+2\*I 0652: NOP(N, 5)=J\*NU+2\*I+1 0653: NOP(N, 6)=J\*NU+I-NROWS 0654 NOP(N,7)=(J-1)\*NU+2\*I+1-0655: NOF(N, 8)=(J-1)\*NU+2\*I 0656. CORD(NOF(N,1),1)=(J-1)\*DX **0657**; CORD(NOP(N, 3), 1)=J\*DX 0658 CORD(NOP(N, 5), 1)=J\*DX 0659 CORD(NOP(N,7),1)=(J-1)\*DX 9669: CORD(NOP(N, 1), 2)=(I-1)\*DY 0661: CORD(NOP(N, 3), 2)=(I-1)\*DY 0662: CORD(NOP(N, 5), 2)=I\*DY 0663: CORD(NOP(N,7),2)=I\*DY 0664:76 CONTINUE 0665: WRITE(NLF, 224) 8666 0667. WRITE(NLP,106) (N, (NOP(N,M),M=1,NBN),N=1,NE) GO TO 78 0668: 77 CALL ELGEN 0669: GO TO 94 0670: 0671.0 8672 : C\* 0673:C GENERATE MIDSIDE NODES Ø674 : C\* 0675 C 0676: 78 CONTINUE D0 54 N=1, NE 0677: J=NDN(N)-1 0678. 00 54 K=1, J, 2 0679: 54 MDF(NOP(N,K))=NDF 0680: 00 68 N=1,NE 0631: JDN=NON(N) 0682: DO 65 I=2, JDN, 2 0683: NN=NOP(N,I) 8684. L=I+10685: IF(I.EQ.NBN) L=1 0636: DO 63 J=1,2 0687: IF(CORD(NN, J), NE. 0. 0) GO TO 63 0688: CORD(NN, J)=(CORD(NOP(N, I-1), J)+CORD(NGP(N, L), J))/2. 0639 -63 CONTINUE 0690: 65 CONTINUE ·8691 : 0692: 68 CONTINUE 0693: 94 CONTINUE 102 FORMAT(215) 0694: FORMAT(110,2F15.10) -8695: 103 106 FORMAT( 218,715) 0656. 0697: 114 FORMAT(4F20,10) -202 FORMAT(5H NCN=, I3) 1 0698: 206 FORMAT(5H NNP=,I3) --0699: 208 FORMAT(4H NE=, 13) 0700:

FETHSOLVAC (CONT.)	1         224         FORMATY//23H         RESOLUTE NODE KUNGEFNED IN MODEL DETA//29H         DETA//20H         DETA//23H         DET
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シナチ . \*\* • 法法 ¥ 4 ÷ ÷ arear are Rehoven INT X. Y COORDINGTED OF MHGTED NODED. . ÷ 大子弟子子子子子子子子子子子子子子 . + \$ \*\*\*\*\*\*\*\*\*\*\*\*\* €. オデチティ 11.11 ÷ \* 4 F 4 INEL. 4.4 ナチジ . LINES \*\*\*\*\*\* ÷ チチチ . 1 CONS ÷ ¥ **BND JR** \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* ¥ ÷ 5 3 \* \* \* 3. 15 "一十十九二十二 INE \* \* \* -1 SEQUENCIAL A DIRECTION. DIRECTON. 66 BLONG 0. -1. . 0. 0. チチテチチ チチキキ RATED NODE. A LIST OF NODE NUMBERS OF 0. 1. \*\*\*\*\*\* ~i 1 1.54 NUMBERED 1.4 \*\*\*\*\*\*\*\*\*\* \*\*\*\*\* ŝ ETA C ×--} NUMBERING લે લે લે નં -. GENES 大学大学学学学学学学学学学学学学学学学学学学学学学学 \*\* Υ. નંજે · 其其其其其不不不不不不不不不不不不不不不不不不不不不不不不不不 READ(5,1002)XH(I),YH(I) WRITE(9,1003)I,XH(I),YH(I) 5 CONTINUE 11=0 NSF1=2\*NYL+1 NSF1=2\*NYL+1 PO 50 I=1,NSF1 DRTR XX/-1.0.0.0.0.1.0.1.0.1.0.1. DRTR 99/-1.0.-1.0.-1.0.0.0.0. 1 ~ EACH ۰. .0+2.0\*(I-1)/(2\*NYL +1 IN NI READ/FRINT CONTROL DATA NXL= NO. OF ELEMENTS IN NYL= NO. OF ELEMENTS IN NN=FIRST NODE NUMBER. ND= DIRECTION PAPAMETER IF ND=1 THEN ELEMENTS A CONSTANT ZETA. IF ND=0 THE SEQUENTIAL SEQUENTIAL 6. 1 × \* 11 12 ·宋清书子书书书书书书书书书书书书书书书书书书书 4 LL 7 KL 7 KL 1-4 COURDINATES F-4 \*-1 \* 151 1 ίι, \* \* bing bing 1. NSF2 SEEESESEEEE ETH COORDINAT NS(I)=NN IF(II.EQ.3) NSF2=2\*NXL+1 PO 45 J=1,NS (CONT. 大学学生大学学 4"L=-1. I I=I I ZETA N57 \*\*\*\* 53 FETHSOL VAC 4 \*\*\* \* \* \*\*\* In, \*\* オオチチ ÷ チチチ ÷. ≯ 000 -チチ ≆ ÷. 乀 ر ا ۍ ا N.S. ن C ; C ;  $\odot$ いいい <u>ر ۱</u> <u>ر</u> ، ۲.,  $\odot$  $\mathcal{M}$ M 

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FETHSOLVAC (CONT.)	8301: XL=1.0-2.0*(J-1)/(2*NXL) 0802: DO 25 IJ=1.8 0804:C************************************	0506 C Emult dentemieu noue. 0307 C************************************	0511: 11.0) 0512: 15 5HP(1J)=0.5*(1.0+XL*XX(1J))*(1.0-YL*YL) 0513: 20 5HP(1J)=0.5*(1.0+YL*XX(1J))*(1.0-XL*XL) 0514: 00 TO 25 0515: 20 5HP(1J)=0.5*(1.0+YL*YY(JJ))*(1.0-XL*XL) 0515: 20 5HP(1J)=0.5*(1.0+YL*YY(JJ))*(1.0-XL*XL)	0817-10 0819-10 - CALOULATE THE X.Y COORDINATES OF EACH NOOE FROM: 0819-10 - CALOULATE THE X.Y COORDINATES OF EACH NOOE FROM: 0820-10 - COLUMN VECTOR (N)=CUMULATIVE [N(I)>CNH(I)] FOR I=1.3. 0821-10 - COLUMN VECTOR (Y)=SUM OF [N(I)>KCNH(I)] FOR I=1.3. 0822-10 - COLUMN VECTOR (Y)=SUM OF [N(I)>KCNH(I)] FOR I=1.3. 0822-10 - COLUMN VECTOR (Y)=SUM OF [N(I)>KCNH(I)] FOR I=1.3.	0823:C 0824: XXX=0.0 0825: YYY=0.0 00.30 K=1.8 XXX=XXX+5HP(K) + XM(K) 0823: 30 CONTINUE 0823: 30 CONTINUE 0823: 30 CONTINUE	0622 08321 08322 45 CONTINUE 08335 45 CONTINUE 08355 45 CONTINUE 08355 45 CONTINUE 08356 455N00=NN-1 08356 455N00=NN-1 08356 455N00=NN-1 08356 455N00=NN-1	3838、C 3839、C ····································	3843. DO 60 NIC=NSS, HAXNOP 3844. URITE(9, 1020)NIC, XFT(NIC), YFT(NIC) 3845. NEL=1 3847.C 3847.C 3847.C 3849.C MEL-THE INCREMENT IN THE ELEMENT AND ALL AND ALL ALTHOUSENT AND ALL DIRECTION. 3849.C.
	00000	n N N	8 C C C C C C C C C C C C C C C C C C C	ସୁସ୍ପୁର୍ଦ୍ନି <b>ନ</b>	5555555 •		<i></i>	

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	FETH	ISOLVÁC	CONT. 2
	0851. 0853. 0854: 0854: 0855. 0856. 0856.	<i>с</i> с	MEL=NYL IF(ND. EQ. 0) MEL=1 DO 130 I=1,NYL IF(ND. EQ. 1) NEL=I NSS=(I-1)*2+1
)	0858. 0859: 0850. 0850. 0850. 0852.	- 04 ***** - 0 - 0 - 0. ***	NOCE NUMBERS ALONG EDGE ZETA=-1 FOR USE IN GEVERATING THE FIRST ELEMENT CEFINETION OF A POW OF ELEMENTS IN THE ZETA DIRECTION. ************************************
5			N1=NE(NEE) NE=NE(NEE+1) NE=NE(NEE+1) DR-14R-T+1, NNL 14-144-00000000000000000000000000000000
والمحافظة والمحافظة والمحافظة والمحافظ والمحافظة والمح	9555 9555 9579, 9572, 9572,	2	NGDE NUMBERS OF ELEMENTS ALONG A FON OF ELEMENTS IN THE ZETA OSING THE SECUENTISL NUMBERING OF THE NODES. The security of the states of the states to the states of the states and the states are states and the states of the sta
	0973: 0974 0875: 0875: 0875: 0875: 0875: 0875: 0880. 0880.		NGF(NEL)3/=N3-1+(J-1)*2 NGF(NEL)5)=N3-1+(J-1)*2 NGF(NEL)5)=N2+1+(J-1)*2 NGF(NEL)7)=N1+2+(J-1)*2 NGF(NEL)5)=N1+1+(J-1)*2 NGF(NEL)1)=N1 +(J-1)*2 NGF(NEL)2)=N2 +(J-1) NEL=NEL+MEL
-Spanner -	0822: 0883: 0884: 0885: 0886: 0886: 0887: 0888:	170	CONTINUE MAXNEL=NXL*NYL WRITE(9,1013) DO 170 NEL=1,MAXNEL WRITE(9,1010)NEL,(NOP(NEL,I),I=1,8) CONTINUE
and the first of the second state of the secon	0889: 0890: 0891 0892	1000 1001 1002	FORMAT(4110) FORMAT(1H1,4X,'NUMBER OF DIVISIONS IN LOCAL X DIRECTION=',IS,//,5X ,'NUMBER OF DIVISIONS IN LOCAL Y DIRECTION=',IS,//,5X,'FIRST NODE NUMBER=',IS,//,5X,'DIRECTION PARAMETER=',IS) FORMAT(2510 3)
5	9854 9854 9855 9856 9856	1003 1010 1013	FORMAT(1%, IS, 4F10, 3) FORMAT(10%, IS, 3%, (NOP=(+8IS) FORMAT(//////, 5%, (MASTER NODAL CO-ORDINATES(+//+ 2%, (NODE(+9%, 1H%, 9%, 1HY)
	0828 0829 0900	· 1014 : 1015	FORMAT(222222, 5%, "NOUHL CO-ORDINATES", 22, 7%, "NODE", 9%, 1H%, 9%, 1HY) FORMAT(22222, 5%, "ELEMENT DEFINITIONS")

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FET	HSOLVAC (CONT.)
3	
, DCD1	· 1929 FORMAT(6%, 15, 2F10, 3)
0902	DO 1022 INH=1, NH
0903	CORD(INH, 1) #KFT(INH)
0504	· CORD(INH, 2)=YPT(INH)
- 8985	: 1022 CUNTINGE
- <u>8</u> 986 - 0007	ј — — — — — — — — — — — — — — — — — — —
<i>ଅଟେଏ।</i> • ଜଣଜନ	
2 0909	
0919	
0911	$: \mathcal{C}$
0912	: Q
0912	
0514	
0916	· · · · · · · · · · · · · · · · · · ·
0917	SUBROUTINE WRITELF
0918	• ①米辛苦苦苦辛苦辛苦辛苦辛辛辛辛辛辛辛辛辛
0913	
0220	· Corrent and the control of the con
- 8922 	, Norman and and and and and and and and and a
0722 1907	
0922 6924	IMPLICIT DOUBLE PRECISION (A-H, 0-Z)
0925	COMMON/CONTF/
0525	1 X, Y, V, CONDE, BETA, CPE, RHG, HCOEX, HCOEY,
0927	2 GPF, GPG, GPH, ENU, XG(3), C3(3), DS, DX, DY,
0928	; J. NP, NH, NE, NE, NDF, NUN, NEN, ITL, NV1, UTKV 
9585 10000	- 4, NTIME, MAENINIFICIIMIMIRIIINURUDINDINDINOI - Mot Mara And Meit, Ntda, Nrahfe, Nrd, Nrd, Nrd, Nr
- <u>199</u> 29 - 1997 - 19	,
9714 3077	COMMON/GEF/
0933	1 TEMP(461), CORD(461, 2), RSPEC(461, 6)
0034	2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553)
0935	3, VALV(560), AVARI(1553), NOP(122, 8), NDN(122), LFR(124)
0956	4, NOPP(461), MDF(461), NCOD(1553), NUDV(560)
0537	COMMUN/BUHRD/ Commun/Buhrd/ contempo con riew/saan inter(2700)
1938	<u>1                                    </u>
- 8727 - ACAR	
09-0	2, MP(8), WDEL(2, 8), WE(2, 8), DMB(2, 72), DWP(72), TT(8)
้อุ่วะริ	3, UU(8), VV(8), URVE(2), VAVE(2), IUPMIN, IWTS, VKIN, VKON
0017	IF (MAFK. NE. 3) WRITE(NLF, 501)
بدكتون	, IF(MARK.EQ.3) WRITE(NLP,500)
19925	00 10 L=1/NH TRE-MRE/1/
0017	: IDE-NDEKLY : JENNER(1)-1
9241 9675	IF(IDF, LT, NDF)G0 T0 5
00.13	IF (NDF. EQ. 2) GO TO 8
A950	WRITE(NLP, 505)L, (VARI(J+I), I=1, IDF)

D

Fethsolvac (CONT.) þ 0951 . GO TO 15 IF(IDF.EQ.1)G0 TO 10 0952 5 9953. WRITE(NLP, 510)L, (VARI(J+I), I=1, IDF) 8 9954 GO TO 15 10 WRITE(NLP, 515)L, VARI(J+1) 0955. 0955 15 CONTINUE 0957 500 FORMAT(/5H NODE, 4%, 11H U-VELOCITY, 8%, 10H PRESSURES, 7%, 11H V-VELOCI 0953 1TY, 6X, 12H TEMPERATURE/) 0959; 501 FORMAT(/5H NODE,4X,11H U-VELOCITY,8X,10H PRESSURES,7X,11H V-VELOCI : TY, Z> 0960 565 FORMAT(15,6E18,10) 0961 510 FORMAT(I5,E18.10,18X,2E18.10) 0962 515 FOPMAT(IS, 18%, E18, 10) 0963) 0964 RETURN END 8955. Ree I 90967 : C <u>aces</u> ÷Ľ 0049.0 0970:0 0971:0 0972:0 0977 ODD4; C\* 0975. SUBROUTINE DATAK 3097E Graakkaakkakkakkakkakk 0977:0 0978. IMFLICIT DOUBLE FRECISION (A-H,O-Z) gera COMMON/CONTR/ 1. Х, Ч, У, СОЛОР, ВЕТА, СРР, ЯНО, НСОРХ, НСОРУ, ର୍ଚ୍ଚରେ : GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 9991 NP, NH, NE, NS, NPF, NCN, NBN, IT1, ND1, MTRD 0932 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI 0983 5, NRT, MWGA, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP 8994 · 6, NCORD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND 09955 0995 COMMON/GEP/ 0987 1 TEMP(461),CORD(461,2),RSPEC(461,6) 2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) ACCE: 2, VALV(560), AVARI(1553), NOP(122, 8), NDN(122), LPR(122) 0989: 4, NOFP(461), MDF(461), NCOD(1553), NODV(560) 0000 0991 COMMON/GUAFD/ 1 SK(40000),ESTIFM(28,28),GISH(500),INTEG(2700) 0992 0993 COMMON/UPWIN/ Deed 1 AF1, AF2, F1, A2, 881, 682, 81, 82, DIS(3, 461) **)**8595 2,WF(8),HDEL(2,8),WB(2,8),DWB(2,72),DWP(72),TT(8) 0996 3,UU(8),VV(8),UAVE(2),VAVE(2),IUPWIN,IWT5,VKIN,VKON 0597.C 0999:0 BOUNDARY CONDITIONS 1000:C\*

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	FETHEOL	VAC	(CONT.)
P			
	1001:0		
	1002.		DO 5 I=1, NF
-	1903.		NCOD(I)=0
- (Sababa)	1004.		BC(I)=0
· ·	1005:	5	CONTINUE
	1085.		READ(NCR, 122) NB
	1007.		WRITE(NLP, 116)NB
3	1005:		NEV=NB
	1009		DO 25 I=1,NB
	1010:		READ(NCR, 124)NUD; MUEG; VAL
	1011:		MDFF=MDF(NUD) Arthopist FD FD ANNOITE(NER 198)
•	1012		IF(A00)(1,5),EV,U/WRITE(NLF)400/
ι.	1013:	-	80 10 (8,10,12,14) MVCC Votectil D. 2003408 VAL
•	1014	8	<u>MR1/E(MLF)2007MVV/7NC</u> 
	1015.		- GU 10 24 Votternu o dalkon Vel
	1015	19	<u>MR1/E(MLF)210/MOU)/NL</u> 
Ð	1017:		- 60 - 10 - 24 - Hotternia - 242 MAD, VAL
	1018	12	METTERNER) ZIZZNOWY YNL 188 TO Od
	1017:		UDITERMIR, SAANNAD, VAL
	1424	14	SARIECHE JEIFINES JIE BARTINIE
	18227	£ 14	TELMDEE ED NOEYGD TO 21
	1022		IF (HDFR BT DYMDER=HDER-1
ì '	1622	•7.4	INTINIE MANTINIE
•	1024	بلد شده	NARF=NAPP(NAD)+MDEG-1
÷.	1923.		NORVETSENODE
D.	1928. 4097 -		VALVET)=VAL
	1821 -		NCGO/NODE)=1
	1020. 1070 -		EC(NODE)=VAL
	1522	25	PONTINUE
	1071	8 m **	60 TO 30
•	1072	28	CONTINUE
1	10-2-		DO 29 I=1, NBV
	1073		NOD=NODV(I)
6	1075		NCOD(NOO)=1
Ð	1076		BC(NOD)=VALV(I)
	10-7	29	CONTINUE
	1078	30	CONTINUE
	1075		00 32 I=1, NP
à	1040		IF(NCOD(I), EQ, 0)60°70°32
	1041		VARI(I)=BC(I)
	1842:	32	CONTINUE
i.	10-5		DD 44 I=1,NP
5	1044	격격	VAEA(I)=VARI(I)
Y	1945.	48	CONTINUE
	1947 1	116	FORMAT
	1047:	-	I(/IS) – 20H EUUNDHRY CUNDITIUNS//SH NUDE:
	1048:	. <b>.</b>	
	10-9:	,	K (68) 38 U.U.F. Z . CV 04 9.0 E 3
1	1050:	,	K JONJUH U. U. F. S

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al Louise (CONT.) FETHSOLVAC 1 1051: \* > 6X; 9H D. O. F. 4> 122 FORMAT (15) 1052 124 FORMAT(215, F20, 10) 1053. 208 FORMAT(15, E15, 7) 1054: 210 FORMAT(IS-15X, E15. 7) 1055: 212 FORMAT(I5,30X,E15.7) 1056 FORMAT(15,45%,E15.7) 214 1057 -FORMAT(1%,68(1H-)) 400 3 1058: RETURN 1059: END 1860: 1061 · C 1062 C 1 1053:0 1064;01865:0 1066:0 Þ 1067.C 1068: 1969 : Carreranneranneranneranneranne SUBROUTINE VARCALC 1070: 1972 C 1973 IMPLICIT DOUBLE PRECISION (A-H,O-Z) COMMON/CONTR/ 1074: 1 X, Y, Y, CONDF, SETA, CPF, RHO, HCGFX, HCGFY, 1075 2 GPF; GPG; GPH; EMU; XG(3); CG(3); OS; DX; DY; 1076; Ø 3 NP; NH; NE; NB; NOF; NCN; NBN; IT1; ND1; MTRD 1077 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI 10785, NRT, MUGA, NNR- NELL, NTRA, NGAUSS, NRR, NCR, NLP, NCR 1079. 5, NCORD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND 1989: COMMON/GEP/ 1081: TEMP(461), CORD(461, 2), RSPEC(461, 6) 1982: 2,R1(1553),R2(1553),VARI(1553),VARA(1553),BC(1553) 1083: 3, VALY(560), AVARI(1553), NOP(122, 8), NON(122), LFR(122) 1984 -4, NOPP(461), MDF(461), NCOD(1553), NODV(560) 51085: 1086. COMMON/GURED/ 1 5K(40000),ESTIFM(28,28),GISH(600),INTEG(2700) 1087COMMON/UFWIN/ 1088: 1089. 2,WP(8),WDEL(2,8),WB(2,8),DWB(2,72),DWP(72),TT(8) 1090: 3,UU(8),VV(8),UBVE(2),VAVE(2),IUPWIN,IWTS,VKIN,VKON 1091: COMMON/TLSKIN1/ TLS(461), EKE(461), TRMU(461), ITERNAN 1092 COMMON/TLSKIN2/ TRCOND(461) 1993 01094 COMMON/ITESTO/UPVBC(1553),NCODV(1553),TBC(1553),NCODT(1553) 1095 0 1097:0 SET UP AND SOLVE EQUATIONS JOOG:C+安安安安安安安安安安安安安安安安安安安安安安安安安安安安安安安 1099:C 1100:C

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Reason and the (CONT.) FETHSOLVAC Þ 1101: ERA=0. 100 1102 -5 CONTINUE RMAX=0.0D0 1103: ITERNAN=0 1104 DO 10 I=1, NP 1105. F2(I)=0.110E: R1(I)=0. 1107: 9 **10 CONTINUE** 1108: IF(MARK. LT. 4. OR. NTR. EQ. 1) GO TO 12 1109: 00 11 I=1 NP 1110: EC(I)=UPVBC(I) 1111. NCOD(I)=NCODV(I) 1112: 11 CONTINUE 1113: 12 CONTINUE 1114: 1115:0 CALCULATE ANY GRADIENT/STRESS BOUNDARY CONDITIONS 1117:0 1119:C DO 25 N=1,NE 1120. IF(LPR(N). EQ. 0)60 TO 25 1121 IF(ITUP2.EQ 0)60 TO 24 1122: CALL EFWISC(N) 1122. CONTINUE 1124: 21 CALL PRESCR 1125 25 CONTINUE **D** 1125 DO 35 I=1, NP 1127: R1(I)=R2(I) 1128 : 1129. 35 CONTINUE CALL TIMER(IT) 1130: ITIME=IT-ITI 1131: WRITE(NLP,214)ITIME 1132: IF(MARK.LT.4.OR.NTR.GT.1) GO TO 290 1133. DO 28 N=1, NP 1134. UFVBC(N)=BC(N) 1135: 9 NCODV(N)=NCOD(N) 112E 28 CONTINUE 1137: 290 CONTINUE 1138: 1139.0 CALL ASSEMBLY/SOLUTION ROUTINE 1141:0 王王姓区,它来来又在来水水水水水水水水水水水水水水水水水水水水水水水 1113:0 11.44 CALL FRONT NTRA=0 1145: CALL TIMER(IT) 1146: ITIME=IT-IT1 1147: WRITE(NLP)216)ITIME 1148: 1149.0 1150: C\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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FETHSOLVAC (CONT.)

TEMPCAL (RMAX, ERA. 0.01 DISC OUTPUT FOR CONTINUING CALCULATION ON RESTART RELAXED 33 D0 52 T=1.IDF N=J+1-1 F(RES(5K(N)).LT.0.ID-05)60 T0 52 F(RES(5K(N)).LT.0.ID-05)60 T0 52 F(RES(5K(N)).SK(N))? F(RE.61.RHRX)RMAX=HR F(RE.61.RHRX)RMAX=HR F(RE.61.RHRX)RMAX=HR F(RE.61.RHRX)RMAX=HR CONTINUE ELAFCT=0.500 & D0 15 N=1.NF D0 15 N=1.NF AVARI(N)=F(N)+(1-RLXFCT)\*VARI(N) RELEATED D0 27 N=1.NF D0 15 N=1.NF D0 27 N=1.NF D1 TIME2=174-T1 URTE(NLF, 154)NTR, ITTHE3 0= 0LD CONTINUE D1 TIME2=174-T11 URTE(NLF, 154)NTR, ITTHE3 0= 0LD CONTINUE D1 TIME2=174-T11 URTE(NLF, 154)NTR, ITTHE3 0= 0LD D1 25 N=1.NF D1 16(NFR, 0E.4) CHLL TENFCAL (RMAX, ERA) TERNAM=1 TERNAM=1 TENTER 0F 4. CHLL TENFCAL (RMAX, ERA) D1 0 02 D1 0 32 D1 0 32 D0 00 20 D1 0 32 D0 00 00 20 D1 0 32 D0 00 00 20 D1 0 32 D0 00 00 00 D1 0 32 D0 00 00 00 D1 0 32 D0 00 00 D1 0 32 D0 00 00 D1 0 32 D0 00 00 D1 0 20 D1 0 00 D1 00 ) \* \* \* \* ( ともと - old related Ð ÐE 00 N b 5-<del>0</del>2 IF (ITIME3, LT, LTIM) GO TO IF (MTRIT, EQ. 0) GO TO 79 WRITE(2) 1 NP, NTR, (VARI(1), I=1, NP) 3 CONTINUE 9 CONTINUE 00 45 N=1, NP VARI(N)=AVARI(N) 7 M 10  $\sim$ S 

 1151
 CONVERGENCE TEST

 1155
 DD 55 JN=1.NH

 1155
 JF(IDF ED. 1)GO TO 5

 1156
 JF(IDF ED. 1)GO TO 5

 1157
 JF(IDF ED. 1)GO TO 5

 1157
 JF(IDF ED. 1)GO TO 5

 1156
 JF(IDF ED. 1)GO TO 5

 1157
 JF(IDF ED. 1)GO TO 5

 1156
 JF(IDF ED. 1)GO TO 5

 1157
 JF(IDF ED. 1)GO TO 5

 1156
 JF(IDF ED. 1)GO TO 5

 1157
 JF(IDF ED. 1)GO TO 5

 1157
 JF(IDF ED. 1)GO TO 5

 1158
 JF(IDF ED. 1)GO TO 5

 1 5

### FETHSOLVAC (CONT. >

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1201		IF(I)1015.06.L1101/00 10 070 IF(I00010 07 0 000 0000 07 55000000 055000
1202		IF (IUFWIN, GI. & HND RMHX, GI. ERHJCHLL DERIY
1283		IF (KNHX, GE, ERH) GU TU S
1284	•	IF (MHFK, NE, S)GU TU 40 DEAD (NAD, IAI)NUCAE
1205		REHD(NUR)1017NHEH (*
1206	•	WEITE(NLP)102)NHEHT
1207	•	IF (NHEHT, EU, U)UU TU 40
1208		WEITE(NLP) 103)
1209		DU 2 1=1, NHEHT
1210		REHD(NUR, 101)NELL, NSID
1211	_	WRITE(NLF-104)NELL,NSID
1212	: 2	CHLL HEUEF
1213	· ·	STUP
1214	- 40	CONTINUE
1215	: C	
1216	: C****	***************************************
1217	:C 01	JPUT RESULTS FOR FLOTTING, EXTRAPOLATING,
1218	:C 01	R TO_USE THEM AS INITIAL CONDITION VALUES
1219	С.,	LETC.
1220	: 疗法安全的	***********
1221	٠Ĉ	
1222	:	IF(NCPPOS.EN.0) GO TO 50
1223	•	DO 42 I=1, NH -
1224	•	IDF=MDF(I)
1225	•	00 42 K=1, IDF
1225	•	J=NOPP(I)+K-1
1227	•	KK=K
1228	•	IF(MARK EQ. 3. AND. IDF. EQ. 3. AND. K. EQ. 2) KK=3
1229		IF (MARK, EQ. 3. AND, IDF, EQ. 3. AND, K. EQ. 3) KK=4
1230		IF (MFRK. NE. 3. AND. IDF. EQ. 2. AND. K. EQ. 2) KK=3
1231	•	MRITE(NCP, 118)I, KK, VARI(J)
1232	. 42	CONTINUE
1233	: 50	UUNTINUE
1234	•	IF(ITUR8.E0.0) GO TO 570
1235	• •	NRITE(NLP, 520)
1236	•	NFITE(NLP, 519)(TLS(K), K=1, NH)
1237	• •	WRITE(NLP: 54U)
1238	•	WFITE(NLP, 530)(EKE(K), K=1, NH)
1229	•	WRITE(NLP, 550)
1240	:	WRITE(NLP·530)(TRMU(K),K=1,NH)
12-1	•	WF11E(NLF)560)
1242		WFITE(NLP,530)(TRCOND(K),K=1,NH)
1243	: 520	FORMAT(1H , 'LENGTH SCALE DISTRIBUTION')
1211	: 530	FORMAT(30X, E15. 7)
1245	: 540	FURMHI(1H) /KINETIC ENERGY DISTRIBUTION')
1245	: 550	FURMHI(1H / TUREULENT VISCOSITY DISTRIBUTION')
1247	: 560	FURMATCAR > TURBULENT CUNDUCTIVITY DISTRIBUTION() -
1248	: 570	CONTINUE
1240	•	IF(RMHX.GT.ERH) GU TO 98
1250	• •	80 10 99

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FETHSOLVAC (CONT.) 1251: 98 WRITE(NLP,208) 1252: STOP 99 CONTINUE 1253: 1254.0 CALCULATE STREAM FUNCTION AND VORTICITY 1256.0VALUES FROM KNOWN VELOCITY FIELD-USING 1257:0 THE (F.E.M.) 1258:C 3 ¢ ه و در د 1260:C READ(5, \*)IPSW 1261 : WRITE(9,106)IPSW 1262: IF(IPSH.EQ.0) GO TO 999 1263 : MARK=6 12-4: - CALL PSICALC 1265: 999 CONTINUE 1266 100 FORMAT(14H ITERATION NO., I3,21H FINISHED AT MILLTIME,I5-6H SECS.) 3 1267. 101 FORMAT(215) 1268: 102 FORMAT(Z7H NHEPT=,I3) 1269. 103 FORMAT(/43H CALCULATIONS OF HEAT TRANSFER COEFFICIENTS/) 1270: 104 FORMAT(//6H NELL=,I3,6H NSID=,I3)  $1271 \cdot$ 106 FOPMAT(1H +6H IPSN=,I3) 1272: 1273: 110 FORMAT(2110,F20.10) FOFMAT(215,F25,20)  $1274 \cdot$ 118 119 FORMAT(I10,E20,10) 1275: **3**1276. 154 FORNAT(15H ITERATION NO. =, [2) 204 FORMAT(7/41H LARGEST RELATIVE CHANGE IN ANY VARIABLE=,E18.10/) 1277: 208 FOPMAT(7/28H SOLUTION NOT VET CONVERGENT//) 1278: 214 FOPMAT(/28H SOLUTION POUTINE ENTERED AT, 15, 6H SECS. //> 1279: 216 FORMAT(/30H EXIT FROM SOLUTION ROUTINE AT, 15,6H SECS. //> 1280. RETURN 1251: END 1282: 1283:C 1284:0 **)**1285 C 1285.0 1287-0 1298:0 1289.01299: 1291: C\* 1292: SUBROUTINE TEMPCAL(RMAX,ERA) 1293. C\* CALCULATE TEMPERATURE FIELD FROM A VELOCITY FIELD. 1295 0 1298 0 1300:0 UNCOUPLING SOLUTION OF FLOW EQUATION FROM TEMPERATURE EQUATION.

LUMINOUT CONT. 2 X.Y. W. CONDF. 2 GF. GFG. GPH. FNU. XG(3). CG(3). D5. DX. DY. 3 NF. NH. NE. NE. NDF. NCN. NEN. IT1. ND1. MTRD 4. NTIME. MARK. NTR. LTIM. WTRTI. NCGRDS. NSTD. NAXI 5. NRL. MARK. NTR. LTIM. WTRTI. NCGRDS. NSTD. NAXI 5. NRL. MARK. NTR. LTIM. WTRTI. NCGRDS. NSTD. NAXI 5. NRL. MARK. NTR. LTIM. WTRTI. NCGRDS. NSTD. NAXI 5. NRL. WARK. NTR. LTIM. NEWTON. ITURB. ICOND 000000/GEP/ 1 TEMP (461). CORD (461, 2). RSPEC (461. 5) 2. R1(1552). P2(1553). VPRI(1553). VPRA(1553). BC(1553) 3. VALV(560). FVARI(1553). NDP(122. 8). NDN(122). LPR(122) 3. VALV(560). FVARI(1553). NDP(122. 8). NDN(122). LPR(122) 4. NDPF (461). NCOD(1553). NDPV(560) 000000/GEP/ 1 SK(48080). ESTIFM(28. 28). GISH(600). INTEG(2700) 1 SK(48080). ESTIFM(28. 28). GISH(600). INTEG(2700) 2. WF(8). WDEL(2. 8). WE(2.8). DMF(2.72). DWP(72). TT(8) 2. WF(8). WDEL(2.8). WAVE(2). IUPHIN. IMTS. VKIN. VKON 00000/TTRSTO/UPVEC(1553). NCODV(1553). TEC(1553). NCODT(1553) 2. UU(8). VV(8). UBVE(2). VHVE(2). IUPHIN. IMTS. VKIN. VKON 00000/TTRSTO/UPVEC(1553). NCODV(1553). TEC(1553). NCODT(1553) Nj T (Н-Н, О PRECISION READ/NCR.122) NE WRITE(NLP.116)NB NBT=NB NBT=NB DO 25 I=1.NE PO 25 I=2.NE READ(NCR.124)NOD.VAL WRITE(NLP.124)NOD.VAL NCOD(NOD)=1 NCOD(NOD)=1 NCODT(NOD)=1 RC(NOD)=VAL TBC(NOD)=VAL TBC(NOD)=VAL TBC(NOD)=VAL TBC(NOD)=VAL 10 10 E 09 IMPLICIT DOUBLE ND1 87.1) NHN -REWIND ND1 IF(NTR. GT. 1 D0 24 I=1, N NCOD(I)=0 NCODT(I)=0 NC(I)=0. R2(I)=0. R2(I)=0. R2(I)=0. (CONT. FETHSOL VAC С1 4 15:10 **CA CA** 5 نہ ا i. D B

	FETHSOL	LVAC	(CONT. )
	1351: 1352: 1353: 1354: 1355: 1356: 1356: 1358: 1358: 1359:	IF D0 NC 270 C0 280 C0 NF NV LG	(MARK. LT. 4. OR. NTR. EQ. 1) GO TO 280 270 N=1;NP OD(N)=NCODT(N) (N)=TBC(N) NTINUE =NP =NP =NDF =NCN
	1360: 1361: 1362: 1363: 1364:C 1365:C* 1366:C 1366:C	NF NC NC ###### SET ######	=nh F=1 N=NEN 'GR=-1 UP AMD SOLVE EQUATIONS ***********
()	1307 .00° 1769 • 0	. <b>I</b>	
	1370: 1370: 1371: 1372: 1372:	CF RE NF DC NC	LL FRONT WIND 10 MITE(NLP)126) MAG N=1,NH MDC(N)=0
•	1274	E.	(N)=0.
Ø	1375: 1376: 1377: 1378: 1379: 1380: 1380:	ТЕ ИР 40 СС СР 11 ИР	MP(N)=5K(N) ITE(NLP,152)N,TEMP(N) NTINUE NLL TIMER(IT) IME=IT-IT1 NTE(NLP,400)ITIME
	1381.0 1782 C*	and the second	********
5	1383:C 1384:C* 1385.C	C1 *****	LCULATIONS OF HEAT TRANSFER COEFFICIENTS ************************************
	1386; 1387; 1388; 1389; 1389;	1) RE 	(RMAX. 8E. ERA) 90 70 3 [AD(NCR, 122)NHEAT MITE(NLP, 123)NHEAT MITE(NLP, 123) MITE(NLP, 125)
•	1301	Di	1 2 I=1, NHEAT
	1392 1393 1394 1395 1395 1395 1397 1397 1397	RI 9 2 Ci 3 Ci 8 1 8 1 8 1 8 1 8 1 8 1 8 1 8 1 8 1 8	AD(NCP,122)NELL,NSID NITE(NLP,127)NELL,NSID NLL HCOEF NTINUE WIND 10 WIND 10 P=NF NF
- rangerar te	1400	NI	IN=LQ

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(CONT.) FETHSOLVAC 9 1401: MWGA=0 116 FORMAT(IS, 32H TEMPERATURE BOUNDARY CONDITIONS) .1402: 122 FORMAT(215) 1403: 2 123 FORMAT(/7H NHEAT=, I3) 1404 125 FORMAT(743H CALCULATIONS OF HEAT TRANSFER COEFFICIENTS/) 1405: 127 FORMAT(7/6H NELL=,I3,6H NSID=,I3) 1406 124 FORMAT(I5, 5%, F20, 10) 1407: 3 1408 126 FORMAT(2,1% NODAL TEMPERATURE VALUES(,2) 152 FORMAT(I5, 6E18, 10) 1409: 204 FORMAT(7746H LARGEST RELATIVE CHANGE IN TEMPERATURE VALUE=, E18.10> 1410: TEMPERATURE CALCULATIONS FINISHED AT () 15, (SECS() 400 FORMAT(\* 1411: RETURN 1412: END 1412: 1414:C 1415:0 1416:0**)**1417:C 1418:C 1419:0 1420:0 1421 : 1422:C\* SUEROUTINE HCOEF 1423. 1424 : C\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 1425:0 91427.0 CALCULATE WALL TEMPERATURE GRADIENTS AT GAUSS POINTS 1429 0 IMPLICIT DOUBLE PRECISION (A-H.O-Z) 1479: COMMON/CONTR/ 1431. 1 X, Y, Y, CONDF, BETA, CPF, RHO, HCOFX, HCOFY. 1432 2 GPF; GPG; GPH; EMU; XG(3); CG(3); DS; DX; DY; 1433: 3 NP; NH; NE; NB; NDF; NCN; NBN; IT1; ND1; MTRD 1434: 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI 1475: 91425 5, NRT, MWGA, NNP, NELL, NTRA, NGRUSS, NPR, NCR, NLP, NCP 6, NCORD, IG, NG, NEY, NET, NEWTON, ITURE, ICOND 1427 COMMON/GEP/ 1438: 1 TEMP(461), CORD(461, 2), RSPEC(461, 6) 1479 2,R1(1553),R2(1553),VARI(1553),VARA(1553),BC(1553) 1440: 3, VALV(560), AVARI(1553), NOP(122, 8), NDN(122), LPR(122) 1441 4, NOPF(461), MDF(461), NCOD(1553), NOOV(560) 1442. COMMON/GUARD/ 1443

1 SK(40000), ESTIFM(28,28), GISH(600), INTEG(2700) COMMON/UFWIN/

1447: 2, WP(8), WDEL(2, 8), WB(2, 8), DWB(2, 72), DWP(72), TT(8)

1448: 3,UU(8),VV(8),UAVE(2),VAVE(2),IUPWIN,IWTS,VKIN,VKON 1449: DIMENSION

1450: 1 P(8), DEL(2,8), B(2,3), CJ(2,2), CJI(2,2)

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# FETHSOLVAC (CONT.)

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1451 :	، د	2, PP(4), BE(2, 4), CB(2, 36), CP(36)
1452		3, DB(2, 72), DP(72), DDA(9)
1453 :		EQUIMALENCE
1454:	1	1 (SK(1), P(1)), (SK(10), DEL(1, 1))
1455	۔ تع	2, (SK(30), B(1,1)), (SK(50), CJ(1,1))
1456:		3, (SK(55),CJI(1,1)),(SK(60),PP(1))
1457:		4, (SK(70),DDA(1)),(SK(80),CB(1,1))
1458:	2 12	5, (SK(160),CP(1)),(SK(200),DB(1,1))
1459:	ć	5, (SK(350),DF(1)),(SK(430),ELX)
1460	7	7, (SK(431), ELY)
1461:0	v	
1462 :		N=NELL
1453		TESTX=0.0
1464		TESTY=0.0
1465		TESTS=0.0
1466		WRITE(NLP.500)N
4467		DO 10 IG=1,NGAUSS
1158		CALL SURFINT
1159		61=0.0
117:7		62=0.0
1171 -		ELX=-ELX
1172		ELY=-ELY
1177-		TECHARK NE. 3) GO TO 15
1171		DO 5 L=1, NEN
17) 4375-		k = TRES(NOP(N, L))
4.472		M4 = NDPP(K) + MDP(K) - 1
1975-		R1=R1+R(1,1)*VAPI(M4)
1977 ለተማወገ		no=no+n/2.1)*VARI/M4)
シャイロン	đ	CONTINUE
1417.	ل	nn TN 25
142 M (	15	00 70 LS 00 20 L=1.NEN
1401. 	اليه عكم	V = IARS(NAP(N, I))
14822) 44872)		$R^{-1}R^{-$
1402 -		11-01-01-0-1-0
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1420) 7.420)	25 75	and the second
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11-11	4.5	MARYEANERIOUUY IDIDIDI Bomtinis
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let Maria in a second	<u></u>	FORMATIVE DATA BEAT FRANCES OBLOVENTIONS ELEMENTIANS $(F_1, F_2, F_3, f_1)$
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1473) 4453	910 -	FUNDON INTEUNOTERT TERTATINES, RELA, REFERENCE Rear For Tectory Ear Form
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 $\sim 10^{-1}$ NO < 0A. 83 TT(8) IN, 983 try G. ũ. N.S. 1 **764 GL** 12: C) 1 1... -•. ે ઘ Ca ui 🗠 T.1 . N N <u>\_\_\_\_</u>64 ٠..... ~ 1. Y ~ 1.22 1. 14 ÷¥ . TH THE ~ ~ H-5 In + - . CS L11 161,6) VARA(1553 2,8),NDV(553 ),NDV(553 IMPLICIT DUGLE FRECISION (A+H.O-Z) COMMONTE/ Z X, Y, Y, CONDF. BETh. CFF. RHO.HCOFK.HCOFY. Z GPF.GPB.GPH.EHU.XGC3).CG(3).DS.DX.DY. S NP.NH.N.N.NDF.NDF.NDN.NBN.TT.NDL.HTRD 5.NPT.HMGA.NNP.NELL.NTRA.NGRUSS.NFP.NGR. 5.NPT.HMGA.NNP.NELL.NTRA.NGRUSS.NFP.NGR. 5.NPT.HMGA.NNP.NELL.NTRA.NGRUSS.NFP.NGR. 5.NPC.COMMON/GEP/ 5.NPT.HGA.NNP.NELL.NTRA.NGRUSS.NFP.NGR. 6.NCOFD.IG.NG.NFY.NELL.NTRA.NGRUSS.NFP.NGR. 7.NCVFD.IG.NG.NFY.NELL.NTRA.NGRUSS.NFP.NGR. 7.NCVFD.IG.NG.NFY.NELL.NTRA.NGRUSS.NFP.NGR. 7.NCVFD.IG.NG.NFL.NTRA.NGRUSS.NFP.NGR. 7.NCVFD.IG.NGF.461.2).RSPEC(461.6) 7.NCVFD.IGEN).RYATI(1553).NGDV(566 7.NCVFD.IGEN).RYATI(1553).NGDV(566 7.NCVFD.NGTAS.NFFIC(1553).NGDV(566 7.NCVFD.NGTAS.NFFIC(1553).NGDV(566 7.NCVFD.NGTAS.NFFIC(1553).NGDV(566 7.NCVFD.NCVFDINN. 7.NCVFD.NGTAS.NFFIC(1553).NGDV(566 7.NCVFD.NCVFDINN.INTURN.INTURN.INTURN. 7.NCVFD.NCFCD.NGF(2).YMPE(2).IUPHIN.INTURN.INTU 1 \* 2 \* -14. E 心证之 ドンウトロロ 10 2 - $\tau_{i,j}$ \* \* \* \* LONDH . ÷. ¥ チチチ · 110月110日 ÷ ÷ \* . ÷ + ÷. 4 4 Q U • ٠ ÷ 10 ÷ of they by ÷. -÷ 6. \* \*\*\* 64 1 5 1 H. \* 15 \* 关于资源资源不会关于关系的资源资源 SUBU - BNILDOUBDS 12 大学学生大学大学 5 1 m NEL • ũĽ: 1 \* 12 + ũ, 10078 10078 1 Tel mit 「日日」 ÷ € ¥ . \* 4 . \*\*\*\* ÷ \* ÷ ٠. \* 5 \* ¥ ¥ いいいいい C. 1  $\odot$ 5.5 • • • • · . • . 

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.... <u>с</u>. 1. - - 1 ..! 11 11. \*\*\* ŧ ÷ 1110071 ÷., ..... ĺΰ 15 \$ CCNN. 5 à lu ۴., US WI T W L . • £ 1.1 11. 1.14 11 ..~ ~ . W .... ... ÷ 3. 10 ٠. . . . ! 1.14 ١. 41.20 ÷. ÷ \* 57 ۴ 3 ...! - \$ - 1 1111 ·· · . 113 3 r+ ; F 4 5 1.1 <u>م</u> . ۇ 学校 心理 ٢ 155 9 10 ★ 1. -4 ÷. • NWY CLANN.  $\sim 10^{-1}$ × + + 1:; 1.1 r.; 5 1.51.5 11 \* C: L1 hili ÷. 14. 唐福 ÷ 6. 6 · 11 EF. 11. 11, 14, 3 14 ÷. 1. 113  $\tau_{11}$ 11111 1 11:11 + if he ÷ 13 . 2<011: + 12 ÷. 4 17 \* ÷ 1. 1 m 4 Ur 4 4 Co 4 1 41 3 . . •16 . ! . 1 . . 1.1 144 ~.1 · \* . . . . . \*. 1 =MP(K)=MP(K)46 F j - 46 -1 \* [1] \* \* 3. \* \* \* ŧ 4. 50\*79\* ÷. s. Lt. + 1.1 D0 60 K=1. NBN H2=P(K) H2=P(K) IF(IUPWIN E0. 2) H NN=IABS(NOP(N, K)) M1=NOPP(NN) M1=M0PP(NN) - JA M1=M2+1 R2(M1)=R2(M1)+H1\*( PURAUN . ONEH . 4 オチャリチャ 121 140 TESTX=0. TESTX=0. TESTX=0. CD 100 10= CD 100 10= CD 100 10= CD 10 **~**. (CONT. 3 See 1 5075 5075 7778 ÷. FETHSOL VAC 后日 6, 6) 11 (1) チチチ . • 7 4 4. 7 ۍ ۲.۱۲.۲۰ 4. 131.3 いいいい 1315 **C**., × . er an web all of a second web all and the second of the last of the last of the last and the last of the last and the last of #\*\*\* £

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FETHEOLVAC (CONT.)

0 R2(M3)=R2(M3)+H1\*G3\*D5 1601: R2(M4)=R2(M4)+H2\*64\*05 1602 -IF(NAXI.EQ.1) R2(M1)=P2(M1)\*62 1603: IF(NAXI.ED.1) R2(M2)=R2(M2)+G2 1504: .IF(NAXI.EQ.1) R2(M4)=R2(M4)\*G2 1605: 60 CONTINUE 1e0e. TESTX=TESTX+DX 1697 TESTY=TESTY+DY **ð** 1608 : 1609 -TESTS=TESTS+05 100 CONTINUE 1610. WRITE(NLP, 500)N. 61, 62, 63, 64 1611: WRITE(NLP, 510) 1612. WFITE(NLP, 520) TESTX, TESTY, TESTS, ELX, ELY 1fil. 1614:5 <u>1515</u> Carebaranaanaanaanaanaanaanaa PRINT RIGHT HAND VECTORS 1616:0 1618:0 WRITE(NLP, 530) 1619 WFITE(NLP, 600) 1829. DO 115 NN=1 NBN 1621: L=IAES(NOP(N, MN)) 1622: IDF=MOF(L) 1822: J=NOPP(L)-1 1624: IF(IDF, LT, NDF)60 TO 105 1625. IF(NDF. E0. 2)60 TO 100 163F WFITE(NLF,605)L,(R2(J+I),I=1,JDF) 1827. 1629 GO TO 115 ÎF(IDF E0.1)90 TO 110 1629 195 138 WRITE (MLP, 510)L, (R2(J+I), I=1, IDF) 1-797 1674 1673 1673 GO TO 115 110 WRITE(NUP, 515)L, R2(J+1) 115 CONTINUE 500 FORMAT(/124 ELEMENT NO., 14, 2%, 9H G-VALUES/4E20. 10) 510 FORMAT(17H INTEGRATION TEST) 01635 1635 1636 520 FORMAT(5E20. 10) 530 FORMATCIN, 18H RIGHT HAND VECTOR/) FOR FORMAT(/5H\_NODE, 4%, 11H\_U-VELOCITY, 8%, 10H\_PRESSURES, 7%, 11H\_V-VELOCI 1978. 1TY, 5X, 12H TEMPERATURE/) 1 505 FORMAT(15, 5518, 10) 1540; 610 FORMAT(15, E18, 10, 18X, 2E18, 10) 1641. 615 FORMAT(15, 18M, E18, 10) 1642: RETURN 1E42: 01-2-1 END 1-45 1535:0 1647:0 1648:0 1619-0 1650 0 ł

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..... 778) V. VKON  $\mathbf{r}_{ij}$ -- "ij 19-14 119 -CL. In it. IMPLICIT DOUGLE PRECISION (A-H, D-Z)
DONMON'CONTP/
X Y, V, CONDT ETA, DPF, RHD, HDDT, HDDT, HTVL
DONMON'CONTP/
S MF: WH: WE. NET, WEW, NEW, TT, MDT, MTRD, NEW
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(CONT.) FETHSOLVAC 1) • GO TO 20 1701: 16 GPG=XG(IG) 1702: GPH=-1. 1703: 20 CONTINUE 1704: IF(IUPMIN. NE. 0) CALL WYSET(NELL) 1705 CALL SFR *170E* CALL DIRECS 1797 **3** 1708 C 1700: C\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* CALCULATE B-MATRIN 1710:0 1711: C\*\*\*\*\*\*\*\*\*\*\*\*\* 1712:0 DETJ = CJ(1,1) \* CJ(2,2) - CJ(1,2) \* CJ(2,1) 1713: IF(DETJ)22,21,22 1714: 21 WRITE(NLP, 215) 1715: STAP 171E 91717 22 CJI(1,1) =CJ(2,2)/DETJ CJI(1,2) =-CJ(1,2) / DETJ 1718: CJI(2,1) ==CJ(2,1) / DETJ 1719 CJI(2,2) = CJ(1,1) / DETJ 172000 23 J=1,2 1721 DD 23 L=1, NBN 1722 B(J,L)=0.1723 DO 23 K=1,2 1724. 23 E(J,L)=E(J,L)+CJI(J,K)\*DEL(K,L) 1725. GO TO (24,28,24,28),NSID 1726: う 24 0%=CJ(2,1)\*CG(IG) 1727 DY=CJ(2,2)\*CG(IG) 1725 GO TO 32 1723 -

28 0X=CJ(1,1)\*CG(IG) 1730; DY=CJ(1,2)\*CG(IG) 1731. 32 CONTINUE 1752) 1733 -

- DS=SORT(DX\*DX+DY\*DY)
- 216 FORMATCZ74H DETJ=O-PROGRAM HALTED IN SURFINT----CHECK MESH DATA AN 1734 : 1735 : 10 COMMON STATEMENTS/> RETURN

1727. 1738:0 1779.0 1749:0 1731 1 1742:0 1717:12

91734-C 91745: 1746 - Crakereneeneeneeneeneeneeneene 1747: SUBROUTINE DIRECS

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4 HAAAN \*\*\*\* -¥ 0 \*\*\*\* Æ **HWN** NOXA £-1 ~ T.J hig ÷ Print. ---<u>¢</u>G 10.00 ÷ VKIN. À 15,52 N N G, NC 99 IMPLICIT DOUBLE PRECISION (A-H, 0-2) CONMON/CONTE/ 2 & Y, Y, CONDE, BETA, CPF, RH0, HCOFX, HCOFY 2 & PF, GPG, GPH, EMU, XG(2), CG(2), DS, DX, DY, 3 NP, NH, NE, NB, NDF, NCN, NEN, IT1, ND1, MTRD 5 NRT, MUGE, NNP, NELL, NTPA, NOAUSS, NSTD, NASY 5 NRT, MUGE, NNP, NELL, NTPA, NOAUSS, NSTD, NASY 6 NCORD, IG, NG, NBV, NBT, NEMTON, ITURE, ICOND 6 NCORD, IG, NG, NBV, NBT, NEMTON, ITURE, ICOND 7 TEMPY 461), CORD (461, 2), RSPEC (461, 6) 2 R1(1552), P2(1553), UPPY 1553), WAPPY 1553), EC(1 3 VALV(560), AVARI (1553), NOPY 1222, 8), NDN/1222), LF 4 TEMPY 461), NDF (461), NCOD (1553), NODY 569) 7 NDPPY 461), NDF (461), NCOD (1552), NDPY 1553), EC(1 3 VALV(560), PY (461), NCOD (1552), NDPY 1553), EC(1 4 TEMPY 461), NDF (461), NCOD (1552), NDPY 1553), EC(1 5 NDPPY 461), NDF (461), NCOD (1552), NDPY 1553), EC(1 5 NDPPY 461), NDF (461), NCOD (1553), NDPY 1553), EC(1 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 1553), EC(1 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 1553), EC(1 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 1553), EC(1 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 153), TT 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 153), TT 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 153), TT 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 153), TT 7 NDPPY 461), NDF (461), NCOD (1553), NDPY 153), TT 7 NDPPY 473), NDP (1)), (SK(10), DF (1), 1)) 7 (SK(10), PC(1)), (SK(10), DF (1), 1)) 7 (SK(10), DDP (1)), (SK(10), DF (1), 1)) 7 (SK(10), DDP (1)), (SK(10), DF (1), 1)) 7 (SK(120), DP (1)), (SK(120), DP (1)), (SK(430), EP (1), 1)) 7 (SK(120), DD (1)), (SK(430), EP (1), 1)) 7 (SK(150), DD (1)), (SK(430), EP (1), 1)) *∽*+0. \*\*\*  $\sim -1$ F -\_\_\_ Q . ÷ --1 ш ÷ -Ч. С ¥ 4 ۍ ۲ 3 님 ÷. \*\* Ŕ チャチナ ц Ш , K)\*COPDCNN, L 1,5 ÷. COSINES 0 4 tre NO NE チリ Ľ, 1100  $\langle \langle \rangle \rangle$ JMFAC  $\hat{\mathbb{Q}}$ ~1 **u**: +  $\gtrsim$ -1 h-4 -5-C. 5 \$ CH CH u ž ۰. ••. -1-1 T • ちしの CUL オチチチ = NEI 0 4 77-CHC \*\*\* 1 ¥ Û) C11 73 \$ ÷. ていい <u>(</u>) Đ. £ Ð Ð D 5

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- 4,NOFF(461),MDF(461),NCOD(1553),NOP(560)
- COMMON/GUARD/ 1 Skiladda) Estiemiod dol ol
  - 1 SK(40000),ESTIFM(28,28),GISH(600),INTEG(2700) COMMON/UFWIN/
  - <u>1</u> AA1, AA2, A1, A2, BR1, BB2, B1, B2, DIS(3, 461)
  - 2, MP(8), MDEL(2,8), MP(2,8), DNB(2,72), DMP(72), TT(8)
- 3,UU(8),VV(8),URVE(2),VAVE(2),IUPWIN,IWTS,VKIN,VKON IF(MAPK.EQ.6)GO TO 3
- 1848: IF(ITUPB.EQ.0)GO TO 3
- 1849: CALL EFVISC(NELL)
- 1850: 3 CONTINUE

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1841:

1842 1943

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1845:

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1847:

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2), TTCS) VKIN, VKON (s) ~ r.j IMPLICIT DOUELE PRECISION (A-H, 0-Z) CONMON/CONTE/ CONMON/CONTE/ EFF. GFG. GPH. EWT. CPF. RH0. HCOFX, HCOFY. 2 GPF. GFG. GPH. EWU. NG(2), CG(3), D5, DX, DY, 2 GPF. GFG. GPH. EWU. NG(2), CG(3), D5, DX, DY, 3 NFT. HUGE, NNP. NELL. NTPAIT. NGPRDS. NSID, NAXI 5, NFT. HUGE, NNP. NELL. NTPAIT. NGPRDS. NSID, NAXI 5, NFT. HUGE, NNP. NELL. NTPAIN. ITURB. ICOND COMMON/GEP/ 6, NCORD, IG. NGV. NBT. NEWTON. ITURB. ICOND COMMON/GEP/ 1 TEMP(461), CORD(461, 2), RSPEC(461, 6) 2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) 3, WHLV(5560), HVRRI(1553), VARI(1553), NODV(556)) 1 TEMP(461), MDF(461), NCOD(1553), NODV(556)) 2, R1(1553), R2(1553), VARI(1553), NODV(556)) 1 TEMP(461), MDF(461), NCOD(1553), NODV(556)) 2, WHLV(5560), HVRRI(1553), VARI(1553), NODV(556)) 1 SK(400000), ESTIFM(28, 28), GISH(600), INTEG(2700) 1 SK(40000), ESTIFM(28, 28), GISH(600), INTEG(2700) 2 MP(2), WV(2), UAVE(2), VAVE(2), IUPUIN, IWTS, VKIN, VK 0 DIMENSION 2, UU(28), VV(29), UAVE(2), VAVE(2), IUPUIN, IWTS, VKIN, VK 0 DIMENSION In Q GL. رتا  $f \sim_1$ 2 60 AND. MARK. NE. 6) 55. 10. 40), MARK KARARARARA DE FUNCTION Karararar ÷. 4 \$ - 3-IF (MMGR. NE. 0. AN GO TO (5. 10. 20. 5 CRLL REFORM1 GO TO 90 CRLL REFORM2 GO TO 90 CRLL REFORM5 CONTINUE CRLL REFORM6 CONTINUE CONTINUE EVP EVP ÷ ŤŤ ÷ 3 5 i S S 40, 90, 4 • ÷ \$ 5 \*\*\* \* \* \* \*\* ÷ Tri-\* 4 いいいいいしいい 1323 CITY COLO 

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÷ ÷ -0.01/27 ¢.i ¥ CUICE  $\sim$ Ţ.j يحر بحر بحر بحر P(8), DEL(2, 8), B(2, 8), CJ(2, 2), CJI
 PP(4), EB(2, 4), CB(2, 36), CP(36)
 DB(2, 72), DP(72), DDA(9)
 S, DB(2, 72), DP(72), DDA(9)
 S, CK(10), P(1)), (SK(10), DEL(1, 1))
 (SK(1), P(1)), (SK(10), DEL(1, 1))
 (SK(20), B(1, 1)), (SK(50), CJ(1, 1))
 (SK(70), DDA(1)), (SK(80), CB(1, 1))
 (SK(160), CP(1)), (SK(200), DB(1, 1))
 (SK(150), DP(1)), (SK(200), DB(1, 1))
 (SK(150), DP(1)), (SK(430), ELX)
 (SK(151), ELY), (SK(430), ELX) ~~~~ +, CULL. <u>~.</u> ----()
()\*CORD(NN.) -5 ł  $\sim$ <u>الت</u> 64 75 ો  $\mathbb{C}_{2}$ с, 00 5 F ... ŝ CO NGRUSS=2 XG(1)=0.77459666921 XG(2)=0.77459666921 XG(2)=0.855555561 CG(2)=0.855555561 CG(2)=0.855555561 CG(2)=0.855555561 CG(2)=0.858888888891 CG(2)=0.858888888891 CG(2)=0.858888888891 CG(2)=0.858888888891 CG(1)=0.858888888891 CGLL WYSET(NELL) CONTINUE CON  $\sim \sim$ 10 01 ÷., •• NELL \* ~ NBN -K=1, NBA 35(NOP(A =0A5 +D5 \_)=0A5 -. C1 C1 \*1 515  $\sim$ CONT. ょう CO II łĮ -1 In the second se 5 12 095000 095000 09500000 ш Q FETHSOL VAC 0, 0) 1, 10 -10 Ċ, . チッチ ÷, ÷ ÷ ÷ ÷. ÷ -いじいいいい  $\omega \omega \omega \omega$ S ن ۲ ~ + + + \*1 \*1 \*1 \*1 \*1 x1 - 1 - 1 - 1 ×1 ×1 P £ £ <u>n</u> 5

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FETHSOLVAC (CONT.)

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1	1951		IF (DETJ)66, 62, 66
	1952	); E2	: WRITE(NLP,505)
	1552	• •	- ARIIE(NLF)JUUINELL - STAP - IVII
	1955	66	CJI(1, 1) = CJ(2, 2)/DETJ
	1956	·	CJI(1,2) =-CJ(1,2) / DETJ
	1957	۲ <u>.</u>	CJI(2,1) = -CJ(2,1) / DETJ
3	1958	•	CJI(2,2) = CJ(1,1) / DETJ
	1959		- DV 68 JF1,2 - DD 29 J -4, NRM
	1959		B(J, L)=0.
	1962	· ·	00 68 K=1,2
	1953	- 68	: B(J,L)=B(J,L)+CJI(J,K)*DEL(K,L)
	1964	:	IF(IUPMIN, EQ. 0)00 TO 59
	1955	•	UU 67 VF1x2 DD 27 I-4 NDM
3	1027		- DO OF L-LJHDA - MRCJ.L)=A
72	1968	• •	D0 67 K=1, 2
	1969	67	<pre>ME(J,L)=MB(J,L)+CJI(J,K)*WDEL(K,L)</pre>
	1970	; 69	CONTINUE
	1971		DA=DE/J*UG(IG)*CG(JG)
	1972	•	DD 77 I-4 NEM
	1212	•	NT=(11-1)*NEN+T
	1975		DP(NJ) = P(I)
	1975	• •	IF(IUPHIN.GT 0)DWP(NJ)=WP(I)
ر	1977	•	00 70 L=1,2
	1978		IF(IUPMIN, GT. 0)DHB(L,NJ)=WB(L,I)
		। ४४ . ७०	-US(C)NUZEO(C)17 - FRANCE
	1001	) / 2 _ P*	
	1982	 : C.****	****
	1983	2	(B) SUPERPARAMETRIC ELEMENT-LINEAR/PARABOLIC
	1004	· 5****	********
2	1005	: C	
~,	1955. Acet	•	nenet Pait Sep
	1000	•	DD - 82 - J = 1 + 2
	1000	•	00 82 L=1, NBN:
	1990	•	B(J,L)=0.
	1991		DO 82 K=1,2
	1992:	82	B(J,L)=B(J,L)+UJI(J,K)*DEL(K,L)
	1992 -	- • •	10 84 1-1) NDN NT=/11-4 \&NRN+T
3	1945	, ,	CP(NJ) = P(I)
	1996		00 83 L=1,2
	1997 :	83	CB(L,NJ)=B(L,I)
	1998:	- 84	CONTINUE
	1900		NENES
	2799 B (	63	Protect 1 1 A C C

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•	FET	HSALVAC (CANT.)
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10	2001 2002	NG=LL*S NGG=LL*4
	2003 2004 2005 2005	.U Comparate the state of the s
19	2007 2008 2009 2010	C WRITE(10) I NELL, NG, LL, ((DE(L, I), L=1, 2), DP(I), I=1, NG), (DDR(L), L=1, LL), NGG 2, ((CE(L, I), L=1, 2), CP(I), I=1, NGG) TEXTUDUTE NE 00 WRITE(0)
	2011 2012 2013 2014 2014	IP(IOPWIN.ME.W) WRITE(8) INELL,NG,LL,((DWB(L,I),L=1,2),DWP(I),I=1,NG) 90 CONTINUE REWIND 10 REWIND 8
闩	2016 2017 2018 2019	: 500 FORMAT(16H ELEMENT NUMBER=,[3) : 505 FORMAT(/74H DETJ=0-PROGRAM HALTED IN DERIVCHECK MESH-DATA AN : 1D COMMON STATEMENTS) : 510 FORMAT(/5H DET=,F10.4,4H LL=,I3) DETURN
(*) (*)	2020, 2022, 2022, 2023, 2024, 2025, 2025, 2025, 2025, 2025, 2027, 2028, 2029, 2029, 2039, 2039,	END END C C C C C C C C C C C C C C C C C C C
2	2022: 2032: 2034 2025: 2026: 2037 2038	C*************************************
3	2039 2040. 2041: 2042: 2042: 2047 2045 2045 2046 2046 2046 2046	C IMPLICIT DOUBLE PRECISION (A-H, O-Z) COMMON/CONTP/ 1 X, Y, V, CONDF, BETA, CPF, RHO, HCOFX, HCOFY, 2 GPF, GPG, GPH, EMU, XG(Z), CG(S), DS, DX, DY, 3 NP, NH, NE, NB, NDF, NCN, NBN, IT1, ND1, MTRD 4, NTIME, MPRK, NTP, LTIM, MTRIT, NCARDS, NSID, NAXI 5, NRT, MWGA, NNP, NELL, NTRA, NGRUSS, NPR, NCR, NLP, NCP 6, NCORD, IG, NG, NEY, NBT, NEWTON, ITUPE, ICOND
	2949 2959.	COMMON/GEP/ 1 TEMP(461),CORD(461,2),RSPEC(461,6)

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# FETHSOLVAC (CONT.)

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	2051	: 2,R1(1553),R2(1553),VARI(1553),VARA(1553),BC(1553)
	2052	: 3. VALV(560), AVARI(1552), NOP(122, 8), NON(122), LPR(122)
	2053	: 4, NOPP(461), MDF(461), NCOD(1553), NODV(560)
	2054	; COMMON/GUPRD/
	2055	: 1 SK(40000)/ESTIF7(28/28)/GISH(600)/INTEG(2700)
	2055	;
	2007	,
B	2008	: ZIMFIGIIMDEL(2)GIIMD(2)GIIDMD(2)YZIIDMFYZIIT(GI 7. HHYSY.WY/SY.HPVF/2Y.WPVF/2Y.THPMIM_IMTE.WYIN.VYAN
	2025	DIMENSION ATTACAS, ATECAS, PCS), RC2, RS
	2000	DIMENSION AA(29, 29), PP(4), BB(2, 4), CB(2, 36), CP(36)
	2962	DIMENSION DB(2,72), DF(72), DDA(9)
	2062	EQUIVALENCE
	2064	<u>1</u> (ESTIFM(1,1)-AA(1,1))
	2065	
	2865	· HNUIFU TRANTO OT ONOMUTERIOOTANTUTONI
刢	2057	·
	2068	·
	<u>とぜつ 7</u> つのでの、	TECTON NE NENDIMER
	2024	$DD \ge J=1, JDN$
	2012.	$HI4\langle J\rangle = 0$
	2073	2  AI2(J) = 0.
	2074	DO 4 I=1, NCN
	2075	00 4 J=1 NCN
to	2075	4  AB(I, J) = 0.
	2977	
	2928	· 1999年来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来来
	2079	1) — REAU IN ELEMENT UNTE ETUM EEKIEHEKHE STUKE Ar rechnisteren en e
	2080	፝ፚ፟፝፝፝፝፝፝፝፝ዀ፞፠፞ቚቝቝቝ፟ቝ፟፟ቝ፟ቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝቝ፟፟፟ዄ፝ዀ፟፝፝፝፝፝ቝ፟፠፟ቚቝ፟፟ዀ፝ዀ፝ዀ፝ዀ፝ዀ፝ዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀዀ
	2001	READ(1A)
	2002	1 N.NG, LL, ((DS(L, I), L=1, 2), DP(I), I=1, NG), (DDA(L), L=1, LL), NGG
	2084	2, ((CE(L, I), L=1, 2), CP(I), I=1, NGG)
	2985	IF(IVFWIN, EQ. 2) PEAD(8)
-	2086-	1 N;NG;LL;{{DNE{L;I};L=1;2};DNP{I};I=1;NG}
	2087 -	00 20 NG=1/1L
	2023	DR=DDR(NG)
	2923	$\frac{DD}{N} = \frac{1}{2} \cdot \frac{DN}{N}$
	2049) 2004 -	0/1/-00//// 0/1/-00////
	2046	UP/TY=DP/NJY
	とピスム ウロロマト	TE(THEWIN EQ 2) WE(T)=DWE(NJ)
-	ខ្លួនធ្ល	$DO = 5 L = 1 \cdot 2$
3	20-7.	WB(L, I) = OB(L, N, I)
	2995	IF(IUPWIN_EQ.2>_WB(L,I>=DWB(L,NJ>
	2097 -	$\in B(L, I) = DB(L, NJ)$
	2958:	S CONTINUE
	2099	$\frac{\partial U}{\partial t} = \frac{1}{1} I M$
	2100.	NJ=(NG-1)*1M+1

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FETHSOLVAC (CONT.)

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2191: $PF(I)=CP(NJ)$ 2192: $D0 \ 9 \ L=1, 2$ 2197: $G \ BB(L, I)=CB(L, NJ)$ 2197: $G \ B=G(L, I)=CB(L, NJ)$ 2197: $G \ = 0$ 2197: $G \ = 0$ 2197: $G \ = 0$ 2199: $G \ = 0$ 2199: $G \ = 0$ 2119: $G \ = 0$ 2119: $G \ = 0$ 2111: $G \ = 0$ 2112: $D \ 12 \ L=1, JDN$ 2115: $H \ = RBS(NDP(N, L))$ 2116: $H \ = NPP(K)$ 2117: $G \ = 0, P(K) \ = 1, HNPP(K)$ 2118: $G \ = 0, P(K) \ = 1, HNPP(K)$ 2119: $G \ = 0, P(K) \ = 1, HNPP(K)$ 2119: $G \ = 0, P(K) \ = 1, HNPP(K)$ 2120: $G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G \ = 0, P(K) \ = 1, HNPP(K) \ = 1, G $				
2192: D0 9 L=1, 2 2197: 9 BB(L, I)=CB(L, NJ) $\frac{\partial M_{1}}{\partial \alpha} + \frac{\partial M_{1}}{\partial \theta}$ 2197: 9 BB(L, I)=CB(L, NJ) $\frac{\partial M_{1}}{\partial \alpha} + \frac{\partial M_{1}}{\partial \theta}$ 2197: 64=0. 2197: 64=0. 2197: 64=0. 2199: 65=0. 2110: 65=0. 2111: 68=0. 2112: D0 12 L=1.JDN 2112: D0 12 L=1.JDN 2113: K=TABSCNP(N, L)) 2114: 41=0PP(K) 2117: 61=61+VHRI(M1)+H4 U.V. 2118: 62=02+D0PD(K, 2)+H4 X,r 2119: G1=61+VHRI(M1)+K4 U.V. 2120: G1=61+VHRI(M1)+K4 U.V. 2121: G2=02+D0PD(K, 2)+H4 X,r 2122: G6=06+VHRI(M1)+K4 V,Vr 2120: G1=61+VHRI(M1)+K4(L) $\partial V/\partial x$ , $\partial VI/\partial Z$ 2121: G5=05+VHRI(M1)+K5(L) $\partial V/\partial x$ , $\partial VI/\partial Z$ 2122: G6=06+VHRI(M1)+K5(2,L) $\partial V/\partial x$ , $\partial VI/\partial Z$ 2123: G7=07+VHRI(M3)+K7(2,L) $\partial V/\partial x$ , $\partial VI/\partial Z$ 2124: G8=08+VHRI(M3)+K7(2,L) $\partial V/\partial x$ , $\partial VI/\partial Z$ 2125: 12 CONTINUE 2126: G7=07+VHRI(M3)+K7(2,L) $\partial V/\partial x$ , $\partial VI/\partial Z$ 2127: IF(NTF E0.1) G1=0.0 2128: G7=07+VHRI(M3)+K7(2,L) $\partial V/\partial x$ , $\partial VI/\partial T$ 2129: IF(NAXI.E0.1)G1=0.0 2129: JF(NAXI.E0.1)G1=0.0 2129: JF(NAXI.E0.1)G1=0.0 2129: C 2129: C 2129: C 2129: C 2129: D0 14 I=1.JDN 2239: K=TABSCNDP(N.I)) 2139: TENRETEMP(K) 2140: IF(MARK.E1.3.0F.ICOND.E0.0) TEMFR=1.0D0 2141: IF(MARK.E1.3.0F.ICOND.E0.0) TEMFR=1.0D0 2142: AI1(1)=AI1(1)FH1+DA+X=EETA+TEMPR 97 2144: AI1(1)=AI1(1)FH1+DA+X=EETA+TEMPR 97 2145: 15 CONTINUE 2146: AI1(1)=AI1(1)FH1+DA+X=EETA+TEMPR-H1+DA*(G1+G5-G4+G6))* 2147: H12(1)=AI2(1)FH1+DA+Y=BETA+TEMPR-H1+DA*(G1+G7-G4+G8)* 2149: 14 CONTINUE 2149: 14 CONTINUE		21.31		9971\-097 <i>M</i> I\
2192: $D0 = 9 L = 1, 2$ 2197: $9 = BE(L, 1) = CE(L, MJ)$ 2197: $G1 = 0$ 2197: $G4 = 0$ 2197: $G4 = 0$ 2199: $G5 = 0$ 2199: $G5 = 0$ 2111: $G7 = 0$ 2112: $D0 = 12 L = 1, JDN$ 2112: $D0 = 12 L = 1, JDN$ 2113: $G7 = 0$ 2114: $G7 = 0$ 2115: $K = 1165 \times MDP(K) = 1$ 2115: $K = 1165 \times MDP(K) = 1$ 2117: $G1 = G1 + 0 PP(K) = 1$ 2117: $G1 = G1 + 0 PP(K) = 1$ 2118: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2119: $G2 = 02 + 02PP(K, 2) + 14 / Xr$ 2120: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 20 / 3r$ , $\partial V_{1} / 3r$ 2121: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 30 / 3r$ , $\partial V_{1} / 3r$ 2122: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 30 / 3r$ , $\partial V_{1} / 3r$ 2124: $G8 = 08 + yPR(M1 \times 86 / 2, L) = 30 / 3r$ , $\partial V_{1} / 3r$ 2125: $12 \cdot CONTINUE$ 2126: $1F / NTP E 0, 1) = 31 = 0$ 2127: $F / NTP E 0, 1) = 31 = 0$ 2128: $G3 = 0$ 2129: $F (NTP K E 0, 1) = 61 = 0$ 2129: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 30 / 3r$ , $\partial V_{1} / 3r$ 2129: $F (NTP K E 0, 1) = 61 = 0$ 2129: $G7 = 0$ 2129: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 00$ 2129: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 00$ 2129: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 00$ 2129: $G7 = 07 + 02PR(M1 \times 86 / 2, L) = 00$ 2129: $G7 = 07 + 02PR(M1 \times 10^{-1} / 16^{-1} $		2181		PPC12-CPCN02
2147: 9 $BB(L, I) = CB(L, NJ)$ $\overline{\partial x}$ , $\overline{\partial y}$ 2147: 10 CONTINUE 2147: $G2 = 0$ 2147: $G2 = 0$ 2147: $G4 = 0$ 2148: $G5 = 0$ 2149: $G5 = 0$ 2149: $G5 = 0$ 2111: $G8 = 0$ 2112: $K = IABS(NOP(N, L))$ 2113: $K = IABS(NOP(N, L))$ 2114: $M = NOPP(K)$ 2115: $M = M = HAP(K)$ 2117: $G1 = 01 + YARI(M1) \times H4$ $U \cdot Y_K$ 2118: $G2 = 02 + COPP(K, 2) + H4$ $X, Y$ 2119: $G1 = 01 + YARI(M1) \times H4$ $V, V_T$ 2120: $IF(ANNT, EQ 0, G0, TO 12$ 2121: $G5 = 05 + VARI(M1) \times H4$ $X, Y$ 2122: $G6 = 05 + VARI(M1) \times H4$ $X, Y$ 2123: $G7 = 05 + VARI(M1) \times H4$ $X, Y$ 2124: $G8 = 05 + VARI(M1) \times H4$ $X, Y$ 2125: $I2 = CONTINUE$ 2125: $I2 = CONTINUE$ 2126: $IF(NTP EQ 1) = 12 = 0$ 2127: $IF(NTP EQ 1) = 12 = 0$ 2128: $G7 = 0$ 2129: $IF(NAXI, EQ 1) = 04 = 0$ 2129: $IF(NAXI, EQ 1) = 05 = 07 + 05$ 2130: $IF(NAXI, EQ 1) = 05 = 07 + 05$ 2131: $C$ 2132: $C = RIGH HAND SIDE$ 2134: $C = RIGH HAND SIDE$ 2135: $C = RIGH HAND SIDE$ 2135: $C = RIGH HAND SIDE$ 2136: $K = IABS(NDP(N, I))$ 2137: $TENPR=TEMP(K)$ 2138: $K = IABS(NDP(N, I))$ 2139: $IENPR=TEMP(K)$ 2140: $IF(IANT, EQ 1) = 07 = 15$ 2142: $AII(I) = AII(I) = HI(I) = HI \times 06 = 07 = 15$ 2144: $GI = 10 = (I) = TH + 06 = Y \times 06 = 16 = 16 = 07 = 04 = 07$ 2145: $I = CONTINUE$ 2146: $AII(I) = AII(I) = TH \times 06 = Y \times 06 = 16 = 16 = 07 = 04 = 06$ 2147: $AI2(I) = AI2(I) = HI = (I) = HI \times 06 = Y \times 06 = 16 = 07 = 04 = 06$ 2149: $I = CONTINUE$ 2149: $I = CONTINUE$		- 2192	:	DO 9 L=1, 2 $and AN;$
2101       10 CONTINUE       ∂x       ∂y         2107       G1=0.       ∂x       ∂y         2107       G1=0.       G1=0.         2108       G5=0.       G1=0.         2111       G7=0.       G1=0.         2112       D0 12 L=1.JDN       G1=0.         2113       G7=0.       G1=0.         2114       G8=0       G1=0.         2115       M3=M1+MDF(K)-1       U.V         2115       G2=02+COPO(K, 2)*H4 Xr       Yr         2116       G4=0.       00 TO 12         2117       G1=G1+VARI(M1)*H4 U.V       Yr         2118       G2=02+COPO(K, 2)*H4 Xr       ∂v/ðz         2117       G1=G1+VARI(M1)*H4 U.V       yr         2128       G2=02+COPO(K, 2)*H4 Xr       ∂v/ðz         2129       IF(ANHT.E0.0.)012       av/ðz         2120       IF(ANHT.E0.0.)012       av/ðz         2121       G2=02+VARI(M1)*H4 U.V       av/ðz         2122       G3=06+VARI(M1)*H4 U.V       av/ðz         2122       G3=06+VARI(M1)*H4 U.V       av/ðz         2125       IF(NTF E0.1) 31=0.       av/ðz         2126       IF(NRXI.E0.1)63=1./62         2127       IF(AN		2407		$BB(1,T)=CB(1,N,T)$ $\frac{\partial M_1}{\partial T}$ , $\frac{\partial M_2}{\partial T}$
2143: 10 CONTINUE 2145: 62=0 2147: 64=0 2149: 65=0 2149: 65=0 2149: 65=0 2119: 65=0 2119: 65=0 2111: 68=0 2111: 68=0 2112: 00 12 L=1, JDN 2115: K=TABS(NOP(N,L)) 2114: M1=NOPF(K) = 1 2115: 62=02+COPD(K, 2)*H4 X,r 2116: 62=02+COPD(K, 2)*H4 X,r 2117: 61=61+YARI(M1)*H4 U.Vr 2129: IF(ANNT.E0.0.)00 TO 12 2121: 62=05+VPRI(M1)*E(2.L) Du/Dx , DVr/Dz 2122: 66=05+VPRI(M1)*E(2.L) Du/Dx , DVr/Dz 2123: 67=67+VPRI(M1)*E(2.L) Du/Dx , DVr/Dz 2124: 68=05+VPRI(M1)*E(2.L) Du/Dx , DVr/Dz 2125: 12 CONTINUE 2126: IF(NTF E0.1) G1=0 2127: JE(NTF E0.1) G1=0.0 2128: 63=0 2129: IF(NAXI.E0.1) G1=0.0 2129: IF(NAXI.E0.1) G1=0.0 2120: IF(NAXI.E0.1) G1=0.0 2120: IF(NAXI.E0.1) G1=0.0 2121: C 2120: IF(NAXI.E0.1) G1=0.0 2121: C 2120: IF(NAXI.E0.1) G1=0.0 2121: C 2121: C 2122: N= IF(NAXI.E0.1) G1=0.0 2122: N= IF(NAXI.E0.1) G1=0.0 2124: GN=0.0 2125: M1=0.0 2125: M1=0.0 2126: D0 14 I=1,JDN 2235: K=IABS(NOP(N.I)) 2139: IEMPR=TEMP(K) 2140: IF(MARK.LT.2.0F.ICOND.E0.0) TEMFR=1.000 2141: IF(ANNT.E0.1) G0 TO 15 2142: A11(1)=A11(1)TH1*DA*K=ETA*TEMPR 91 2144: A11(1)=A11(1)TH1*DA*K=ETA*TEMPR 91 2145: 15 CONTINUE 2144: G0 TO 14 2145: 15 CONTINUE 2144: G1 TO 14 2145: 15 CONTINUE 2144: A11(1)=A11(1)TH1*DA*K=ETA*TEMPR-H1*DA*(G1*65-04*66)* 2147: A12(1)=A12(1)TH1*DA*Y=BETA*TEMPR-H1*DA*(G1*67-G4*68)* 2149: G 2140: A12(1)=A12(1)TH1*DA*Y=BETA*TEMPR-H1*DA*(G1*67-G4*68)* 2144: A12(1)=A112(1)TH1*DA*Y=BETA*TEMPR-H1*DA*(G1*67-G4*68)* 2149: G 2141: IF(CONTINUE 2144: A12(1)=A12(1)TH1*DA*Y=BETA*TEMPR-H1*DA*(G1*67-G4*68)* 2145: 14 CONTINUE		2202	نى . مەربى	Determine 38 34
2105: 61=0. 2107: 64=0. 2108: 65=0. 2110: 67=0. 2111: 68=0. 2112: 00 12 L=1.JDN 2113: K=TABS(NDP(N,L)) 2114: M1=NDPP(X) 2115: M3=M1+MDF(X)-1 2116: M4=P(1) 2117: 61=61+VARI(M1)*H4 U.Vx 2118: 62=62+00P(X,2)*H4 Xr 2119: 62=62+00P(X,2)*H4 Xr 2129: 15 CANUPTER VARIANS+H4 V.Vr 2120: 15 CANUPTER VARIANS+H4 V.Vr 2121: 62=62+VARIANS+H4 V.Vr 2122: 62=62+00P(X,2)*H4 Xr 2122: 62=62+VARIANS+H4 V.Vr 2123: 62=62+VARIANS+H4 V.Vr 2124: 62=62+VARIANS+H4 V.Vr 2125: 12 CONTINUE 2125: 12 CONTINUE 2126: 12 CONTINUE 2127: 15 CANUPTER VARIANS+H2 V.SE 2129: 15 CANUPTER VARIANS+H2 V.SE 2120: 15 CANUPTER VARIANS+H2 V.SE 2120: 15 CANUPTER VARIANS+H2 V.SE 2121: 15 CANUPTER VARIANS+H2 V.SE 2123: 15 CANUPTER VARIANS+H2 V.SE 2124: 15 CONTINUE 2124: 15 CONTINUE 2125: 15 CONTINUE 2126: 15 CONTINUE 2127: 15 CONTINUE 2129: 15 CONTINUE 2129: 15 CONTINUE 2129: 15 CONTINUE 2129: 15 CONTINUE 2129: 15 CONTINUE 2124: 15 CONTINUE 2125: 15 CONTINUE 2125: 15 CONTINUE 2126: 15 CONTINUE 2127: 15 CONTINUE 2129: 15 CONTINUE 2129: 15 CONTINUE 2129: 15 CONTINUE 2120: 14 CONTINUE 2120: 14 CONTINUE 2120: 14 CONTINUE 2120: 14 CONTINUE 2120: 14 CONTINUE		21174	: 1t	
2107: 02=0. 2107: 04=0. 2109: 05=0. 2110: 07=0. 2111: 08=0. 2112: D0 12 L=1.JDN 2112: K=IBS(NDP(N.L)) 2113: M3=M1+MDF(K)-1 2115: M3=M1+MDF(K)-1 2116: 02=02+COPD(K,2)*H4 %r 2119: 02=02+COPD(K,2)*H4 %r 2120: IF(RNWI E0 0.500 TO 12 2121: 05=05+VPRI(M3)*H4 v.Vr 2120: IF(RNWI E0 0.500 TO 12 2121: 05=05+VPRI(M3)*H4 v.Vr 2122: 06=05+VPRI(M3)*H4 v.Vr 2123: 07=07+VPRI(M3)*F(L,L) &v/bx, 0Vr/bz 2121: 05=05+VPRI(M3)*F(L,L) &v/bx, 0Vr/bz 2122: 06=05+VPRI(M3)*F(L,L) &v/bx, 0Vr/bz 2123: 07=07+VPRI(M3)*F(L,L) &v/by, 0Vr/bz 2125: 12 CONTINUE 2126: IF(NTF E0.1) 01=0.0 2128: 03=0 2128: 03=0 2129: 01F(NAXI E0.1)03=0.400 2129: 02=0 2120: 0***********************************		2105		13月1日11日11日11日11日11日11日11日11日11日11日11日11日1
210-5: 02-0. 2109: 05-0. 2109: 05-0. 2111: 08-0 2112: 00 12 L=1.JDN 2112: K=IABS(NOP(N,L)) 2111: M3=M1+MDFP(X) 2112: K=IABS(NOP(N,L)) 2114: M1=NOPP(X) 2115: G2=02+COPD(X,2)*H4 Xr 2116: G2=02+COPD(X,2)*H4 Xr 2119: G2=02+COPD(X,2)*H4 Xr 2119: G2=02+COPD(X,2)*H4 Xr 2119: G2=02+COPD(X,2)*H4 Xr 2110: G5=03+VAPI(M1)*6(2,L) Du/Dx, DVI/Dz 2120: G5=03+VAPI(M1)*6(2,L) Du/Dx, DVI/Dz 2121: G5=03+VAPI(M1)*6(2,L) Du/Dy, DVI/Dr 2122: G5=03+VAPI(M1)*6(2,L) Du/Dy, DVI/Dr 2122: G5=03+VAPI(M1)*6(2,L) Du/Dy, DVI/Dr 2122: G5=03+VAPI(M2)*6(2,L) Du/Dy, DVI/Dr 2123: G7=07+VAPI(M2)*6(2,L) Du/Dy, DVI/Dr 2124: G8=08+VAPI(M3)*8(2,L) Du/Dy, DVI/Dr 2125: 12 CONTINUE 2127: IF(NTF E0,1) G1=0 2128: G3=0. 2129: G3=0. 2120: IF(NAVI.E0.1)G1=0. 2129: JF(NAVI.E0.1)G1=0. 2129: JF(NAVI.E0.1)G1=0. 2129: JF(NAVI.E0.1)G1=0. 2120: JF(NAVI.E0.1)G1=0. 2121: JF(NAVI.E0.1)G1=0. 2121: JF(NAVI.E0.1)G1=0. 2122: JF(J)=A12(I)+H1+DA*X*EETA*TEMPR 91. 2124: G0 T0 14 2144: G0 T0 14 2145: J5 CONTINUE 2144: G0 T0 14 2145: J5 CONTINUE 2146: J2 CONTINUE 2147: A12(I)=A12(I)+H1+DA*X*EETA*TEMPR-41*DA*(G1*65-04*66)* 2147: A12(I)=A12(I)+H1*DA*Y*EETA*TEMPR-41*DA*(G1*65-04*66)* 2149: G		2403		
2107: 04=0 2109: 05=0 2109: 05=0 2110: 07=0 2111: 08=0 2111: 08=0 2111: 08=0 2112: K=IRBS(NOP(N,L)) 2113: M3=M1+MDF(K)-1 2114: 02=02+00PO(K,2)+H4 V.V 2119: 02=02+00PO(K,2)+H4 V.V 2119: 02=02+00PO(K,2)+H4 V.V 2120: 05=05+VRPI(M1)+6(1,L) Du/Dx, DV/DZ 2121: 05=05+VRPI(M1)+6(1,L) Du/Dx, DV/DZ 2122: 06=06+VRPI(M1)+6(2,L) Du/Dx, DV/DZ 2121: 05=05+VRPI(M2)+6(1,L) Du/Dx, DV/DZ 2122: 07=07+VRPI(M2)+6(1,L) Du/Dx, DV/DZ 2123: 07=07+VRPI(M2)+6(1,L) Du/Dx, DV/DZ 2125: 12 CONTINUE 2126: 07=0 2127: IF(NTP E0,1) 31=0.0 2127: 07=07+VRPI(M3)+8(2,L) Du/Dy, DV/DT 2129: 07=0 2120: 07=0		2140		$G \mathcal{Z} = \mathcal{O}$ .
2108: 65=0. 2109: 65=0. 2110: 07=0. 2111: 08=0. 2112: 00 12 L=1, JDN 2112: V = IASS(NDP(N,L)) 2114: M1=NDPP(X) 2115: M3=M1+MDF(K)-1 2116: G1=G1+VART(M1)+H4 U.Vr 2119: G1=G1+VART(M1)+H4 V.Vr 2120: G1=G1+VART(M1)+H4 V.Vr 2120: G1=G1+VART(M1)+H4 V.Vr 2120: G1=G4+VRRT(M1)+H4 V.Vr 2120: G1=G4+VRRT(M1)+H4 V.Vr 2120: G1=G6+VRRT(M1)+H4 V.Vr 2121: G5=G5+VRRT(M1)+H4 V.Vr 2122: G1=G7+VRRT(M3)+F(1,L) DV/Dx, DV/Dz 2122: G1=G7+VRRT(M3)+F(1,L) DV/Dx, DV/Dz 2123: G1=G7+VRRT(M3)+F(1,L) DV/Dx, DV/Dz 2124: G8=G8+VRRT(M3)+F(1,L) DV/Dx, DV/Dz 2125: 12 CONTINUE 2126: IF(NTP E0,1) G1=0.0 2127: IF(NTP E0,1) G1=0.0 2127: IF(NTP E0,1) G1=0.0 2129: G3=0. 2120: IF(NAKI.E0,1)G3=1 /G2 2120: IF(NAKI.E0,1)G3=1 /G2 2120: IF(NAKI.E0,1)G3=1 /G2 2120: IF(NAKI.E0,1)G3=1 /G2 2120: CRIGHT HAND SIDE 2124: G2=0. 2125: D0 14 I=1, JON 2127: M1=HP(I) WL 2128: K=IHBS(NDP(N,I)) 2139: TEMPPTEMP(K) 2140: IF(CHARK.LT.3.0R.ICOND.E0.0) TEMFR=1.000 2141: IF(GAWT.E0.1) G1 D1 S 2140: G0 D14 I=1. JON D15 2142: AI1(I)=AI1(I)=H1+DR+V+BETR+TEMPR 91 2141: IF(GAWT.E0.1) G0 T0 15 2142: AI1(I)=AI1(I)=H1+DR+V+BETR+TEMPR 93 2144: G0 T0 14 2145: IS CONTINUE 2144: G0 T0 14 2145: IS CONTINUE 2144: G1 T0 14 2145: IS CONTINUE 2144: G1 T0 14 2145: IS CONTINUE 2145: IS CONTINUE 2146: AI1(I)=AI1(I)=H1+DR+V+BETR+TEMPR 93 2144: G1 T0 14 2145: IS CONTINUE 2144: G1 T0 14 2145: IS CONTINUE 2146: I CONTINUE 2147: AI2(I)=AI2(I)=H12(I)=H1+DR+V+BETR+TEMPR-41+DR+(G1+G5-G4+G6)+ 2147: AI2(I)=AI2(I)=H12(I)=H1+DR+V+BETR+TEMPR-41+DR+(G1+G7-G4+G8)+ 2149: G		2107	•	R4=R
<pre>3149: 03-0. 2149: 03-0. 2110: 07=0 2111: 08=0 2112: 00 12 L=1.JDN 2117: K=IABS(NOP(N.L)) 2117: K=IABS(NOP(N.L)) 2117: G1=G1+VARI(H1)*H4 U.Vr 2118: 02=02+00P0(K.2)*H4 Yr 2119: 02=02+00P0(K.2)*H4 Yr 2120: 02=02+00P0(K.2)*H4 Yr 2121: 05=03+VARI(H1)*K(L)) Ju/Jr, JVZ/Jr 2121: 05=03+VARI(H1)*K(L)) Ju/Jr, JVZ/Jr 2122: 06=06+VARI(H1)*K(L)) Ju/Jr, JVZ/Jr 2123: 07=07+VARI(H1)*K(L)) Ju/Jr, JVZ/Jr 2124: 08=06+VARI(H3)*S(2,L) Ju/Jr, JVZ/Jr 2125: 12 CONTINUE 2127: IF(NTP E0.1) 31=0.0 2127: IF(NTP E0.1) 31=0.0 2127: 03=0 2127: 03=0 2128: 03=0 2129: 03=0 2129: 014 I=4.JDN 2129: 014 I=4.JDN 2129: C************************************</pre>			•	
2109 66-0. 2110: 67-0. 2111: 68-0. 2112: 00 12 L=1, JDN 2112: K=TABS(NDP(N,L)) 2114: M1=NOPP(K) 2115: M3=M1+NDF(K)-1 2116: 62=02+COPD(K,2)*H4 X,r 2118: 62=02+COPD(K,2)*H4 X,r 2119: 62=63+VPPI(M1)*6(1,L) Du/bx, DU/bZ 2120: 65=65+VPPI(M1)*6(1,L) Du/bx, DU/bZ 2121: 65=65+VPPI(M1)*6(2,L) Du/bX, DU/bZ 2122: 67=67+VPPI(M1)*6(2,L) Du/bX, DU/bZ 2122: 67=67+VPPI(M1)*6(2,L) Du/bX, DU/bZ 2123: 67=67+VPPI(M1)*6(2,L) Du/bX, DU/bZ 2124: 63=68+VPPI(M1)*6(2,L) Du/bX, DU/bZ 2125: 12 CONTINUE 2125: 12 CONTINUE 2126: 63=0. 2129: 1F(NAFE, 0, 1) 91=0. 2129: 03=0. 2129: 03=0. 2129: 03=0. 2120: 03=0. 2120: 03=0. 2120: 03=0. 2120: 03=0. 2120: 00 14 I=1, JDN 2127: H1=WP(I) WL 2127: M1=WP(I) WL 2129: K=IABS(NOP(M,I)) 2139: TEMPR=TEMP(K) 2140: 1F(MAFE, 1, 3, 0F, ICOND, E0, 0) TEMFR=1, 0D0 2141: 1F(ANAT, E0, 1, ) 00 TO 15 2142: A11(I)=A11(I)+H1*DA*X*EETA*TEMPR 91 2144: 00 TO 14 2145: 15 CONTINUE 2144: 00 TO 14 2145: 15 CONTINUE 2144: 00 TO 14 2145: 15 CONTINUE 2144: A12(I)=A12(I)+H1*DA*V*EETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2140: A11(I)=A12(I)+H1*DA*V*EETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2144: 00 TO 14 2145: 14 CONTINUE 2146: 14 CONTINUE 2149: 00	U	2108.		65=e.
2110: G7=0. 2111: G8=0 2112: V = INBS(NOP(N,L)) 2113: M3=M1+NOP(X) 2114: M1=NOPP(X) 2115: M3=M1+NOP(X) 2116: H4=P(L) 2117: G1=G1+VARI(M1)*H4 U.Vx 2118: G2=G2+COPD(X,2)*H4 X.r 2119: G4=G4+VAPI(M3)*H4 V.Vr 2120: IF(ANWT.EQ.0.)GO TO 12 2121: G5=G5+VARI(M2)*E(L) Du/Dx, DVz/Dr 2122: G6=G6+VARI(M2)*E(L) Du/Dx, DVz/Dr 2123: G7=G7+VARI(M2)*E(2,L) Du/Dx, DVz/Dr 2124: G8=G8+VARI(M2)*E(2,L) Du/Dx, DVz/Dr 2125: 12 CONTINUE 2125: I2 CONTINUE 2126: IF(NTF EQ.1) 31=0.0 2127: IF(NTF EQ.1) 31=0.0 2128: G7=0. 2129: IF(NATLEQ.1)G4=0.9 2128: G7=0. 2129: IF(NATLEQ.1)G4=0.9 2129: IF(NATLEQ.1)DA=DA*G2 2110: C 2130: C RIGHT HAND SIDE 2131: C 2135: C 2135: C 2135: C 2136: DO 14 I=1,JDN 2237: H1=WP(I) W: 2138: K=IABS(NOP(N,I)) 2139: TEMPR=TEMP(K) 2140: IF(MAPK,LT.3.OR.ICONO.E0.0) TEMFR=1.000 2141: IF(GAWT.E0.1)TH1*DA*X*EETA*TEMPR 97 2142: AI1(I)=AI1(I)TH1*DA*X*EETA*TEMPR 97 2144: G0 TO 14 2145: I5 CONTINUE 2144: G0 TO 14 2145: I15 CONTINUE 2146: AI1(I)=AI1(I)TH1*DA*X*EETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I)TH1*DA*X*EETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2149: G0 TO 14 2149: G1 CONTINUE 2149: G1 CONTINUE	1	2100		$G \mathcal{E} = \mathcal{O}$ .
<pre>2117. 01-01. 2112. D0 12 L=1, JDN 2112. K=TABS(NDP(N,L)) 2113. M3=M1+MDF(K)-1 2115. M3=M1+MDF(K)-1 2116. H4=P(L) 2117. 01=01+VARI(M1)*H4 U.Vx 2118. 02=02+DOPD(K,2)*H4 V,V 2129. 04=04+VARI(M3)*H4 V,Vr 2120. 05=05+VARI(M3)*H4 V,Vr 2121. 05=05+VARI(M3)*E(L,L) Du/Dx , DVz/DZ 2122. 06=06+VARI(M1)*E(2,L) Du/Dx , DVz/DZ 2123. 07=07+VARI(M3)*E(2,L) Du/Dx , DVz/DZ 2124. 08=08+VARI(M3)*E(2,L) Du/Dx , DVz/DZ 2125. 12 CONTINUE 2126. 07=07+VARI(M3)*E(2,L) Du/Dy , DVz/DZ 2127. 1F(NTF E0.1) 31=0.0 2128. 03=0. 2128. 03=0. 2129. 1F(NAXI.E0.1)06=0.0 2129. 014(NAXI.E0.1)06=0.0 2120. 014(1=1,JDN 2127. H1=MP(J) Wi 2125. 213. 00 14 I=1,JDN 2127. H1=MP(J) Wi 2128. K=IABS(NDP(N,I)) 2139. TEMPATEMP(K) 2140. IF(MAPK.LT.3.0P. ICOND.E0.0) TEMPR=1.000 2141. IF(ANKT.E0.1) 00 TO 15 2142. AI2(1)=AI2(1)TH1*DA*V*BETA*TEMPR 91 2143. 00 TO 14 2145. 15 CONTINUE 2144. 00 TO 14 2145. 15 CONTINUE 2144. AI1(1)=AI1(1)TH1*DA*V*BETA*TEMPR-H1*DA*(01*05-04*06)* 2147. AI2(1)=AI2(1)TH1*DA*V*BETA*TEMPR-H1*DA*(01*05-04*06)* 2149. 14 CONTINUE 2144. AI1(1)=AI1(1)TH1*DA*V*BETA*TEMPR-H1*DA*(01*05-04*06)* 2147. AI2(1)=AI2(1)TH1*DA*V*BETA*TEMPR-H1*DA*(01*05-04*06)* 2149. 14 CONTINUE 2144. AI1(1)=AI1(1)TH1*DA*V*BETA*TEMPR-H1*DA*(01*05-04*06)* 2144. AI1(1)=AI1(1)TH1*DA*V*BETA*TEMPR-H1*DA*(01*05-04*</pre>		3113		13 T=10
2111: 05=4 2112: 00 12 L=1, JDN 2112: K=IABS(NOP(N,L)) 2114: M1=NOPP(X) 2115: M3=M1+MDF(K)-1 2116: H4=P(L) 2117: GL=GL+VARI(M1)*H4 U.Vx 2129: GC=G2+CORPC(K,2)*H4 X.Y 2129: GC=G2+CORPC(K,2)*H4 X.Y 2120: GC=G2+VARI(M3)*H4 V.Vr 2120: GC=G5+VARI(M3)*H4 V.Vr 2121: GC=G5+VARI(M3)*H4 V.Vr 2122: GC=G5+VARI(M3)*H4 V.Vr 2122: GC=G5+VARI(M3)*H4 V.Vr 2122: GC=G5+VARI(M3)*H4 V.Vr 2122: GC=G5+VARI(M3)*H4 V.Vr 2122: GC=G5+VARI(M3)*H4 V.Vr 2123: GT=GT+VARI(M3)*H4 V.Vr 2124: GS=G5+VARI(M3)*H4 V.Vr 2125: 12 CONTINUE 2125: I2 CONTINUE 2126: GT=GT 2127: IF(NTF EQ.1) 31=0.0 2128: GT=G. 2129: IF(NAXI.EQ.1)GA=0.0 2129: GT=GA 2120: CRIGHT HAND SIDE 2124: CRISH WAND SIDE 2124: CRISH WAND SIDE 2127: CRIGHT HAND SIDE 2129: CRIGHT HAND SIDE 2120: CRIGHT HAND SIDE 2120: CRIGHT HAND SIDE 2121: CRIGHT HAND SIDE 2121: CRIGHT HAND SIDE 2122: CRIGHT HAND SIDE 2124: CRIGHT HAND SIDE 2124: CRIGHT HAND SIDE 2124: CRIGHT HAND SIDE 2124: CRIGHT HAND SIDE 2125: CRIGHT HAND SI		2714		
2112: 00 12 L=1, JDN 2112: K=IABS(NOP(N,L)) 2114: M=MOFP(K) 2115: M3=M1+MOF(K)-1 2116: H4=P(L) 2117: G1=G1+VARI(M1)*H4 U.Vx 2118: G2=G2+UOPD(K,2)*H4 V,Vr 2129: G2=G4+VAPI(M3)*H4 V,Vr 2120: G2=G5+VPPI(M1)*R(L,L) Du/Dx , DVz/DZ 2121: G5=G5+VPPI(M1)*R(L,L) Du/Dx , DVz/DZ 2122: G2=G5+VPPI(M1)*R(L,L) Du/Dx , DVz/DZ 2124: G3=G5+VPPI(M3)*B(2,L) Du/Dx , DVz/DZ 2125: 12 CONTINUE 2126: I2 CONTINUE 2127: IF(NTP F0.1) 31=0.0 2128: G3=0. 2128: G3=0. 2129: IF(NAXI.E0.1)G4=0.0 2129: IF(NAXI.E0.1)G4=0.0 2120: IF(NAXI.E0.1)G4=0.0 2120: G7=G7+VARI(E0.1)G3=1 /G2 2120: G7=G7+VARI(E0.1)G3=1 /G2 212		2111.	:	88=4
<pre>2112: K=IRBS(NOP(N,L)) 2114: M1=NOP(K) 2115: M3=M1+MDF(K)-1 2115: M3=M1+MDF(K)-1 2116: H4=P(L) 2117: G1=G1+WARI(M1)*H4 U.Vr 2119: G2=02+00PD(K,2)*H4 Y.r 2119: G2=02+00PD(K,2)*H4 Y.r 2120: IF(ANUT.E0.0.)GO TO 12 2121: G5=65+WARI(M1)*E(1,L) Du/Dr, Du/Dr, Du/Dz 2122: G7=67+WARI(M2)*P(1,L) Du/Dr, Du/Dz, Du/Dz 2122: G7=66+WARI(M1)*E(2,L) Du/Dr, Du/Dr, Du/Dz 2122: G7=66+WARI(M1)*E(2,L) Du/Dr, Du/Dr, Du/Dz 2122: G7=67+WARI(M2)*P(1,L) Du/Dr, Du/Dr,</pre>		2112		DD = 12 + 1 + 10 N
2112: K-105K(NG(K)(K)) 2114: M10FP(K) 2115: M3=M1+MDF(K)-1 2115: M3=M1+MDF(K)-1 2116: G2=02+CORD(K, 2)*H4 %r 2119: G2=02+CORD(K, 2)*H4 %r 2119: G2=03+WARI(M1)*H4 U.Vr 2120: IF(ANWT.E0.0.00 TO 12 2121: G5=05+WARI(M1)*F(1,L) Du/Dr, DV/Dr 2122: G6=06+WARI(M1)*F(1,L) Du/Dr, DV/Dr 2123: G7=07+WARI(M2)*F(1,L) Du/Dr, DV/Dr 2124: G8=06+WARI(M1)*F(2,L) Du/Dr, DV/Dr 2125: I2 CONTINUE 2125: I2 CONTINUE 2126: IF(NTP E0.1) 31=0.0 2127: IF(NTP E0.1) 31=0.0 2128: G3=0 2129: IF(NARXLE0.1)0A=0.0 2129: IF(NARXLE0.1)0A=0.0 2120: GX=0 2120: IF(NARXLE0.1)0A=0.0 2120: C************************************				K-TODE (NOR(N 1 ))
2114 M1=MDF(K)-1 2115 M3=M1+MDF(K)-1 2115 H4=P(L) 2117 G1=G1+VARI(M1)*H4 U.Vr 2119 G2=G2+COPD(K, 2)*H4 %r 2129 IF(AMMT.EQ.0.)GO TO 12 2120 G6=G6+VARI(M1)*E(1,L) DV/Dr, DV/DZ 2121 G5=G6+VARI(M1)*E(2,L) DV/Dr, DV/DZ 2122 G6=G6+VARI(M1)*E(2,L) DV/Dr, DV/DZ 2123 G7=G7+VARI(M3)*E(2,L) DV/Dr, DV/Dr 2125 12 CONTINUE 2125 IF(NTP EQ.1) G1=0.0 2127 IF(NTP EQ.1) G1=0.0 2128 G3=0 2129 IF(MAXI.EQ.1)G3=1 /G2 2120 IF(NAXI.EQ.1)G3=1 /G2 2120 IF(NAXI.EQ.1)DA=DA=G2 2121 C RIGHT HAND SIDE 2124 C************************************		2112		N = I D D V BUC V BY E Y Y
<pre>2115: M3=M1+MDF(K)-1 2115: H4=P(L) 2117: G1=01+VARI(M1)*H4 U.Vr 2119: G2=02+CORD(K, 2)*H4 %r 2119: G2=02+CORD(K, 2)*H4 %r 2119: G2=05+VARI(M1)*R(1, L) Du/Dr, DVr/Dr 2120: G5=05+VARI(M1)*R(1, L) Du/Dr, DVr/Dr 2121: G5=05+VARI(M2)*R(2, L) Du/Dr, DVr/Dr 2122: G6=06+VARI(M2)*R(2, L) Du/Dr, DVr/Dr 2125: 12 CONTINUE 2125: 12 CONTINUE 2125: I2 CONTINUE 2126: G7=0, 2127: IF(NTP E0, 1) 01=0, 0 2128: G3=0, 2129: IF(NARXI E0, 1)03=1 /02 2120: IF(NARXI E0, 1)04=0, 0 2120: C************************************</pre>		2111		M1=NOFP(K)
2115 2117: 01-01+VAFI(M)*H4 U.Vr 2118: 02=02+COPD(K, 2)*H4 %r 2119: 04=064+VAFI(M)*AC(1, L) &V/8r 2129: IF(ANWT.E0.0.)60 TO 12 2121: 05=05+VAFI(M)*AC(1, L) &V/8r 2122: 07=07+VARI(M2)*AC(1, L) &V/8r 2122: 07=07+VARI(M2)*AC(1, L) &V/8r 2124: 08=08+VARI(M2)*AC(1, L) &V/8r 2125: 12 CONTINUE 2125: 12 CONTINUE 2126: IF(NTF E0.1) 31=0.0 2127: IF(NTF E0.1) 31=0.0 2128: 03=0. 2129: IF(NAVI.E0.1)08+0.0 2129: IF(NAVI.E0.1)08+0.0 2129: IF(NAVI.E0.1)08+0.0 2129: IF(NAVI.E0.1)08+0.0 2120: C RIGHT HAND SIDE 2124: C************************************				MZ = MI + MDF (K) - I
2115 H4=P(L) 2117: G1=G1+VARI(M1)*H4 U.Vz 2119: G2=G2+COPD(K, 2)*H4 X.r 2119: G2=G2+COPD(K, 2)*H4 X.r 2120: IF(ANWI.E0.00 TO 12 2121: G5=G5+VARI(M1)*E(1,L) &V/&z, $\partial Vz/\partial z$ 2122: G6=G6+VARI(M1)*E(2,L) $\partial V/\partial z$ , $\partial Vz/\partial r$ 2123: G7=G7+VARI(M2)*E(1,L) $\partial V/\partial z$ , $\partial Vz/\partial r$ 2124: G8=G8+VARI(M2)*E(2,L) $\partial V/\partial z$ , $\partial Vz/\partial r$ 2125: I2 CONTINUE 2125: IF(NTP E0.1) 31=0.0 2127: IF(NTP E0.1) 31=0.0 2128: G3=0. 2129: JF(NAKI.E0.1) G3=1 /G2 2130: IF(NAKI.E0.1) G3=1 /G2 2130: IF(NAKI.E0.1) G3=1 /G2 2131: C 2132: C RIGHT HAND SIDE 2134: C RIGHT HAND SIDE 2135: C D0 14 I=1, JON 2137: H1=WP(I) W: 2138: K=IABS(NOP(N.I)) 2139: TEMPR=TEMP(K) 2140: IF(ANKI.E0.1) G0 TO 15 2142: AI1(I)=RII(I)#H1*DA*X*EETA*TEMPR 91 2142: AI1(I)=RII(I)#H1*DA*X*EETA*TEMPR 97 2144: G0 TO 14 2145: I5 CONTINUE 2144: AI1(I)=RII(I)#H1*DA*X*EETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: H12(I)=RI2(I)#H1*DA*X*EETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: H12(I)=RI2(I)#H1*DA*Y*EETA*TEMPR-H1*DA*(G1*G7-G4*68)* 2149: I4 CONTINUE 2149: I4 CONTINUE 2144: G0 TO 14 2145: I5 CONTINUE 2146: AI1(I)=RI2(I)#H1*DA*Y*EETA*TEMPR-H1*DA*(G1*G7-G4*68)* 2147: H12(I)=RI2(I)#H1*DA*Y*EETA*TEMPR-H1*DA*(G1*G7-G4*68)* 2149: C				and a second construction of the second s
<pre>2117: G1=G1+VAFI(M1)*H4 U.Yr 2118: G2=G2+COPD(K, 2)*H4 Y,r 2119: G4=G4+VAFI(M3)*H4 V,Vr 2129: IF(ANWT.E0 0.360 TO 12 2121: G5=G5+VAFI(M1)*E(1,L) 3u/3r, 3Vr/3z 2122: G7=G7+VAFI(M2)*E(1,L) 3u/3r, 3Vr/3z 2124: G8=G8+VAFI(M3)*E(2,L) 3u/3y, 3Vr/3r 2125: 12 CONTINUE 2125: 12 CONTINUE 2126: IF(NTF E0.1) 31=0.0 2127: IF(NTF E0.1) 31=0.0 2128: G3=0. 2129: IF(NAVI.E0.1)G3=1 /G2 2131: C 2131: C 2131: C 2132: C RIGHT HAND SIDE 2134: C RIGHT HAND SIDE 2134: C RIGHT HAND SIDE 2135: C RIGHT HAND SIDE 2136: D0 14 I=1, JON 2137: H1=WP(I) W: 2138: K=IABS(NOP(N.I)) 2139: TEMPR=TEMP(K) 2140: IF(MAPK.LT.3.0F.ICOND.E0.0) TEMFR=1.000 2141: IF(GNWT.E0.1) 00 TO 15 2142: AI1(I)=AI1(I)#H1*DA*X*EETA*TEMPR 91 2142: AI1(I)=AI2(I)#H1*DA*X*EETA*TEMPR=H1*DA*(G1*G5-G4*G6)* 2144: II2(I)=AI2(I)#H1*DA*Y*BETA*TEMPR=H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I)#H1*DA*Y*BETA*TEMPR=H1*DA*(G1*G7-G4*G8)* 2149: I 4 CONTINUE 2144: I 4 CONTINUE 2144: I 4 CONTINUE 2145: I 4 CONTINUE</pre>		2116		
2118: G2=G2+CORD(K, 2)*H4 %, 2119: G2=G2+CORD(K, 2)*H4 %, 2120: IF(ANUT, E0, 0, 00 TO 12 2121: G5=G5+VARI(M1)*B(1, L) DU/Dx, DV/Dz 2122: G6=G6+VARI(M1)*B(2, L) DU/Dx, DV/Dz 2122: G7=G7+VARI(M2)*F(1, L) DU/Dx, DV/Dz 2123: G7=G7+VARI(M3)*B(2, L) DU/Dx, DV/Dz 2125: 12 CONTINUE 2125: 12 CONTINUE 2126: IF(NTP E0, 1) 31=0.0 2127: IF(NTP E0, 1) 31=0.0 2128: G3=0. 2129: IF(NAMI, E0, 1) G4=0.0 2128: G3=0. 2120: IF(NAMI, E0, 1) DB=DA*G2 2170: IF(NAMI, E0, 1)DB=DA*G2 2171: C 2170: IF(NAMI, E0, 1)DB=DA*G2 2171: C 2170: IF(NAMI, E0, 1)DB=DA*G2 2171: C 2170: IF(NAMI, E0, 1)DB=DA*G2 2171: C 2170: IF(NAMI, E0, 1)DB=DA*G2 2171: C 2174: C 2175: C 2176: D0 14 I=1, JCN 2177: H1=MP(I) W: 2178: K=IAB5(NOP(N, I)) 2179: TEHFP=TEMP(K) 2140: IF(ANMI, E0, 1, ) G0 TO 15 2142: AI1(I)=AI1(I)+H1*DA*X*EETA*TEMPR 91 2142: AI1(I)=AI2(I)+H1*DA*X*EETA*TEMPR 93 2144: G0 TO 14 2145: 15 CONTINUE 2144: AI1(I)=AI1(I)+H1*DA*X*EETA*TEMPR 93 2144: G0 TO 14 2145: 15 CONTINUE 2144: AI1(I)=AI1(I)+H1*DA*V*EETA*TEMPR-41*DA*(G1*G5-G4*G5)* 2147: AI2(I)=AI2(I)+H1*DA*V*EETA*TEMPR-41*DA*(G1*G7-G4*G8)* 2149: C	1	3117		$R_1 = R_1 + VR_2 T \langle M_1 \rangle * H_4 = U \cdot N x$
2119: 62=64-VAPI(M.2*M+4 V.Vr 2119: 64=64-VAPI(M.3*H4 V.Vr 2120: IF(ANUT.EQ.0.300 TO 12 2121: 65=65+VAPI(M.1*E(1,L) & V/&, av/dz 2122: 66=66+VAPI(M.1*E(1,L) & V/a, av/dz 2122: 67=67+VAPI(M.1*E(1,L) & V/a, av/dz 2122: 67=67+VAPI(M.3*E(2,L) & V/ay, av/dz 2123: 12 CONTINUE 2125: 12 CONTINUE 2125: 12 CONTINUE 2125: 12 CONTINUE 2126: 63=9. 2129: IF(NTP EQ.1) 81=0.0 2128: 63=9. 2129: IF(NAPI.EQ.1)08=074:82 2130: 1F(NAPI.EQ.1)08=074:82 2130: 1F(NAPI.EQ.1)08=074:82 2130: 2132: C RIGHT HAND SIDE 2132: C RIGHT HAND SIDE 2134: C************************************	2			
2119: GJ=G4+VAPI(M3)*H4 V,Vr 2120: IF(ANUT, EQ 0, )GO TO 12 2121: G5=G5+VAPI(M1)*6(1,L) >V/>r, >V//>Z 2122: G6=G6+VAPI(M1)*6(2,L) >V/>y, >V//>Z 2123: G7=G7+VAPI(M3)*8(2,L) >V/>y, >V//>Z 2124: G8=G8+VAPI(M3)*8(2,L) >V/>y, >V//>Z 2125: 12 CONTINUE 2125: IF(NTP EQ,1) 31=0.0 2127: IF(NTP EQ,1) 31=0.0 2128: G3=0 2128: G3=0 2129: IF(NAPXI, EQ,1)G3=1 /G2 2131: C 2131: C 2132: C RIGHT HAND SIDE 2131: C 2132: C RIGHT HAND SIDE 2134: C RIGHT HAND SIDE 2135: C DD 14 I=1, JON 2137: H1=MP(I) W: 2138: K=IABS(NOP(N, I)) 2139: TEMPR=TEMP(K) 2140: IF(MAPK, LT, 3, OP, ICONO, EQ, 0) TEMFR=1, 000 2141: IF(ANWT, EQ, 1, ) GO TO 15 2142: A11(I)=A11(I)+H1*DA*K*EETA*TEMPR 91 2143: A12(I)=A12(I)+H1*DA*K*EETA*TEMPR 93 2144: GD TO 14 2145: I5 CONTINUE 2144: A11(I)=A11(I)+H1*DA*K*EETA*TEMPR 93 2144: GD TO 14 2145: I5 CONTINUE 2144: A11(I)=A11(I)+H1*DA*K*EETA*TEMPR 93 2144: GD TO 14 2145: I5 CONTINUE 2144: A11(I)=A11(I)+H1*DA*K*EETA*TEMPR 93 2144: GD TO 14 2145: I5 CONTINUE 2144: A11(I)=A12(I)+H1*DA*K*EETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2149: C		2118	•	62=92+0080(K)2/*844 <b>/*</b> 14
2120: IF(ANWT.EQ.0.)GO TO 12 2121: GS=GS+VARI(M1)*R(1,L) Du/Dz, DVZ/DF 2122: GF=GF+VARI(M2)*R(1,L) Du/Dy, DVZ/DF 2123: GF=GF+VARI(M2)*R(2,L) Du/Dy, DVY/DZ 2124: GS=GS+VARI(M2)*R(2,L) DV/Dy, DVY/DZ 2125: 12 CONTINUE 2125: IF(NTF EQ.1) 31=0.0 2126: GF=0. 2127: IF(NTF EQ.1) 64=0.0 2128: GF=0. 2129: IF(NAKI.EQ.1)6F=1/62 2170: IF(NAKI.EQ.1)6F=1/62 2170: IF(NAKI.EQ.1)6F=1/62 2171: C 2172: D************************************		2110		G4=G4+VA₽I(M3)*H4 V,Vr
2120: IF (MM). B (1.10 10 12 ) J/br , $\partial Vz/\partial Z$ 2121: G5=G5+VARI(M1)*E(1,1) ) J/br , $\partial Vz/\partial Z$ 2122: G6=G6+VARI(M1)*E(2,1) ) J/br , $\partial Vz/\partial Z$ 2123: G7=G7+VARI(M2)*E(1,1) ) J/br , $\partial Vz/\partial Z$ 2124: G8=G8+VARI(M3)*E(2,1) ) J/br , $\partial Vz/\partial Z$ 2125: 12 CONTINUE 2125: 12 CONTINUE 2127: IF (NTR EQ. 1) G1=0.0 2128: G3=0. 2128: G3=0. 2130: IF (NAKI.EQ. 1)G3=1 /G2 2131: C 2132: C************************************		34.55		TEVENUT ED & VOD TO 10
2121. G5=65+VAPI(M1)*E(1,L) DV/DT, NV/DT 2122. G7=67+VAPI(M1)*E(1,L) DV/DT, NV/DT 2123. G7=67+VAPI(M2)*F(1,L) DV/DT, NV/DT 2124. G8=68+VAPI(M3)*8(2,L) DV/DT, NV/DT 2125. 12 CONTINUE 2125. 12 CONTINUE 2126. IF(NTP E0.1) G1=0.0 2127. IF(NTP E0.1) G1=0.0 2128. G3=0. 2129. IF(NAXI.E0.1) G4=0.0 2129. IF(NAXI.E0.1) G4=0.0 2120. IF(NAXI.E0.1) G4=0.0 2120. IF(NAXI.E0.1) DA=DA*G2 2170. IF(NAXI.E0.1) DA=DA*G2 2171.C 2170. IF(NAXI.E0.1) DA=DA*G2 2171.C 2170. IF(NAXI.E0.1) DA=DA*G2 2171.C 2171.C 2172.C************************************		2124	•	The must be strong to 15 yrs 9/1/94
2122: G6=06+VARI(M1)*6:2,L) Du/dy, dvz/dr 2123: G7=07+VARI(M2)*F(1,L) dv/dz, dv/dz 2124: G8=06+VARI(M3)*8(2,L) dv/dy, dv/dz 2125: 12 CONTINUE 2126: IF(NTP E0.1) 31=0.0 2127: IF(NTP E0.1) 04=0.0 2128: G3=0 2129: IF(NAMI.E0.1)63=1 /62 2130: IF(NAMI.E0.1)63=1 /62 2130: CRIGHT HAND SIDE 2131: C 2131: C 2132: CRIGHT HAND SIDE 2134: CRIGHT HAND SIDE 2134: CRIGHT HAND SIDE 2135: C 2136: D0 14 I=1, JDN 2137: H1=MP(I) W: 2138: K=IABS(NOP(N, I)) 2139: IF(MAPK.LT.3.OR.ICONO.E0.0) TEMFR=1.000 2141: IF(MAPK.LT.3.OR.ICONO.E0.0) TEMFR=1.000 2141: IF(ANUT.E0.1) G0 TO 15 2142: AII(I)=AII(I)#H1*DA*X*5ETA*TEMPR 91 2142: AII(I)=AII(I)#H1*DA*V*5ETA*TEMPP 93 2144: G0 TO 14 2145: 15 CONTINUE 2144: AII(I)=AII(I)#H1*DA*V*5ETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I)#H1*DA*V*5ETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2149: C		2121		G5=G5+VPRI(M1)*R(1,L) <b>&gt;"/3" , ""/</b> 0"
2122 G7-G7+VARI(M2)*F(1,L) 2V/2x, 2V/2z 2123 G8-G8+VARI(M3)*8(2,L) 2V/2x, 2V/2z 2125 12 CONTINUE 2125 If CONTINUE 2125 IF (NTP F0,1) 31=0.0 2127 IF (NTP F0,1) 64=0.0 2128 G3=0 2129 IF (NAXI.E0.1) 64=0.0 2129 IF (NAXI.E0.1) 64=0.0 2131 C 2131 C 2131 C 2132 C RIGHT HAND SIDE 2134 C************************************				RE=RE+VERI(MI) + E-2.1 > au/Au . AN/Au
2427: G7=G7+VHRF(CM2)*E(1,L) BV/Bx, BV/Bz 2124: G8=G8+VARI(M3)*B(2,L) BV/By, BV/Bz 2125: 12 CONTINUE 2125: IF(NTP EQ. 1) 31=0.0 2127: IF(NTP EQ. 1) 64=0.0 2128: G3=0 2129: IF(NAXI.EQ.1)63=1 /62 2130: IF(NAXI.EQ.1)63=1 /62 2131:C 2131:C 2132: C RIGHT HAND SIDE 2134: C************************************		<u>لا الم</u>		
2124: G8=G8+VARI(M3)*8(2.1) ∂v/∂y, ∂vr/∂r 2125: 12 CONTINUE 2125: IF(NTF EQ.1) 31=0.0 2127: IF(NTF EQ.1) 04=0.0 2128: G3=0. 2129: IF(NAXI.EQ.1)08=1 /G2 2130: IF(NAXI.EQ.1)08=08*32 2131:C 2132:C RIGHT HAND SIDE 2132:C RIGHT HAND SIDE 2134:C************************************		2123:		REALANDER (WESTER DALOR ) SALAT
2122: 12 CONTINUE 2125: 12 CONTINUE 2125: 12 CONTINUE 2126: IF(NTP EQ. 1) 91=0.0 2127: IF(NTR EQ. 1) 04=0.0 2128: G3=0. 2129: IF(NAXI. EQ. 1) 0A=0A+02 2120: IF(NAXI. EQ. 1) 0A=0A+02 2121: C 2122: C***********************************		21.2.1		BS=BS+VBRI(MZ)*S(2,1) suls $CM/OZ$
2125: 12 (0M 1492 2126: IF(NTP E0.1) 31=0.0 2127: IF(NTP E0.1) 64=0.0 2128: G3=0. 2129: IF(NAMI.E0.1)08=09+62 2120: IF(NAMI.E0.1)08=09+62 2121: C 2122: C***********************************				20171
2125: IF (NTP E0. 1) 31=0.0 2127: IF (NTR E0. 1) 64=0.0 2128: G3=0. 2129: IF (NAXI. E0. 1) 03=1 /62 2170: IF (NAXI. E0. 1) 08=09*02 2171: C 2172: C************************************		2125:	12	TUNI 1NDE
2127: IF(NTR EQ. 1) 64=0.0 2128: G3=0. 2129: IF(NAXI.EQ. 1)63=1 /62 2170: IF(NAXI.EQ. 1)DA=DA+62 2170: IF(NAXI.EQ. 1)DA=DA+62 2170: C 2170: C 2170: C 2170: C 2176: D0 14 I=1, JDN 2175: C 2176: D0 14 I=1, JDN 2177: H1=WP(I) W: 2178: K=IABS(NOP(N, I)) 2179: TEMPR=TEMP(K) 2140: IF(MAFK.LT.3.OR.ICOND.E0.0) TEMFR=1.000 2141: IF(ANWT.E0.1.) G0 TO 15 2142: AII(I)=AII(I)+H1+DA+X×EETA+TEMPR 91 2142: AII(I)=AII(I)+H1+DA+X×EETA+TEMPR 93 2144: G0 TO 14 2145: 15 CONTINUE 2144: AII(I)=AII(I)+H1+DA+X+BETA+TEMPR-H1+DA+(61+65-64+66)+ 2147: AI2(I)=AI2(I)+H1+DA+Y+BETA+TEMPR-H1+DA+(61+67-64+68)+ 2149: C	2	3126		TE(NTP_EQ.1) 31=0.0
2127. IF (NTX EW. 1) 64-0. 0 2128: 63=0. 2129: IF (NAXI. EQ. 1)63=1 /62 2130: IF (NAXI. EQ. 1)0A=DA+62 2131: C 2132: C RIGHT HAND SIDE 2132: C RIGHT HAND SIDE 2132: C RIGHT HAND SIDE 2134: C************************************	• )			
2128: G3=0. 2129: IF(NAXI.E0.1)G3=1 /62 2170: IF(NAXI.E0.1)DA=DA*G2 2171:C 2170: C************************************		2227		IF(0)7 EW. 17 04-0.0
2129 IF(NAXI.EQ.1)03=1 /62 2120 IF(NAXI.EQ.1)DB=DB+02 2131 C 2132 C RIGHT HAND SIDE 2124 C************************************		2128.		- GS=-0.
21270 IF (NAMI. EQ. 1)DB=DA+G2 2131 C 2132 C RIGHT HAND SIDE 2132 C RIGHT HAND SIDE 2134 C************************************				TERNAMT FO 4 YRR=1 200
2170 IF(NHX1.EW.1)DH=DH+U2 2171 C 2172:C************************************		<b>.</b>		
2131 C 2132: C************************************		2170		IF(NHX), EU, 1)DH+DH+G2
2112:C**********************************		3474	, <b>-</b>	•
2132:C RIGHT HAND SIDE 2132:C RIGHT HAND SIDE 2174:C************************************			· · · · · ·	en en esta de
2133:C RIGHT HAND SIDE 2124 C************************************		2122:	1.****	****
2174 C************************************		2122.	C	RIGHT HAND SIDE
21.4 (C************************************			S	
2175.0 2136. DO 14 I=1, JDN 2137: H1=WP(I) W: 2138: K=IABS(NOP(N,I)) 2139: TEMPR=TEMP(K) 2140: IF(MAPK.LT.3.OR.ICOND.ER.0) TEMPR=1.0D0 2141: IF(ANWT.EQ.1.) GO TO 15 2142: AI1(I)=AI1(I)+H1+OP+X*EETA*TEMPR 91 2142: AI1(I)=AI1(I)+H1+OP+X*EETA*TEMPR 93 2143: GO TO 14 2145: 15 CONTINUE 2144: GO TO 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)+H1+DR*X*EETA*TEMPR-H1+DR*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I)+H1+DR*X*EETA*TEMPR-H1*DR*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		21-4	1	
2136       D0 14 I=1, JDN         2137       H1=WP(I)         2138       K=IABS(NDP(N,I))         2139       TEMPR=TEMP(K)         2140       IF(MAPK, LT. 3. OR. ICOND. EQ. 0)         2141       IF(ANWT.EQ. 1.)         2142       AI1(I)=AI1(I)+H1+OP+X*EETA*TEMPR         2142       AI1(I)=AI1(I)+H1+OP+X*EETA*TEMPR         2143       GO TO 14         2144       GO TO 14         2145       15 CONTINUE         2146       AI1(I)=AI1(I)+H1+OP+X+BETA*TEMPR         914       GO TO 14         2145       15 CONTINUE         2147       AI1(I)=AI1(I)+H1+OP+X+BETA*TEMPR-H1+DP+(G1+G5-G4+G6)*         2147       AI2(I)=AI1(I)+H1+DP+Y+BETA*TEMPR-H1+DP+(G1+G7-G4+G8)*         2147       AI2(I)=AI2(I)+H1+DP+Y+BETA*TEMPR-H1+DP+(G1+G7-G4+G8)*         2148       14 CONTINUE         2149:0       14 CONTINUE	•	2175	Ū.	
2126. DO 14 12000 2127: H1=WP(I) W: 2128: K=IABS(NOP(N,I)) 2139: TEMPR=TEMP(K) 2140: IF(MAPK.LT.3.OR.ICOND.ER.0) TEMPR=1.000 2141: IF(ANWT.E0.1.) GO TO 15 2142: AI1(I)=AI1(I)+H1+OA+X+EETA+TEMPR 91 2143: AI2(I)=AI2(I)+H1+OA+Y+EETA+TEMPR 93 2144: GO TO 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)+H1+DA+X+EETA+TEMPR-H1+DA+(G1+G5-G4+G6)+ 2147: AI2(I)=AI2(I)+H1+DA+Y+EETA+TEMPR-H1+DA+(G1+G7-G4+G8)+ 2148: 14 CONTINUE 2149:C	Ą	3475	••	DD 11 T=1. TDN
2137: H1=WP(1) Wi 2138: K=IABS(NOP(N,I)) 2139: TEMPR=TEMP(K) 2140: IF(MARK.LT.3.OR.ICONO.ER.0) TEMPR=1.000 2141: IF(ANWT.EQ.1.) GO TO 15 2142: AI1(I)=AI1(I)¥H1*DA*X*EETA*TEMPR 91 2143: AI1(I)=AI1(I)¥H1*DA*Y*EETA*TEMPR 93 2144: GO TO 14 2145: 15 CONTINUE 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)¥H1*DA*X*EETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I)¥H1*DA*Y*EETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		2220.		La Carlo de Transfer de La Carlo de Car Carlo de Carlo de Car
2178: K=IABS(NOP(N,I)) 2139: TEMPR=TEMP(K) 2140: IF(MAPK.LT.3.OR.ICOND.ER.D) TEMPR=1.0D0 2141: IF(ANWT.EQ.1.) GO TO 15 2142: AI1(I)=AI1(I)+H1*DA*X*EETA*TEMPR 91 2142: AI2(I)=AI2(I)+H1*DA*Y*EETA*TEMPR 93 2144: GO TO 14 2145: 15 CONTINUE 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)+H1*DA*X*EETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I)+H1*DA*Y*EETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		21371		H1=WP(1) Wi
2110 2179 TEMPR=TEMP(K) 2140 1F(MAPK, LT. 3. OR. ICONO. EQ. 0) TEMPR=1.000 2141 IF(ANWT. EQ. 1.) GO TO 15 2142 AI1(I)=AI1(I)+H1+OP+X*EETA*TEMPR 91 2143 GO TO 14 2145 15 CONTINUE 2146 AI1(I)=AI1(I)+H1*DP+X*EETA*TEMPR-H1*DP*(G1*G5-G4*G6)* 2147 AI2(I)=AI2(I)+H1*DP+X*EETA*TEMPR-H1*DP*(G1*G7-G4*G8)* 2148 2148 14 CONTINUE 2149:0		2170		K=TARS(NDP(N,T))
2179 2140: IF(MAPK.LT.3.OP.ICOND.ED.0) TEMPR=1.000 2141: IF(ANWT.EQ.1.) GO TO 15 2142: AI1(I)=AI1(I) + H1+DA+X*EETA*TEMPR 91 2143: AI2(I)=AI2(I) + H1+DA+Y*BETA*TEMPR 93 2144: GO TO 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I) + H1*DA+X*SETA*TEMPR-H1+DA+(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I) + H1*DA+Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C				
2140: IF(MAPK.LT.3.0P. ICOND.ED.0) TEMPR=1.000 2141: IF(ANWT.ED.1.) GO TO 15 2142: AI1(I)=AI1(I) #H1*DA*X*EETA*TEMPR <b>91</b> 2143: AI2(I)=AI2(I) #H1*DA*Y*BETA*TEMPF <b>93</b> 2144: GO TO 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I) #H1*DA*X*BETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I) #H1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		2239		$I \subseteq II = F \equiv I \subseteq II = \{X, Y\}$
2141: IF(ANWT.EQ.1.) GO TO 15 2142: AII(I)=AII(I) + H1 + OA + X + EETA + TEMPR 91 2142: AI2(I)=AI2(I) + H1 + OA + Y + BETA + TEMPR 93 2144: GO TO 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I) + H1 + DA + Y + BETA + TEMPR - H1 + DA + (G1 + G5 - G4 + G6) + 2147: AI2(I)=AI2(I) + H1 + DA + Y + BETA + TEMPR - H1 + DA + (G1 + G7 - G4 + G8) + 2148: 14 CONTINUE 2149: C		2120		IF(MARK.LT.3.DR.ICOND.ER.0) TEMPR=1.ADA
2142: 2142: AI1(I)=AI1(I)¥H1*DA*X*EETA*TEMPR <b>91</b> 2143: GU TU 14 2144: GU TU 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)¥H1*DA*X*BETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I)¥H1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		34 14		TEVANUT ED 4 > DD TD 45
2142: AI1(I)=AI1(I)+H1*OA*X*EETA*TEMPR <b>71</b> 2143: AI2(I)=AI2(I) <b>F</b> H1*OA*Y*BETA*TEMPR <b>93</b> 2144: GO TO 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I) <b>F</b> H1*DA*X*BETA*TEMPR-H1*DA*(G1*G5-G4*G5)* 2147: AI2(I)=AI2(I) <b>F</b> H1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		2141.		17 (HNW), 2W, 1, 7 GC 10 10
9143, AI2(I)=AI2(I) <b>T</b> H1*DA*Y*BETA*TEMPF 93 92144; GO TO 14 92145; 15 CONTINUE 2146, AI1(I)=AI1(I) <b>T</b> H1*DA*X*BETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147; AI2(I)=AI2(I) <b>T</b> H1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148; 14 CONTINUE 2149:C		21421		
2143: 2144: 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)FH1*DA*X*SETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=BI2(I)FH1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C				aig/i}_aig/i}Thi*Aa*V#reto#tempe <b>0-4</b>
92144: GU TU 14 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)∓H1*DA*X*SETA*TEMPR-H1*DA*(G1*G5+G4*G6)* 2147: AI2(I)=RI2(I)∓H1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		<u> </u>		and the second
♥ 2145: 15 CONTINUE 2146: AI1(I)=AI1(I)∓H1*DR*X*SETA*TEMPR-H1*DR*(G1*G5-G4*G6)* 2147: AI2(I)=RI2(I)∓H1*DR*Y*BETR*TEMPR-H1*DR*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C		2144		- GU - TU - 14
2146 AI1(I)=AI1(I) <b>T</b> H1*DA*X*SETA*TEMPR-H1*DA*(G1*G5-G4*G6)* 2147: AI2(I)=AI2(I) <b>T</b> H1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* 2148: 14 CONTINUE 2149:C	y	2125.	15	CONTINUE
-2146; HILLI/=911/I/TECOURTSACCIRTICUCSTAL*DF*(91*95-64*95/* -2147; HI2(I)=812(I)#H1*DA*Y*BETA*TEMPR-H1*DA*(91*97-64*68)* -2148; 14 CONTINUE -2149:C			ال بلد	GIA/INGIA/INTURGUUDETENTEMPE MAIAAIJAAJAA AKAGENADHUT
-2147: AI2(I)=RI2(I) <del>]</del> H1*DA*Y*BETA*TEMPR-H1*DA*(G1*G7-G4*G8)* -2148: 14 CONTINUE -2149:C		21 <sup>44</sup>		「ロイエア」と、「ロイエア」と、「ロイル」に、「レンジ」には、「マンジー」「ロイアン」と、「ロイアン」と、「ロイアン」と、「ロイエア」と、「ローイエア」と、「ローー」、「ローー」、「ローー」、「ローー」、「ローー」、「ローー」、「ローー」、ローー」、
2148: 14 CONTINUE 2149:C		2147.		
2149 C			4.4	PANTINHE
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2150. D\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

141, 522, 141 JII , J22 31, J22 11 \*GS\*ANNT **033** J+1, JJ 933 923 51,17 913 1,17 IF (ANWT. EQ. 1.)60 TO 17 AR(J1.J2)=AR(J1.J2)+H7 AR(J1.J2)=AR(J1.J2)+H7 AR(J1.J2)=AR(J1.J2)+H7+H8\*G3\*V **33** 60 TO 25 60 TO 25 AR(J1.J2)=AR(J1.J2)+H7+H8\*G3\*V+H1\*0F\*H4\*G3 AR(J1.J2)=AR(J1.J2)+H7+H8\*G3\*V+H1\*0F\*H4\*G3 AR(J1.J2)=AR(J1.J2)+H2\*DA\*H4\*G5\*PNWT **31** AR(J1.J2)=AR(J1.J2)+H2\*DA\*H4\*G5\*PNWT **31** AR(J1.J2)=AR(J1.J2)+H2\*DA\*H4\*G5\*PNWT **31** AR(J1.J2)=AR(J1.J2)+H2\*DA\*H4\*G7\*PNWT **31** AR(J1.J2)+J2)+J2+DA\*H4\*G7\*PNWT **31** AR(J1.J2)+J2)+J2+DA\*H4\*G7\*PNWT **31** AR(J1.J2)+J2)+J2)+J2+DA\*H4\*C7\*PNWT **31** AR(J1.J2)+J2)+J2)+J2)+J2)+J2)+J2)+ 36 **Q32 A**12 212 **a**22 5(+1, 72 Р 11, 12 031 azı r F 2551 C FORM FLUID MATRIX 2555 C FORM FLUID MATRIX 2556 D0 18 12=1.2 0.13 = [11-1)\*5+2\*12+1 0.13 = [11-1)\*5+2\*12+1 0.13 = [11-1)\*5+2 0.13 = [ A. (CONT. FETHSOL VAC 5 \$ 6 5 R 5

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FETHSOLVAC (CONT.)

1 . . 121 ÷£ 1 ÷ ۲٦ 15 Ŭ F \$ N01 **T** 71 1: 1 ·\* 1 ... . \* -\$ true *د*م. n Ú 4 G. 8 R ٠. 12.4 14 ÷  $1 \leq q$ 0 4 Q ••••• 3 14 \*\*\*\* ¥ 💭 m a 1. EL. にアト 20 2: ŰŁ. 通じ **.**... · . Li ÷ 4 1.3% С С) ÷Ę **F**12 u.h. a ÷ Z T ¥ 12. £ 🗋 4 ULMON 臣 16 . 30 1 11 1 111 ---· \* - 4 £14 F= 14 1 C. イナスティ -11 ÷ 14 11: 3 1.\_-15 ų. モチ C ...... եղևլ £1., ie Uj 24 1 ÷ + 101 --- 1 111 lui ¥ at the 25 4 ч. キロ 山北 1 1 ---1) (L) 4 (L) 73-5.0 Y++ `~ A TNO NOLL to be Fing >  $\tilde{*}$ \* . · · · × 14 15 \* \* T T C.|| 11 4 ŰĽ. ÷ T1. ~~ L13 NUMB ł.... \*\*\* C :-1 14 .... 152 111 Sec. 64 ~ ( C) ] (c) -÷4-112, J22 12, J22 12, J22 TRO CN: ×. 1-5 •-. . . . ..... ·\*\*. 10-1-1 Arry Bary +--+ ÷. \* ÷. -1 + +1 ·.\_\_ 2 资*1*111年 1月2日日 1月2日日 •••• H 81-4 N 30-4 \* 2. \* - $\gamma_{i} \in \Gamma(j)$ ÷ KK2=IABS(NOP(N, K TEMPR=TEHP(K2) IF(HARK, LT, 2, OR IF(NTR, EQ, 1) GO AA(J1, J22)=AA(J1, AA(J1, J22)=AA(J1, AA(J1, J22)=AA(J1, 5 . A. . . . . •\*\* -, her buy **美** 北日 4 3. m. X យ ច េ 🗲 -ft u Liz 医白素 2 11 11 + A DUNER ¥ I~ ₹ See. N1 4 4 -1-5 11 2 Non all 1- + 1 000 41.14 ÷ (1) ÷ 西非齐 7 6 11 3 1-1 A. 4. 84 10.01 տե տի ٠. 50, 64 NO 200, 64 NO eres es 1.1 ٠ -••••• · · · · Umi \* ÷. 4 3 4 チト・チ 110N111 148844 TRACTI TRACTI NRX5=6 NRX5=6 NRX5=6 NRX5=6 NENTON ₹. Ш 10 10 10 10 チチ \*2.\* \* Ur Y ÷ ÷¢ ÷ ÷ 0000 0000 0101 チチチ ۰0 4. L. 10.03.15 ÷ 14. 14. 64 <u>چ</u>. \*1 \*1 54 ÷. ..... ÷ 1 ÷ ÷. ¥ ÷. - 5-CONTRACTORS. しい **化-化-化-化-化**-化-化-化-1.5 T. S. L. L. L. S. S. S. S. S. S. • • • 5 Ð P 5 5 **C**^

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2258	2 GPF, GPG, GPH, EMU, NG(3), CG(3), DS, DM, DY.
2257	I NP, NH, NE. NE, NDF, NCN, NEN, IT1, NP1, HTFP
22-9-	4, NTIME, MAEK, NTRALTIM, MTELT, MCARDS, NSIO, NAMI
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2257.	1 N, NG, LL, ((DE(L, I), L=1, 2), DP(I), I=1, NG), (DDP(L), L=1, LL), NGG
2244	2.((CE(L, I), L=1, 2), CE(I), I=1, NGG)
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\*10\*10+10+10\*10\*10\*04404 ٠. 54\*66)\*#NWF 34\*68)\*#NWF HD A\*PP(L1)/FH0 <u> ビガナ くらけき さごナビ ガキごけき</u> -; 法法法法法法法 NOTION WILLING ADD MUDI-0 +0 +0 • \* ٠. EQUATION Reversion 4 6 \$ H7=H1+0A+164+H5+64+H67 H2=H1+0A+164+H5+64+H67 H8=H1+0A+14+63 A+H1+0A+H4+65+RHHT A+H1+0A+H4+65+RHHT A+H1+0A+H4+65+RHHT 1+H1+0A+H4+65+RNHT 1+H1+0A+H4+62+RNHT 1+H1+0A+H4+62+RNHT \*\*\*\*\* 99 \* \* \* \*\*\*\*\* ۲J, ••• , •\*•, -11-1 +0++(0) +0++(0) "是年来是是来来来来来来来来来来来。" 10岁,110日,14日日,1401日,1401日,1401日,1401日,1401日,1401日,1401日,1401日,1401日,1401日,1401日,1 Г<u>г</u> э Ľ ∡ 117-205×20-\*<del>TH+</del>A\*#U\*1 \*TH+X\*#U\*1 15) . संदर्भ दाष्ट्रप् 1.1.1.1. -المند 64 4 1 64 C 4 4 チチー F. C.C. £ PR(J1, J1) PR(J1, J1) PR(J21, 1 61 \* \* 0777 0777 0777 0777 Carta m. 4 \*000 \*000 \*004 -004 \*00 \*0 \*00 \*0 an tu ba di H1=4P(I) FF(ANWT) BI1(I)=PI2(I) BI2(I)=PI2(I) G0 T0 14 C0NTINUE BI2(I)=PI2(I) BI2(I)=PI2(I) BI2(I)=PI2(I) BI2(I)=PI2(I) A. M. 1001 1000 (CONT. <u>ر</u> :-チョイ . 3. 4. \* 0. \* \* 0. \* \* 0. \* \* 0. \* \* 0. \* \* 0. \* 美国著 й. У •\$ FETHSOL VAC ۲1 \*\*\* チャチチ ÷ 1 n \*\*\* -1 •\$ \*1 4 . いいいしい to Bate to take 

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(CONT. ) FETHEOLVAC ×) 1+H1+DA\*H4\*B6\*ANNT 2484 : AA(311, J2)=AA(311, J2)+DA\*V\*H2\*H5 2462 1+H1+DA×H4+G7\*ANWT 2403; 2494 ( 0 2483、门中央市务安全市务务力学校安安大学大学会学校 2406 C - CONTINUITY EQUATION 2487、Crannerrannerrannerrannerranner 🔊 2485 (Č IF(12.50.2)60 TO 16 2409 -HA(J1+1, J2)=HA(J1+1, J2)+DA\*FP(I1)\*H5 2410 AR(J1+1,J22)=AP(J1+1,J22)+DR\*PP(I1)\*H6+FP(I1)\*DA\*H4\*G3 2411 16 CONTINUE 2412: 18 CONTINUE 2413: 20 CONTINUE 2414. 00 22 I=1. JDN 2415. K=IABS(NOP(N, I)) 2416 M1=NOPF(K) 2417: Z M3=M1+MDF(K)-12419: R1(M1)=R1(M1)+BI1(I) 2119. R1(M3)=P1(M3)+AI2(I) ្តិរ*ិត* -2421 -22 CONTINUE 24223 RETURN END 2423 : 2424 (1) 2425:0 🛪 2407 . Ö 242 I. 2428.0 · . 2429-0 2439.0 SUBPOUTINE EFVISC(IELEM) 2471 IMPLICIT DOUBLE PRECISION (R-H, 0-Z) 2422 DIMENSION EMUT(8), EMUE(8); CONDET(8), 2433: -CONDFE(S), VKINH(122), VMUDYN(122), VCOND(122) 2423 -COMMON/CONTP/ 2425: 1 X, Y, Y, CONDE, BETA, CPE, RHD, HCOEX, HCOEY, 24381 OPF, GFB, GFH, EMU, NG(3), CG(3), DS, DX, DY, 2437: NF, NH, NE, NB, NDF NCM, NEN, IT1, ND1, MTRD 2479. 3 A, NTIME, MERK, NTP. LTIM, MTRIT, NCARDS, NSID, NENI 2272: 5. NET, MWGP, NMP. NELL, NTPA, NGAUSS, NPR. NCR. NLP. NCP 2449 -5, NCOPD, IG, NG, NEY, NET, NEWTON, ITURE, ICOND 2442. COMMON/GEP/ 24-2: 1 TEMP(461),CORD(451,2),RSPEC(461 6) 2443 2443 -2,F1(1553),R2(1533),VARI(1553),VARA(1553),BC(1553) 3 2,VALV(560),AYARI(1552),NOP(122,8),NON(122).LPR(122) 2445; 4,NOPP(461),MDF(461),NCOD(1552),NOOV(560) 2446) COMMON/GUARD/ 2447: 1 SK(40000),ESTIFM(29,28),GISH(600),INTEG(2700) 2118: 2342 -COMMON/UPMIN/ 2459:

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	FETH	ISOLVAC	(CONT.)
Ģ			
	2451 :		, WP(8), WDEL(2,8), WB(2,8), DWB(2,72), DWP(72), TT(8) 
	2452:	ک	,HU(8),VV(8),UHVE(2),YHVE(2),IUHWIW,IW(3),VKIW(VKUW Rommoniitisetna / Tesidaan, Ekerdean, Temu(461),ITERNAN
•	2401. 2454		IF(MARK, EQ. 2)60 TO 1
	2455		DO 11 I=1, NH
4	2456.		105=906(12 I-NORR/I)
-	2457. 2450 -		J=NUFF(1) IF(IDF, EQ. 2) JJ=J+1
0	2450.		IF(IDF. EQ. 3) JJ=J+2
	e i Ee :		DIE(1, I)=VARI(J) U ? Uncounded solo
	2451 -		DIS(2) I)=VHRI(UU), V J Cooperation, Distance of the second secon
•	29827 2457 -	11	CONTINUE
	2464 :		60 70 3
•	2465	4	CONTINUE
	ខ្នាត់តិត ការ៤១។		UU 2 1-1/NA TAFEMARE(T)
	2467. 2420-		J=NOPP(I)
	24 <u>5</u> 9		IF(IDF = EQ, 3)JJ=J+1
	2479		$\frac{1F(1)F}{F(1)} = \frac{1}{2} $
	2471: 0:170-		DIS(2, I)=VAPI(JJ) V ( Gupley Soly.
	2472. 2477-		DIS(3, I) = VARI(JJ+1) T J
	2474	- 2	CONTINUE
	2475.	<u>.</u>	CONTINUE og 10 t-1 New
Q	2475: aven		VG IG I-I,NDN KEIRRS(NNP(IF/FM,I))
4	249 2179		UU(I)=DIS(1,K) U 2 Nodal values
•	2473		WW(I)=015(2. K) V + alement level.
	2480		$TT(1)=DIS(1,K) \top $
	249 <u>1</u> : 2492 :	: <u>1</u> 8	
•	2483. 2483	. 17 19 (19 (19 (19 (19 (19 (19 (19 (19 (19 (	***************************************
	2494	1.444	SHOULD TUREULENCE OCCUR THEN EVALUATE
2	2455	e all star spirate	HEFEUTIVE VISUUSITY DE EDEEN NODE N IOM THE RESE NE THE FANTNRE NE
• · · ·	2475. 7307	n an an an Tha an Ar	TUPEULENCE INTENSITY, TUREULENCEE KINETIC ENERGY
•	Carr. Carr	امر . الجويبيوات التي ا	AND THE LENGTH SCALE OF TURBULENCE 3 1. e.
	eaee.		(Prandtl-Kolmozorov) one equation
	2490. तर्दन		Model of Jurdalence. THE ANALORY RETWEEN THERMAL AND MOMENTUM DIFFUSIVITY
•		in a state	IS BEING CALLED UPON - VIA THE Prondtl-Number -
	2453.		WHERE EFFECTIVE CONDUCTIVITY IS DEDUCED USING THE
5	249d.	ju¶generet Latin Latin and	<u>-CHLUULH1ED</u> -EHFEU/1VE-V15UU511Y 
•	249). 2494)	r en er er er er er en er e en	ት እም የመመጠቅ መመጠቅ መሆን የሚያገኘ የ የሚያገኝ የሚያገኘ የሚያገ
•	2457	• •	IF (MARK. GE. 4. AND. ITERNAN. EQ. 1) GO TO 64
	2498		IF(ICOND, NE. 0) GO TO 12
4	2405		18(NIR.EU.1) GU (U 630 Pontikhe

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2500: 12 CONTINUE

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FETHEOLVAC (CONT.) **K**3 VKINM(IELEM)=0.0 V 2591VMUDYNYIELEM>=0.0 JL. 2502 2503 VCOND(IELEM)=0.0 K DO 300 KVV=1,8 256d · 2585:0 -LENGTH SCALE OF TUREULENCE FOR THE REGION OF 2507:0--2508:C----THE INLET TO THE CONVECTIVE CHANNEL. **\$**} <u>52899 - 6</u>2222 - 202 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 2022 - 202 - 202 - 2022 - 202 - 2022 - 20 2510:0 IF(IELEM.LE. 3. OF. (IELEM GE. 13. AND. IELEM.LE. 15))THEN 2514 512 ZLY=CORD(IAES(NDP(IELEM,KVY)),2) ZLY2=0.05100-ZLY 2512 CMU=0, 4476 Length scale of Turbulence lu = ZLLX. 1 514 2515 771<u>1-0</u> 500 251E ZPT2=ZPT1 ELLKT=2.0\*CMU\*ELY\*ZLY2\*ZPT1\*ZPT2 2517 2519 ZLN81=ZLY\*ZFT1\*SQRT(ZLY2\*\*2,0+ZFT2\*\*2,0) 2519 ELXE2=ZLY+ERT2\*50RT(ELY2\*\*2,0+EFT1\*\*2)0> ZLKE3=3L42\*3PT1\*50RT(3L4\*\*2,0+2PT2\*\*2,0) 2520 2LN84=2LY2\*2PT2\*5QRT(2LY\*\*2,0+2PT1\*\*2,0) 2321 ZLLXS=ZLXE1+ZLX82+ZLX82+ZLX84 2522 Turbulence Intensity 2523. ZLLX=ABS(ZLLXT/ZLLXB)◀ TINS=20.0D9 🔫 2524 UV=(S0PT((UU(KVV)\*\*2,000)+(V<u>V(</u>KVV)\*\*2,000)))/DIS(1)4) 2525: 2525 SOK=SORT(1.5D0)\*TINS\*89 VKinetic Energy ZLLY=ZLLX\*ABS(SQK) 2527 ELSE IF ((IELEM. GE. 4. AND. IELEM. LE. 10). DR. 2528 -(IELEM. GE. 16. AND. IELEM. LE. 22)) THEN 9 510 -LENGTH SCALE OF TUREULENCE FOR THE CONVECTIVE 532 -CHANNEL ITSELF. 2534 2535 252€ ELX1=COPD(IABS(NOP/IELEM,KVV)),1) 2577 ZLX2=0.0900-ZLX1 CMU=0. 4400 2538 ZFT1=0.509 2519 ZPT2=ZPT1 2540. ZLLXT=2.0\*CMU\*ZLX1\*ZLX2\*ZPT1\*ZPT2 2341. ZLXB1=ZLX1\*ZPT1\*SQRT(ZLX2\*\*2.0+ZPT2\*\*2.0) 2542 ZL%52=ZL%1\*ZFT2\*SQRT(ZL%2\*\*2,0+ZFT1\*\*2,0) 7517 ZLNES=ZLN2\*ZPT1+FORT(ZLN1\*\*2,0+ZPT2\*\*2,0) 2541 2940 2545 ZLX24=ZLX2\*ZPT2\*SQPT(ZLX1\*\*2,0+ZPT1\*\*2,0) ZLLX8=ZLX81+ZLX82+ZLX83+ZLX84 2546 ZLLX=ABS(ZLLXT/ZLLXS) 2547. TINS=17.000 2549 UV=(SORT((UU(KVV)\*\*2.0D0)+(VV(KVV)\*\*2.0D0)))/DIS(1,4) 2532 SQK=SQRT(1.5DQ)\*TINS\*UV 2552:

# FETHSOLVAC (CONT.)

2	)	
-	2551	: ZLLY=ZLLX*ABS(SOK) ELSE IF((IELEM.EQ.11.OF.IELEM.EQ.12).OR.
	2553	- <ielem. 23.="" 247.="" e0.="" ielem.="" ok.="" ur.<br="">-<ielem. 25.="" 267.="" e0.="" ielem.="" op.="" or.<br="">-<ielem. 35.="" 377.="" and.="" ge.="" ielem.="" le.="" or.<="" th=""></ielem.></ielem.></ielem.>
:)	2555 2557 2558	:
y	2559 2560 2561	:CLENGTH SCALE OF TURBULENCE FOR THE COMMON .CCHIMNEY BUTLET. :C++M***********************************
	2562 2557 2554 2565	:C : ZLX1=CORD(IABS(NOP(IELEM,KVV)),1) : ZLX2=0 198D0-ZLX1 : CMU=0 44D0
2	2588. 2587 2583 2583	:
	2579. 2571. 2572. 2572.	:
ら	2574 2575. 2574. 2577.	<pre> ELLN=AES(ELLNT/ELLNB) UV=(S0PT((UU(KVV)**2,0D0)+(VV(KVV)**2,0D0)))/DIS(1+4) TINS=19,0D0 S0K=S0RT(1,5D0)*TINS*VV</pre>
	2579) 2579) 2580)	: ZLLY=ZLLX*ABS(SQK) : ELSE IF((IELEM:GE.27.AND.IELEM.LE.34).OR. - (IELEM.GE.38.AND.IELEM.LE.45).OR. - (IELEM.GE.49.AND.IELEM.LE.45).THEM
	2582 2582 2582	CARAFTERENT SCALE OF TUREVLENCE FOR THE ROOM.
3	2595. Daos	- ** - TOTAL HORIZONTAL FLOW - **
	2507	TINS=7.0D0 ZLY=CORD(IAES(NOP(IELEM,KVV)),2) UV=(SORT((UU(KVV)**2.0D0)+(VV(KVV)**2.0D0)))/DIS(1.4)
	27-9 2591 2592 2592	ZLY2=1.022-ZLY CMU=0.44D0 ZFT1=0.5D0 ZFT2=ZFT1
3	594 7594 7595	2, 1272, 2 ZLLXT=2, 0+CMU*ZLY*ZLY2*ZPT1*ZPT2 ZLXB1=ZLY*ZPT1*SQRT(ZLY2**2, 0+ZPT2**2, 0) ZLXB2=ZLY*ZPT2*SQRT(ZLY2**2, 0+ZPT1**2, 0) ZLYB2=ZLY*ZPT4*Z0DT(ZLY2**2, 0+ZPT1**2, 0)
	1057); 7599; 7599; 7599;	ZLNB4=ZLY2*ZPT2*SORT(ZLY**2.0+ZPT2**2.0) ZLNB4=ZLY2*ZPT2*SORT(ZLY**2.0+ZPT1**2.0) ZLLNB=ZLMB1+ZLNB2+ZLNB3+ZLNB4 ZLLN1=ABS(ZLLNT/ZLLNB)

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FETHEOLVAC (CONT.)

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ZLX1=COPD(IPPS(NOP(IELEM, KYY)), 1) \*-TOTAL VERTICAL FLOW-\* ZLX2=1. 14800-ZLX1 1403 <u>ZLINT=2.0+CMU+ZLN1+ZLN2+ZPT1+ZPT2</u> ZLXE4=ZLX4+ZPT4+S0RT(ZLX2++2, 0+ZPT2++2, 0) 2-05 <u> 71 xe2=71 x4+7pt2+50pt(71 x2++2, 0+7pt4++2, 0)</u> 1607 1607 71 X87=71 X2\*7874\*5087771X4\*\*2, 0+7872\*\*2, 0) ZLYE4=ZLY2+ZPT2+S0RT(ZLY1++2, 0+ZPT1++2, 0) b lees ZLLME=ZLME1+ZLME2+ZLME3+ZLME4 <u>ZLLMS-ABS(ZLLMT/ZLLMB)</u> TLLMAD=(TLLMA+TLLM2)+0.500 3-11 2513 C----BOOM INLET HALL JET FLOH 2613 C----BOOM INLET HALL JET FLOH **9** 2417 2417 2417 2419 <u> 2142-214-0, 06000</u> 711 YT=2 @#FMII#71 U#71 U2#7074#7072 TI YEA-TI UNTETANGORT (TI UZANZ, BATPTZANZ, B) <u>=[yp==][y\*]pie\*enpi(][ye\*\*2]0+]pi4\*\*2</u>0} <u>71 YB2-71 U2+7FT1+COBT(71 U++2, 0+7FT2++2, 0)</u> <u>ZLYE4=ZLY2+ZFT2+SORT(ZLY++2,0+ZFT1++2,0)</u> <u>ZLLX9=ZLX94+ZLX92+ZLX92+ZLX94</u> 2628 73 ZLM2-ZLM4-0. 150500 <u>TLLXT=2.0+CMU+ZLX4+ZLX2+ZPT4+ZPT2</u> TLYE4-71 M4+7PT4+50PT(71 M2++2, 0+7PT2++2, 0) ZLYE2=ZLY1+ZPT2+SORT(ZLY2++2, 0+ZPT1++2, 0) <u>ZLMPZ=ZLM2\*ZPT1\*SORT(ZLM1\*\*2, 0+ZPT2\*\*2, 0)</u> <u> 71 MP4=71 M2+7P72+50P7(71 M4++2, 0+7P74++2, 0)</u> 2 <u>7|| xb+7| xb4+7| xb3+7| xb3+7| xb4</u> ZLLX4-ABSKZLLXTXZLLXBX <u> 21 | M24=21 | M2+21 | M4 - '</u> 2679 £ \_\_\_\_ ្តិភ្លាំដទា E----THE FLOW UP THE BACK WALL KIN THE ROOMS. <u>ZLM2+1.07200-ZLM1</u> ZLLXT=2.0+CMU+ZLX1+ZLX2+ZPT1+ZPT2 <u>71 x P1 = 71 x1 + 7 P T1 + 50 PT (71 x2++2) 8+ 2 PT 2++2, 8 ></u> <u>ZI VB2-ZI V1+ZPT2+SODT(ZI V2++2, 0+ZPT1++2, 0)</u> 2547 -ZLMPZ+ZLM2+ZPT1+SORTKZLM1++2.0+ZPT2++2.0} <u>neas</u> <u>ZLME4-ILMI#ZPTI#ENRT(ILM1##1,0+ZPT1##0,0)</u> ZLLX9=ZLX94+ZLX92+ZLX92+ZLX94 3**5**76 ZLLX5=APS(ZLLXT/ZLLMP) 711.8+711.842+711.824+711.85 SOK=SORT(1.500)+TINS+UY ZLLY=ZLLX+RES(SOM)

FETHSOLVAC (CONT. ) TINS=12. 000 3 ZLY=CORD(IAES(NOP(IELEM\_KVV)), 2) 2654) 2652) 2652) UV=(SORT((UU(KVV)\*\*2, 000)+(VV(KVV)\*\*2, 000)))/DIS(1,4) ZLY2=0. 0E2D0-ZLY \*\* - { LENGTH SCALE OF TURBULENCE ? FOR THE ROOM INLET DUCT · } 3F54 2633) 2633) 2637 2637 2657 2659 ZPT1=0. 500 ZPT2=ZPT1 ZLLYT=2.0+CMU+ZLY+ZLY2+ZFT1+ZFT2 ZLXE1=ZLY+ZPT1+SORT(ZLY2++2, 0+ZPT2++2, 0) ZLXP2=ZLV+ZPT2+SORT/ZLV2++2, 0+ZPT1++2, 0) nera -2[X02=2140+2071+CORT(214+2,0+2070++2,0) 2[ YE4=7[ Y2+7072+EDDT/7[ Y++2 B+7074++2 B) 711 MB=71 MB4 +71 MB2+71 MB7+71 MB4 ZLLM-ABS(ZLLMT/ZLLMB) SOK-SORT(1. SD0)+TINS+UV 22.2.3 ZLLY=ZLLY+ABS(SOK) 2665 2675 ELSE Ceta an de nême 2571 2672. p 2672. p 2474. p IF THE INLET CHANEL FLOW IS TURBULENT SUPPRESS 0675 06776 06776 2677 2677 THE FOLLOWING STRTEMENT i.e. (se to f2) HITH A "C" IN COLUMN ONE ē الأحافظ الأحافة المحافظ بالمراطب المراطب المراطب المحاصي بمحاطب المراطب المراطب المراطب المراطب المراطب المحاطب المراطب المراطب المحاطب المراطب المحاطب المراطب المحاطب المراطب المحاطب 2 2879 P 60 TO 52 2650-ZLX4=CORD(IRES(NOR(IELEM, KVV)),4) ZLX2=1. 41900-ZLX1 <u> PMU=0, 44D0</u> ZPT1=0.5D0 2420 7012=7014 2 2200 ZLLXT=2. @\*CMU\*ZLX1\*ZLX2\*ZPT1\*ZPT2 <u>7LX81=7LX1+7PT1+50PT(7LX2++2,0+7PT2++2,0)</u> ZLXE2=ZLX1+ZFT2+S0RT(ZLX2++2, 0+ZFT1++2, 0) 2233 ZLMPZ=ZLM2+ZPT4+SORT(ZLM4++2, 0+ZPT2++2, 0) 24,24 ZLXEd=ZLX2+ZPT2+SORT/ZLX4++2, 0+ZPT4++2, 0) 26.70 ZLLXE=ZLXE1+ZLXe2+ZLXE2+ZLXE4 2231 ZLLX-RES(ZLLXT/ZLLXE) 26.73 TINS=5. apa 2673 UV=(SORT((UU(KVV)++2, BDB)+(VV(KVV)++2, BDB)))/DIS(1,4) 8 2555 S SOK-SORT(1. SDOX+TINS+UV ZLLYHZLLY+RES(SRK) 20.55 END IF 2257 EMUT(KYY)=0. 0 Mt giria ЕМИЕСКИЧУ-0.0 🖊 е 2202. CONDET(KUY)=0. 0 Kt 2700-CONDEERKYYY=0. 0 Ke EMUTYKYYYEPHN\*PPEYZLLYY EMUEYKYYY=YKIN\*RHO+EMUTYKYYY CONDETCRUMY=CO. ZEDO\*EMUTCRUMY\*URDMY/URIN\*PHO CONDEECRUUS-URDNICONDETCRUUS CALL TLEKIN(KYY, IELEM, NH. NE, ZLLM, SOK. EMUT. NOP. NEM. COMPETY

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	FETHS	SOLVAC	(CONT.)	
2				I
	2701	380	CONTINUE	
	2792 - 2787 -		- EMU=0.0 - V=0.0	
	2794		CONDE-0. 0	
	2785 - 2785 -		DD 400 LVV=1,0 EMU=EMUECLVVSV0 ADAS Me 2 0 1	1
	2797 2797		CONDE=CONDE+COONDEECLUUX/9, ADAY Ke Fer Elowent	ļ
9	2702	400		
	2749 - 2719 -		Y=EMUZRHD	5 5
	2711	••	CO TO EIO	
	2712 2712	52	CUNTINUE EMUEVKIN+RHD	;
			IUPHIN=IHTS	'
	2745 9745		9=9K1N PONDE=940N	
3	1	620	CONTINUE	
	27(8) 9719		UKINAKIELEMY-U UMURUNYTELEMY-EMU	
	2729 -		VCDND(IELEM)-CDNDF	
	2721	E.S.	да та Еба Галттине	
	2722 -	= ''	V=VKINMCIELEMY	
	2724		ENU-UNUDUNITELENS	ı
-	2725 9774	650	CONTINUE	
V	2727	-5	CONTINUE	
	2729 0714	0000	ИНГЛЕКИ УУУУЛЕГТ ЕМИ,У. СОМОЕ ЕФЕМАТСТИ КЕГЕМЕНТ НА К КЕМИ,И РАНИЕ АРЕ-2 ТЕ.2620 103	
	2770	****	PETUDA	
			END Choranting theking ter by we as any emit was not south	
	2772		INPLICIT DOUPLE PRECISION (P-H.D-7)	• : .'
	2773		DIMENSION NOPCHE, NENS, EMUTCHENS, CONDETCHENS	
3			COMMON/TLEKINIZ TLEGAEI>,EKEGAEI>,TRMUGAEI>,ITERNAN Pommon/TISKINGZ TEPONOGZEIS	
			KN-IRESCNOPCIELEM. KWWYY	
	జైన, గ్ జైనాని:		TLS(KN)=ZLLM FKEZKN)=SOK	
	อีรีสุด		TRMUCKNY=EMUTCKVVY	
,	2741 9749 -		TREEND(KN)-CENDET(KVV)	
	2747		END	
9	2733 2735 -	<u> </u>		
	2745	2 C		
	2747 2719	Ē.		
	2749	r r		
	2750	ē		
			SCERCOIINE FYFROPCIELEM? IMPLICIT DOUBLE PRECISION (P-H.A_7)	
			DIMENSION DVISC(2), EFKON(2), STEMP(2)	
`I			CUMMUN/CONTR/	

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## FETHSOLVAC (CONT.)

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1 X, Y, Y, CONDF, BETA, CPF, RHO, HCOFX, HCOFY, 2751 : 2 GFF, GFG, GPH, EMU, NG(3), CG(3), DS, DN, DY, 2752 -3 NP, NH, NE, NE, NOF, NCH, NBN, IT1, ND1, MTRD 2753: 4, NTIME, MARK, NTR. LTIM, MTRIT, NCARDS, NSID, NAXI 2754 -5, NRT, MWGA, NNP, NELL, NTRA, NGAUSS, NFR, NCR, NLP, NCP 2755. 6, NCORD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND 2756: COMMON/GEP/ 2757. **2**2758; 1 TEMP(461), CORD(461, 2), RSPEC(461, 6) 2, R1(1553), R2(1553), VARI(1553), VARA(1552), BC(1553) 2759: 3, VALV(560), AVARI(1553), NOP(122, 8), NON(122), LPR(122) 2750: 4, NOPF/461), MDF(461), NCOD(1553), NODV(560) 2761: COMMON/GUARD. 2762 1 SK(40000), ESTIFM(28, 28), GISH(500), INTEG(2700) 2762: COMMONZUPHINZ 2764 : 1 AA1,AA2,A1,A2,EB1,B22,81 82,0IS(3,461) 2765 2, WP(\$), WDEL(2, 8), WB(2, 8), DWB(2, 72), DWP(72), TT(8) 2766. **2**2767 2768:0 3,UU(8),VV(8),UAVE(2);VAVE(2),IUPWIN,IWTS,VKIN,VKON EVALUATE THE VISCOSITY AND CONDUCTIVITY ON THE BASIS 2770 · C\*\*\* OF VARIABLE PROPERTY CONSTRATS DEFENDENT ON 2772 - 0\*\*\* 2772:0\*\*\* THE TEMPERATURE (K). 2774.0 2775) 2776) IF(NTR. GT. 1) RETURN DO 115 NN=1.NEN 3 STEMP(NN)=0. 0 2777 2778 L=IABS(NOP(IELEM, NN)) 2772 IDF=MDF(L) 2790 J=NOFP(L)-1 2721 -IF(IDF LT NOF) GO TO 105 IF/NDF E0.2) GO TO 115 2782 STEMP(NN)=VARI(J+IDF) 2783 2784-GO TO 115 105 IF(IDF. EQ. 1) GO TO 110 2785 3 GO TO 115-2796 2797. STEMP(NN)=VARI(J+1) 110 115 CONTINUE 2788: 2799 TAV=0 0 DO 100 IVV=1,8 2790 2791 TEMPK=0. 0 DVISC(IVV)=0.0 2792. 2792 EFKONCIVY)=0.0 2794 TEMPK=STEMP(IVV)+273.0 VNUM1=((TEMPK)\*\*1.5)\*1.4580-06 2795 VDEN=110.4+TEMPK 2795 DVISC(IVV)=VNUM1/VDEN 2737: SNUMK=2.64820-03+SQFT(TEMPK) 2798 SDENK1=-12. 0/TEMPK 2799-SDENK2=10. 0\*\*SDENK1 2800:

12 不不不不不不不不 V CURTAURT & 大学家有些大学学生学生学生学生学生学生 UPWINNING ũ. NPNT NLP, NCF s, 1 **UNH** IMPLICIT DOUGLE PRECISION (A-H, Q-Z) COMMON/CONTP/ COMMON/CONTP/ 2 Kry V. CONDF, BETA, CPF, RHO, HCOTX, HCDFV, 2 GPF, GPG, GPH, EMU, XG(Z), CG(Z), DS, DX, DY, 2 NP, NH, NE, NP, NDF, NCM, NBN, ITL, NOL, MTRO 4, NTIME, MAPK, NTR, LTIM, MTRIT, NCARDS, NSTO, NP 5, NRT, MMCB, NNP, NELL, NTPA, NGAUSS, NPR, NCP, NL 6, NCORD, IG, NG, NPV, NBT, NEWTON, ITURE, ICOND に度し 11 بدع \* 2 11 TUOH. \*\*\* ं भ EQUATION -1.5  $\mathbf{r}_{\mathbf{r}}$ ٦ź છું + .... 11 13 ----(01-10 SDENK4=1. 0+(SDENK2)/TEMPK SPENK4=1. 0+(SDENK2)/TEMPK EFKON(IVV)=(SNUMK/SDENK4) TRV=TRV+(TEMPK/S.) TRV=TRV+(TEMPK/S.) CONTINUE EMU=0. 0 V=0. 0 V=0. 0 V=0. 0 V=0. 0 CONDF=0. 0 C 56726 ~ (CONT. ~子子子子子子子 MOINTIG FETHSOL VAC 100 200 たいいいいい だってい たってい てってい たってい ていてい たいていてい  $\mathbf{C}$ 0 Ø D P Ň

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### (CONT.) FETHSOLVAC COMMON/GEP/ 2851: 1 TEMP(461),CORD(461,2),RSPEC(461,6) 2852: 2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) 3. VALV(560), AVARI(1552), NOP(122, 8), NON(122), LPR(122) 2854 4, NOPP(461), MDF(461), NCOD(1553), NODV(560) 2855. COMMON/GUARD/ 2856:

1 SK(40000),ESTIFM(29,28),GISH(600),INTEG(2700) COMMON/UPWIN/

- 1 881,882,81,82,881,882,881,82,0IS(3,461)
- 2, WP(8), WDEL(2, 8), NB(2, 8), DWB(2, 72), DWP(72), TT(9) 3. UU(8), VV(8), UPVE(2), VAVE(2), IUPWIN, IWTS, VKIN, VKON
  - DIMENSION AI1(8), AI2(8), F(8), B(2,8), AI3(8)
  - DIMENSION RA(28, 28), PF(4), BE(2, 4), CB(2, 36), CP(36) DIMENSION DB(2,72),DP(72),DDR(9)
- 2864 EQUIVALENCE 2965 1 (ESTIFM(1,1),98(1,1)) -2866.
- **)**2867.0 2863 -ANWT=0.0
  - IF (NTR. GT. 2) ANNT=FLOAT (NEWTON) JDN=NON(NELL)
  - THEL IF(JDN. NE. NEN)IM=3 -
  - DD 2 J=1, JDN
  - A[1(3)=0]AIS(J)=0.
- 2875: 2 AI2(J)=0. 2875 -
- 00 4 I=1, NCN 2377 -DO 4 J=1, NCN 2873.
- よ 月日(I、J)=9. 2879)

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- 2889-0
- - READ(10) 1 N, NG, LL, ((DB(L) I), L=1, 2), DF(I), I=1, NG), (DDR(L), L=1, LL), NGG 2, ((CE(L, I), L=1, 2), CP(I), T=1, NGG) IF(IUPWIN. EQ. 0)GC 70 7 READ(S) 1 N,NG,LL,((DWB(L,I),L=1,2),DWF(I),I=1,NG) CONTINUE 7 DG 20 NG=1, LL DA=DDA(NG) DO S I=1. JON NJ=(NG-1)\*JDN+I P(I)=DP(NJ) WP(I)=P(I)
- 2897 IF(IUPWIN.GT.@)WP(I)=DWP(NJ) 2900
- D0 6 L=1,2 2200
- B(L, I)=DB(L, NJ) 2999

2 2981 -NB(L, I)=B(L, I) IF(IUPWIN. GT. 0)NE(L) I)=DWE(L, NJ) 2992 CONTINUE 2997 Б S CONTINUE 2984 00 10 I=1, IM 2005. 91 du Q12 ais a14 NJ=(NG-1)+IM+I 2598 P 0 2997 PP(I)=CP(NJ) azz a21 ars 924 2 DO 9 L=1,2 2998 5B(L, I)=CB(L, NJ) 92 9 2999 a34 ٧ ass 231 932 10 CONTINUE 2910. τ 2911  $G_{1=R}$ a43 941 a42 a44 62=0 2912 64=0. 2947 G5=0. 2914 GF=0. 2415 2915 67=0. 2917 2913 69=0. 69=0. J1, J22+1 J1, J22 JI,JJ JUJ2 2919 619=0 24.79 00 12 L=1, JON J1+1, J22+1 Jitle Jez K-IASS(NOP(N.L) JHJJ 2921 J#19J2 Mi=NOPP/KY 2222 J11, J22+1 J11, Jz JIN, J22 51,55 MI=MI-MOF(K)-3 477 HUS=F(L) 2₽2a J11+1, J22 JIHIJJ J11H, J22+1 J11+1, J2 alval-Marindiv-H4 -62-0870(N) 20-H/ \_ Ē., Gauga-Harring and IF (ANWT, EQ. 9)60 TO 12 30 . . : Md=M]as-as-verichly-rel 1. 3 C\_AFTUATIONA V&FYS 1. 3 5 G7=G7+VAFI(M3)\*S(1)  $\{\cdot\}$ e=ge=vari(M2)+F(2,L) G Befeerneeling vaare (\* 1) G10=G10+VARI(M4)\*872.L> 12 CONTINUE 17(NTR 50.1) Al=0 A 17(NTR 50.1) 34=9 A 13了 = 17 IFRNAKI, ED. 1962=1.202 IFRNAMI, ED. 1904=09×02 يقد القرائف بعاريقراريك الفاريك الجاريي بيارتم بمراجه FIGHT HEND EIDE 医生产性的 化化化化 化化化化化 c.; \_ 2047 IF(PNWT EQ.0200 TO 3 00 14 I=1.JON że, z ⊈a,2 H1=P/I> ್ಷೆಗೂ WH1=WP(I)

FETHSOLVAC

(CONT.)

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•	rait	ABOLYAC KOUNT. A	
U	2951 : 2952 : 2953 : 2954 : 2954 : 2954 : 2955 : 2955 :	AI1(I)=AI1(I)+H1*DA*(G1*G5+G4*G5)*ANWT AI2(I)=AI2(I)+H1*DA*(G1*G7+G4*G8)*ANWT AI3(I)=AI3(I)+WH1*DA*(G1*G9+G4*G10)*ANWT 14 CONTINUE 5 CONTINUE	
2	2957 2953 2953		
	1952 2952 2952 2952 2952 2955 2955 2955	DO 19  1=1, IM DO 18  2=1, 2 J1=(I1-1)*7+4*I2-3 J11=(I1-1)*7+3*I2 K1=2*(I1-1)+I2 H1=P(K1)	
9	2967 2963 2963 2963 2973 2971 2972 2973	<pre>WH1=WP(K1) H2=B(1,K1) WH2=WB(1,K1) H3=B(2,K1) WH3=WB(2,K1) D0 18 L1=1,IM JJ=(L1-1)*F+2</pre>	
D	2974 2975 2976 2976 2977 2977 2977 2973 2979	-C -C**********************************	
0	2398 2398 2398 2398 2988 2988 2988 2988	AA(J11,JJ)=FF(J11,JJ)+H1*DA*BB(2.L1)/RHD DD 18 L2=1,2 J2=(L1-1)*7+4*L2-3 J22=(L1-1)*7+3*L2 K2=2*(L1-1)+L2 H4=F(K2) H5=B(1,K2) H5=B(1,K2) H6=B(2,K2)	
	222222222222222222222222222222222222222	C*************************************	- >
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FETHSOLVAC (CONT. ) Ð 2001: 1+WH1\*DA\*/G1\*H5+G4\*H5> 2001. IFRANNT. EQ. 0)60 TO 15 AR(J1, J22)=AR(J1, J22)+H1\*DR\*H4\*GE\*ANNT 2007 Tend d AR(J11,J2)=AR(J11,J2)+H1\*OA\*H4\*G7\*ANWT 2007 AA(J11+1,J2)=AA(J11+1,J2)+WH1\*DA\*H4\*G9\*ANNT CA RA(J11+1, J22)=AR(J11+1, J22)+NH1+DA\*H4\*G10\*ANNT 043 1.160 CONTINUE 3007 15 2009:0 2009:0 法法法法法法法法法法法法法法法法法法法法法 2010-0 CONTINUITY EQUATION 20<u>3</u> 4 \* 012 IF(12.E0.2)80 TO 15 20127 AA(J1+1, J2)=AA(J1-1, J2)+PP/I1)+04+H5 3013 7945 3945 AR(J1+1, J22)=AR(J1+1, J22)+FP(I1)\*DA\*H6+PP(I1)\*DA\*H4\*G3 CONTINUE  $1 \epsilon$ 3017 18 CONTINUE 3019 20 CONTINUE 00 22 I=1.JON 2015 K=IARS(NOP(N, I)) 1020 2021 M1=NOFP(K) 022 <u>M3=M1+MDF(K)-2</u> 2022: 2024: Md=M3+1 R1(M1)=R1(M1)+A11(I) 7827) 7825) 7825) 7827) R1(ME)=R1(ME)+FI2(I) P1(M4)=R1(M4)+PIE(I) 22 CONTINUE RETURN ENO ς. e Carr <u>sp</u>ra 2025) 2025-0 \*\*\*\*\*\* 2029 2029 2029 SUERDUTINE TEMPM 3941 3842.0 MATRIN EQUATION FOR TEMPERATURE ED FOR KNOWN VELOCITY. 2042 D 2044 D PRISYMMETRIC AND CARTESIAN SYSTEMS IUPMIN=0.WITH UPMINDING. -Peas IUPMIN=1, WITHOUT UPWINDING Ted -SPECIFIED TEMPERATURE GRADIENTS ON EQUNDARY IS NOT INCLUGED 3047:0 EXCEPT ZEPOS TEMPERATURE GRADIENTS. 2049-0 \$ \$ × \* 3043 0 IMPLICIT DOUBLE PRECISION (A-H, 0-Z) 2050 -

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	1072	Ч. Д.К.Ү.Ү.СӨМӨГ/ССИПЛОГ/КЛӨЛЛСӨГА/ЛСӨГҮ А АЛГ АССАССИН ТАХЭХ АСХХ АС АЧ АЙ.
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	ತಳವರ. ಶಾವನ್	2, MPTSN, MNELT2, SV, MPT2, SY, NMPT2, 723, NMP(723, TT(8)
Ð	20072-	2. HILLSY, WELEY BY MAVER 2Y, WAVER 2Y, THEWIN, INTS, VKIN, VKON
	2016 7622	DIMENSION P(S), R(2, S)
	ンジウズ マルマの・	NIMENSION AR728, 281, PP/41, PR(2, 4), CR(2, 36), CP(36)
	2011	nimension devo.70%.dev70%.ddeve2%.deve2%.deve2%.dev
	2072.	Enitvelenet
	コピノニーフルプラー	1 /ESTIEM/1.19. AA/1.199
	20-2.	TONANDNINEIIY
	2019.	I CARTA CARA CALLER
	2873. Tate:	TELION NE NENITMES
9	2012. 2077:	DD d T=1.NRN
	シジョン・	$DD = 4 T^{-1} DD$
	2878. 7076-	$A = \frac{1}{1} $
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	ఎద్బారా నామలిగి -	。 · · · · · · · · · · · · · · · · · · ·
	2522.	C PEAN IN FIEMENT NATA ERNM PERIPHERAL STAPAGE
	2002.	· ····································
	వాలాలు. నారాముడి:	
	7005	· READ(19)
Ş		1 N. NG. (1, ((DB(1, T), L=1, 2), DP(T), T=1, NG), (DDA(L), L=1, LL), NGG
	7007	2. ((CB(L, I), L=1, 2), CP(I), I=1, NGG)
	7092	TEC THENTH ER 1) READ(8)
	7,000	1  N, NG, LL, ((GWR(L, I), L=1, 2), DWR(I), I=1, NG)
	7,32,3	DD 2P NG=1.LL
	7,701	OR=DDA(NG)
	7340	DO = S = I + JDN
	2092	NJ = (NG - 1) * JDN + I
	2004	P(I)=DP(NJ)
Ø	2045	WP(I) = P(I)
	2004	IF(IUPWIN EQ. 1)WP(I)=DWP(NJ)
	3097	DO 6 L=1,2
	2000	$(E \in E \setminus I) = DE \setminus L, NJ$
	3005	WE(L, I) = B(L, I)
4	3100	IFCIUPWIN, EQ: 1)WECL, I)=DWECL, NJ)

L))\*CONDF//RHO\*CPF)\*DA L)+WE(2, I)\*B(2, ÷ ٠, \* \* \*\*\*\*\* - 1 1 1 . -TNENT \* 子王子子 \* -. 14 ч. 111 11 1 4 \*\* \*\*. 5 4 \* 法法法法法 ~ r j hang. ~~ NOITENO チチ . Qj \*\*\*\*\* (19) † and and and and ~ 1 % and and such such \*\*\*\*\* くす 40 13 14 નંદો એદ્યો 0 0 1 74 エオシシシシ 77- $\sim \sim$ \*\*\*\*\* J. + -1 ..... HO C ů, <u>م</u>م 3 -÷., • ----1 ÷., -17 CONTINUE G2=0. G2=0. G2=0. G2=0. G2=0. G2=0. G2=0. C2=0. C2= -**3**-. N L L =1. JDN F-1 (1) - य न न य छ 大学学生文学文学生文学 CCONT. 1. 4 ۶. FETHEOL VAC ÷ 11 ÷ \*1 त्र पी हे क o» 5 • ان 1 の自己 . 1 \* \* ¥ ÷¢. -Æ -# いんいうん たいたいたいたいたい 1212 1..... 

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D SHAPE FUNCTION ROUTINE 3151:C 3152 C G AND H DENOTE XSI AND ETA VALUES AT THE POINT CONSIDERED 3154 · C IMPLICIT DOUELE PRECISION (A-H, 0-Z) 3155: 3156 COMMON/CONTP/ 1 X, Y, Y, CONDF, BETA, CPF, RHO, HCOFX, HCOFY, 3157 3158 -- GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 2 D, 2159: 3 NP; NH; NE; NE; NDF; NCN; NEN; IT1; ND1; MTRD 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAMI 2150: 5. NRT, MWGA, NNF, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP 3161 5, NCORD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND 2152 COMMON/GEP/ 2162 1 TEMP(461), CORD(461, 2), RSFEC(461, 6) 2164 2165 2, R1(1552), R2(1553), VARI(1553), VARR(1553), BC(1553) 2, YALY(SE0), AVAFI(1553), NOP(122, 8), NDN(122), LPR(122) 2166. 4, NOPP(461), MDF(461), NCOD(1553), NODV(560) 3167 2 3169 -COMMON/GUARD/ 1 SK(40000), ESTIFM(28, 28), GISH(600), INTEG(2700) 3129: COMMONZUEWINZ 7170 7474 -1 AA1, AA2, A1, A2, BB1, BB2, B1, B2, DIS(3, 461) 2; WP(8), NDEL(2, 8), WB(2, 8), DWB(2, 72), DWP(72), TT(8) 3172; 3. UU(8), VV(2), UAVE(2), VAVE(2), IUPWIN, IWTS, VKIN, VKON 2172 -3174 DIMENSION 2475 1 P(8),DEL(2,8),B(2,8),CJ(2,2),CJI(2,2) 5176 3177: 2, PP(4), EB(2, 4), CE(2, 36), CP(36) ð 3,08(2,72),0P(72),0DA(9) 2478 EQUIVALENCE /SK(1),P(1)),(SK(10),DEL(1,1)) 2175: 1 2,(SK(30),S(1,1)),(SK(50),CJ(1,1)) 239. 2181 3,(SK(55).CJI(1,1)),(SK(60),PP(1)) 4, (SK(70), DDA(1)), (SK(80), CB(1, 1)) 5,(5K(160),CP(1)),(SK(200),DB(1,1)) 6, (SK(350), DP(1)), (SK(430), ELX) 7, (SK(431), ELY) ٥ 7187 G = GPG2188 H=GFH 7199-NIC=NBN/4 3199 3151 60 TO (2,4,6),NIC 2 CONTINUE 3152.C 3152.C 西南南南南南南南南南南南南南南南南南南南南南南南南南南南南南南南南南西西<sup>\*\*</sup> 7794 ( 7295) ( FOUR NODED APBITRARY QUADRILATERAL • ANTICLOCKWISE NUMBERING 3196 3197:0 3199: GH=G\*H 3100. P(1) $= \langle 1, -G-H+GH \rangle/4.$ 3200: P(2) =:(1,+G-H-GH)/4;

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## FETHSOLVAC (CONT.)

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	2004	- $        -$
,	2202.	$= \{x_2\} = \{x_2, \exists a \exists a \exists a \exists a \forall a \forall a \exists a \forall a \forall a \forall a$
	3202	P(4) = (1, -G+H-GH)/4.
-		$\nabla F (A   A) = A   A   A   A  $
		Construction of the second sec
	7701	DFI(1,2) = (-1,-H)/4
,		
	1280.	DELKIJSZ A K I. TRZZA, S S S S
	7202	OEL(1, 4) = (-1, -H)/4.
	ニビビア .	$C = DEL(2) \pm 2 = (-1, \pm 3)/4.$
•	2200	DF((2,2) = (-1,-6)/4
2	and the fail is a second s	
•	22977	$UEL(2) \supset J = (-2, \pm G) Z 4.$
	2240	DELTO, d Y = T - RYZd
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	7212	A CONTINUE
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	7000.	$GU = G \omega U$
	ఎడడల్.	
	3221 :	GG = G * G
	20100	
	<b></b>	<u> </u>
	7227-	GGH = GG*H
,	1224.	
	7225	62 = 6*2
. '	an daa ka ka ka ka	ta and the second se
Δ,	1220.	HZ = H*Z
	7227-	BH2 = BH*2
,	an a	
	3228:	P(-1) = (-1, +GH+GG+HH-GGH-GHH)/4.
-		P = C + A + H = R P + R P H + C P
	a an an -	
	1230:	P(-3) = (-1, -dH + dd + HH - ddH + dHH)/4.
•	1.7.7.4	$P \land A \land = \land A \land A P = P P = P P P P P$
	222 A.	
	7272.	P( 5) = (-1.+6A+66+AH+66H+6AH)/4.
•		$P \land P \land P \land A \land A H = R R = R R H \land P \land P$
•	، خاند خانه د	f(0) = f(1) = 0
	<u>723</u> 4 :	F( 7) = (-1, -3H+3G+8H+3GH-3HH)24, -
. '		$ \bigcirc \land \bigcirc \land $
	7276.	DEL(1,1)=( H+G2=GH2=HH>Z4.
•		D = 1/4 $O = -O = O = O = O = O = O = O = O = O =$
•	See S	
	2028.	DEL(1,3)=(-H+G2-GH2+HH)/4
		<u>VELV1</u> ,47=C-1,700772.
	7230	0E((1,5)=( H+B2+BH2+HH)/4
•		n and a star with the second
		<i>VEL(1)67= -0-08</i>
	2242	ハビレイオ、アンピイーダキロジキロゼシーダゼンズボ
•	1	la d'aleman () aleman () de la servicie de la servic
	22420	ひとしくゴン ダンキバーゴン ナガガンアン
	7744	NEL (9.4)=/ R+H9-RR-RH9\/A
•		اس کی است کر میں کا کہ میں کہ است کر است کی کہ کہ میں کہ کہ کہ میں میں کہ
•	7245.	DEL(2,2)=(-1.+00)/2.
•	77.12.	DEL /O RY-/LAIMOLAALAMOY/A
	ಎ <u>ದ ಇರ</u> ್ಷ.	VELNE/SV-NTUTALUUTUAL//4.
	3247:	DEL(2,4)= -H-GH
	77.10	NEL / 9 SY-/ RIMOIRRIDHOY //
	24720	νεμιάλαλαγ-ι υτηζτυμτμηζληφ.
	<u>7249</u> ;	DEL(2,6)=( 1,-66)/2.
	7750	DEL (0 75-/_BIDIRG_BUD5/4
` '	: تا المنظر ت	νειναληγ-κτυτπατυυτυπαλλ4.

FETHSOL VAC (CONT. )

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G2=((1, +G)/2)
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2) • • • 3301:0 3303 SUBROUTINE WYSET(MM) 3305:0 3309:0 2240 2242 2242 IMPLICIT DOUBLE PRECISION (A-H, O-Z) COMMON/CONTE/ 1 X, Y, Y, CONDE, BETA, CPE, RHD, HCOEX, HCOEY, 2 GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 7744) 7745 7747 7747 NPS NHS NES NES NOFS NONS NENS IT1, ND1, MTFD 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAMI 5, NRT, MWGA, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP 2 6, NCOPD, IG, NG, NEY, NET, NEWTON, ITURE, ICONO 2218 COMMON/GEF/ 2219: 1 TEMP(461), COPO(461, 2), RSPEC(461, 6) 2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) 2,VALV(560),AVARI(1551),MOF(122,8),NDN(122),LFR(122) 4, NDPP(461), MDF(461), NCOD(1553), NOOV(560) COMMON/GUARO/ 3324 : - 1 SK(40000), ESTIFM(28, 28), GISH(600), INTEG(2700) 3725) 03325) 3327) COMMON/UFWIN/ 2,NP(8),HDEL(2,8),WB(2,8),DWB(2,72),DWP(72),TT(8) 2223 3,UU(8),YY(8),UPYE(2),YAVE(2),IUPMIN,IWTS,YKIN,YKOM DIMENSION 

 JIMENSION

 1 P(8), DEL(2, 8), B(2, 8), CJ(2, 2), CJI(2, 2) 2 • 3247 DO 11 I=1, NH 3248 -IDF=MDF(I) <u>3749</u> J=NOPP(I) 3350 -IF(IDF. EQ. 2) JJ=J+1

FETHEOLVAC

(CONT.)

IF(IDF, EQ, 3) JJ=J+2 DIS(1,I)=VARI(J) DIS(2,I)=VARI(JJ) 11 CONTINUE 60 TO 3 CONTINUE DO 2 I=1,NH IDF=MDF(I) J=NOPP(I) IF(IDF. EQ. 3)JJ=J+1 IF<IDF. EQ. 4>JJ=J+2 DIS(1, I)=VARI(J) DIS(2, I)=VARI(JJ) CONTINUE CONTINUE >IF(IUPMIN.EQ.1> ALPHA=CONDF/(RH0\*CFF) IF(IUPWIN.ED.2) ALPHA=V DFX=ALFHA DPY=ALPHA DO 10 I=1,NSM K=IABS(NOP(MM, I)) UU(I)=DIS(1,K) VV(I)=DIS(2,K) 10 CONTINUE UAVE(1)=(UU(1)+UU(3))\*0.5 UAVE(2)=(UU(5)+UU(7))\*0.5 VAVE(1)=(VV(3)+VV(5))\*0 5 VAVE(2)=(VV(1)+VV(7))\*0.5 XX1=0. 25\*A55(UAVE(1))\*HX/DFX-IF(XX1.LE. 0. 001) GO TO 21 881=(1. /TANH(XX1))-1. /XX1 XX1=2, \*XX1 XX=TANH(XX1) #1=2. \*XX-4. /XX1+(2. +##1\*XX1)\*(3. \*XX-XX1)/(XX1\*XX1) GO TO 22 21 AA1=0. H1=0. 22 CONTINUE IX1=IABS(NOP(MM,5)) 3400: IX2=IABS(NOP(MM,7))

くさんさゃごろんシンくさんんーえんゃ \*XX-XX2)/CXX2\*XX2) ずんきゃすんきょくく ちんきーたきゃ "我不是我不不不不不不不不不不不不不不不不不不不不不不不不不不不 +842+XX2)\*<3. ロノオーロンナキの日日 2)\*(744\*788+ HX1=CORD(IX1,1) HX2=CORD(IX2,1) HX2=CORD(IX2,1) HX2=CORD(IX2,1) HX2=CORD(IX2,1) HX2=CORD(IX2,1) HX2=CORD(IX2,1) HX2=CORD(IX2,1) HX2=CORD(IX2,2) HX2=CORD(IY1,2) HY2=CORD(IY1,2) HY2+CORD(IY1,2) HY2+CORD( 2))\*HX/DPX ) TO 23 -1. /XX2 haŭ/hH\* 3-73 55 09 <u>م</u>م ц, 1-10 IF(UAVE/1). A1=-A1 frij Gij भूः दिनु  $\sum_{r \in I}$ 14 141 frj Frj くらくらん 

FETHSOLVAC (CONT.) 2 3451: AA1=-AA1 3452 / 41 IF(UAVE(2), GT. 0, ) GO TO 42 3453 H2 = -H2*HR2=-HR2* 2353 42 IF(VAVE(1). GT. 0. ) GO TO 43 3455; 3456: B1 = -E1881=-681 3457 43 IF(VAVE(2).GT.0.) GO TO 50 3458: 3459: 82=-52 882=-882 3460 1461 SP CONTINUE 3462: ·WRITE(NLP,101) MM, AA1, A1, AA2, A2, BE1, 61, BB2, B2 101 FORMAT(110, SF10, 5) 3463: <u>73F1</u> · RETHEN END 3465: 3466 0 N3467:0 3468:0 3459-0 2470-0 3471:0 2472:0 arkererererererererere 3474 SUPROUTINE FRONT 3479; 17424\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* FFONTEL ELIMINATION ROUTINE USING DIRGONAL PIVOTING 3478:0 <u> Paqq</u>, (). 3481) IMPLICIT DOUBLE PRECISION (A-H, O-Z) 3492 COMMON/CONTR/ 2483 1. Х. Ү. Ү. СОМОР, ВЕТА, СРР, РНО, НСОРХ, НСОРУ, 7494 -GEF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 2485-3 NP+NH, NE+NB; NDF; NCN; NEN; IT1; ND1; MTR0 3484 4, NTIME, MARKS NTP, LTIMS MTRIT, NCARDS, NEID, NAXI 3497. 5, NPT, MWGA, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP 7499. 6, NCORD, IG, NG, NEY, NET, NEWTON, ITURE, ICOND. 1424 COMMON/GER/ 1 TEMP(461),CORD(461,2),FSPEC(461,6) 7240 2,R1(1553),R2(1553),VARI(1553),VARA(1553),EC(1553) てはつきょ 2492: 3, VALV(560), AVARI(1553), NOP(122, 8\, NDN(122), LPR(122) 7497 4, NOPP(461), MDF(461), NCOD(1553), NODW(560) 7292 COMMON/GURRO/ 3495: 1 SK(40000),ESTIFM(28,28),GISH(600),INTEG(2700) 7492 COMMONZUPWINZ 7497 1 AA1)AA2,A1,A2,BB1,BB2,B1,B2,DIS(3,461) 7492. 2,NP(8),HDEL(2,8),WB(2,8),OWB(2,72),DWP(72),TT(8) 3499 -3,UU(8),VV(8),UPVE(2),VAVE(2),IUPWIN,IWT5,VKIN,VKOM 3500: COMMON/TLSKIN1/ TLS(461),EKE(461),TEMU(461),ITERNAN

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2, E0(200, 280), LHED(250), KHED(250), KPIV(2
3, JM0D(250), 00(250), KHED(250), KPIV(2), 00(1))
4, NEOUNDA(28)
1 (SK(1), E0(1, 1)), (GISH(1), 00(1))
2, (ESTIFN(1, 1), AA(1, 1)), (INTEG(69), KFIV(2)), LDEST
3, (INTEG(30), KDEST(1)), (INTEG(69), KHED(2), KHED(2)), (INTEG(29), LPIV(2)), (INTEG(360), LPIV(2)), (INTEG(360), LPIV(2)), (INTEG(360), LPIV(2)), (INTEG(260), LPIV(2)), (
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3559	- 14	CONTINUE
2569		LCOL=0
356%.		00 16 I=1 NMAX
3562:		DO 16 J=1,NME%
2562		EO(J, I) = 9.
3564	15	CONTINUE
3547	18	NELL=NELL+1
2566.		CHLL HEFIND
-3567		
3588 B <b>r</b> as	•	JUNENDA(NELL) Do odo fek kok
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2572		ALENCERARY AND ALENCE
	•	TDF=MDF/KY
2222	•	
	•	
7920		
551	•	NEOUNOA(KC)=M
7507		IF(NCOD(M), EQ. 0) GO TO 210
7567		NEOUNDA(KC)=-M
2594		MPL=ECKM?
2525		KD=0
7556.		00 211 IR=1, JON
2587;	•	KK=IARS(NOE(N·IA))
3598		LL=NCFPYKKY
12233		CIDE=MDF(KK)
1599.		00 211 JJ=1 IIDF
7741		Reference Reference and the second
1993		MM#11+JJ=1 Transmis - Total
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; FETHSOLVAC (CONT.)

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NEOUNDA(KC)=K IF(NCOD(K), EO. 0) GO TO 260 NECUND- (KC)=-K VAL #BOYK) 长谷丰盛 00 279 IP=1,JDA KK=IABS(NOP(N,IAY) KD=KD+1 FICKKN FPICKKY-BACKD, KO)+VPL 279 FONTINUE 260 CONTINUE 290 CONTINUE Fran IF(MWGA, EO, 0:00 TO 21) 00 20 I=1. JON NK(I)=NGE(N,I) 20 CONTINUE KC=JON *GO TO 23* 21 CONTINUE DD 22 J=1, JPN NN=NDP(N.J) 

 3421:
 M=IABS(NN)

 3421:
 M=IABS(NN)

 3420:
 IDF=MDF(M)

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 3520:
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 3620:
 II=K+L-1

 3621:
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 3621:
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 3621:
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 3630:
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 3640:
 IF(LCOL, EQ, 0)GO TO 28

 3641:
 IF(IABS(NODE), EQ: IABS(LF)

 3642:
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 3642:
 MEIASS(NN) IF(NEOUNDA(LK), LT. 0) 60 TO 36 IF(IABS(NODE), EQ:IABS(LHED(L)))G0 TO 32 24 CONTINUE 28 LCOL=LCOL+1 LDEST(LK)=LCOL LHED(LCOL)=NODE GO TO 36 2650 32 LDEST(LK)=LL

FETHEOLVAC (CONT.)

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2651 -LHED(LL)=NODE 3652. SE CONTINUE 1-53: IF (MRRK. GE. 4. AND. NTR. EQ. 1. AND. ITERNAN, EQ. 0) 3654. -WRITE(NLP, 490)N, LCOL 2653:00 NRITE(NLP) 420)KROW, LCOL 2656.00 WRITE(NLP) 424) MRITE(NLP,429) (KHED(K),LHED(K),K=1,NMBX) 3637.00 2659:00 2659:00 WRITE(NLP, 432) WRITE(NLP,428) (KDEST(K),LDEST(K),K=1,KC) IF(LCOL.LE.NMAN)GO TO 54 Seer. 3651: NEFROF=2 2662 HPITE(NLP:417)NEEROR 3683: STOP 36643 54 CONTINUE 1667) 1655) 00 55 1=1,KC IF(NEOUNOB(L), LT. 0) 60 TO 56 3667 LL=LDEST(L) 3663: 3563: D0 57 K=1,KC IF(NBOUNDA(K), LT. 0) GD TO 57 2679 KK=LDEET(K) 3671: EQYKK, LL>=EQ<KK, LL>+AA(K, L) 3672; 57 CONTINUE 3673. SE CONTINUE 3674:00 NRITE(NLP, 456)NEL 2673:00 HFITE(NLP.440)((EC(I,J),J=1,NMFX),I=1,NMFX) 126762 IF(LCOL, LT, NCRIT, AND, NELL, LT NE)GO TO 18 3677:0 2679. C FIND OUT WHICH MATRIX ELEMENTS ARE FULLY SUMMED 2691-0 3682 60 LC=0 D0 64 L=1.LCOL Seed KT=LHED(L) 13635: IF(KT. GE. 9)80 TO 64 iere -LC = LC + 13687 -LFIV(LC)=L 2688) 2688,00 64 CONTINUE NRITE(NLP, 448)LC, KR 3690 00 WRITE(NLP)428)(LPIV(K),KPIV(K),K=1,NMAX) 3291. IF(LC.GT.9) G0 T0 72 1692). 2692 -IF(NELL, LT, NE) GO ΤÐ 18 NEEROR=3 13693 WRITE(NLP,418)NEPROR 3695. STOP JESE. 72 CONTINUE 2697.00 WRITE(MLP, 460) 3699:00 WRITE(NLP: 464)(I: R1(I): I=1: NP) 3699.0

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K 2703:C 2704 · FIVOT=0. 3705: DO 76-L=1.LC 4 Č. – 370E: 2797: LPIYC=LPIV(L) KFIVR=LPIVC († 2709) († 2709) († 2710) PIVA=EQ(KPIVR, LPIVC) IF(AES(PIVA), LT. PIVOT)GO TO 74 FIVOT=FIVA ì 2711. LPIVC0=LPIVC 2742) 3712) KPIVRO=KPIVR 74 CONTINUE 12 5 3714) 5 2715:0 76 CONTINUE \$ 3720 LCO=IASS(LHED(LPIVCO)) KR0=LC0 3722 78 CONTINUE 3722 IF(ABS(PIVOT).LT.1E-10)60 TO 152 ţţ. 1 3724 · 1 2725. DO SO L=1, LCOL QQ/L)=EQ(KPIVRO,L)/PIVOT ) 2726 ; 2727 ; S0 CONTINUE RHS=R1(KR0)/FIVOT 1727: 1728:00 1728:00 1728:00 1721:0 1722:0\* R1(KR0)=RHS WRITE(NLP, 468) MRITE(NLP,440)(QQ(L),L=1,LCOL) 1 ELIMINATE THEN DELETE PIVOTAL ROW AND COLUMN 1 | | | | 2724 2 3725:0 3726) 2727) IF(KPIVRO EQ. 1)GO TO 104 KPIVR=KPIVR0-1 3728: DO 100 K=1, KPIVE - KRW=IABS(LHED(K)) 3739: 3740; FAC=EO(K, LFIVCO) WRITE(NLP,480)FAC 3741:00 3742+ 3742+ IF(LPIVCO, EQ. 1. OR. FAC. EQ. 0. )GO TO 88 ••• LPIVC=LPIVCO-1 3744 DO 84 L=1, LPIVC EQ(K,L)=EQ(K,L)-FAC\*QQ(L) 3746; 84 CONTINUE 88 IF(LPIVCO.EQ.LCOL)GO TO 96 3747: LFIVC=LFIVC0+1 3748: 1 3749 DO 92 L=LPIVC, LCOL 2750: EQ(K, L-1) = EQ(K, L) - FAC + QQ(L)

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•	3337789012333788901 7777890123337888901 77778901233377788901 77778901233377788901	0000000 * * 000000 * *	150 ***	<pre>WRITE(ND1) 1 KR0.LCOL, LFIVCO, (LHED(L), RR(L), L=1, LCOL) DO 130 L=1, LCOL EQ(L, LCOL)=0. EQ(LCOL, L)=0. CONTINUE WRITE(NLP, 436)NELL WRITE(NLP, 440)((EQ(I, J), J=1, NMAX), I=1, NMAX) WRITE(NLP, 460) WRITE(NLP, 464)(I, R1(I), I=1, NP) ************************************</pre>
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•	77789012545678994125 777789012545678994125	20 0000000 * *	150 ***	<pre>WRITE(ND1) 1 KR0.LCOL, LPIVCO, (LHED(L), QQ(L), L=1, LCOL) D0 130 L=1, LCOL EQ(L, LCOL)=0. EQ(LCOL, L)=0. CONTINUE WPITE(NLP, 436)NELL WRITE(NLP, 440)((EQ(I, J), J=1, NMAX), I=1, NMAX) WPITE(NLP, 460) WRITE(NLP, 464)(I, P1(I), I=1, NP) ************************************</pre>
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•	5778901034367899010343677779901034367778990103436777777779999999999999999999999999999		150 *** *** 132	<pre>WRITE(ND1) 1 KR0.LCOL, LFIVCO, (LHED(L), QQ(L), L=1, LCOL) DO 130 L=1, LCOL EO(L, LCOL)=0. EQ(LCOL, L)=0. CONTINUE WFITE(NLF, 436)NELL WRITE(NLF, 440)((EQ(I, J), J=1, NMAX), I=1, NMAX) WFITE(NLF, 460) WRITE(NLF, 460) WRITE(NLF, 464)(I, R1(I), I=1, NF) ************************************</pre>
3	33323333333333333333333333333333333333		150 *** *** 152 152	<pre>WRITE(ND1) 1 KR0.LCOL, LPIYCO, (LHED(L), QQ(L), L=1, LCOL) D0 130 L=1, LCOL E0(L, LCOL)=0. E0(LCOL, L)=0. CONTINUE WPITE(NLP, 436)NELL WRITE(NLP, 436)NELL WRITE(NLP, 440)((EQ(I, J), J=1, NMAX), I=1, NMAX) WPITE(NLP, 460) WRITE(NLP, 464)(I, R1(I), I=1, NP) ************************************</pre>
3	5778901234367890122456789012343678901234367899012343678999999999999999999999999999999999999		130 *** 132 132	<pre>WRITE(ND1) 1 KR0.LCOL, LPIVCO, /LHED(L), QQ(L), L=1, LCOL) DO 130 L=1, LCOL EO(L, LCOL)=0. EQ(LCOL, L)=0. CONTINUE WRITE(NLP, 436)NELL WRITE(NLP, 436)NELL WRITE(NLP, 440)((EQ(I, J), J=1, NMAX), I=1, NMAX) NPITE(NLP, 460) WRITE(NLP, 464)(I, R1(I), I=1, NP) ************************************</pre>
	5778901234767890122456799 777778901234767898999999999999999999999999999999999		130 *** *** 132 135	<pre>WRITE(ND1) I KR0.LCOL, LPIYCO, (LHED(L), QQ(L), L=1, LCOL) DO 130 L=1, LCOL EQ(L, LCOL)=0. EQ(LCOL, L)=0. CONTINUE WRITE(NLP, 436)NELL WRITE(NLP, 436)NELL WRITE(NLP, 440)((EQ(I, J), J=1, NMAX), I=1, NMAX) MPITE(NLP, 460) WRITE(NLP, 464)(I, R1(I), I=1, NP) ************************************</pre>
	33323333333333333333333333333333333333		130 *** *** 132 136	<pre>WRITE(ND1) % KR0.LCOL, LFIVCO, (LHED(L), QQ(L), L=1, LCOL) DO 130 L=1, LCOL EO(L, LCOL)=0. EQ(LCOL, L)=0. CONTINUE WFITE(NLP, 436)NELL WFITE(NLP, 440)((EQ(I, J), J=1, NMRX), I=1, NMRX) NFITE(NLP, 460) WFITE(NLP, 464)(I, P1(I), I=1, NF) ************************************</pre>
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FETHSOLVAC (CONT.)

3801 : CC WRITE(NLP,428) (KHED(K),LHED(K),K=1,NMAX) 2802 : C DETERMINE WHETHER TO ASSEMBLE, ELIMINATE, OR BACKSUBSTITUTE 3804 : C 1805 (C 3807 ( IF(LCOL. GT. 1. OR. NELL. LT. NE) GO TO 60 13888: LCO=IABS(LHED(1)) KFIVE0=1 3809. 2810) 2811 : PIVOT=EQ(1,1) KEN=LED 2812. 2813: LFIVC0=1 QQ(1)=1.TECARS(PIVOT), LT. 15-08)60 TO 152 2814 R1(KPO)=P1(FRO)/PIYOF 2815 2816 : 2817 : WRITE(ND1) KRO, LCOL, LPIVCO, LHED(1), QQ(1) 1 3818: PROSUE CALL 60 TO 156 7519 152 CONTINUE 3920. 3521: WRITE(NLP) 476) 2822 2823 : WFITE(NLP,488) LFF0N=1 3824: NTRH=0 3825 DO 154 I=1, NP )7826. 7827 7828 IF(NCOD(I),GT.0)NCOD(I)=1 154 CONTINUE REWIND 10 1825 RENIND ND1 1919 REWIND 8 CALL FRONTA 156 CONTINUE 400 FORMAT(SH NODE, 6H NLAST) 404 FOFMAT(1X+215) 408 FORMAT(7/16H NODPL NUMBERING/) 412 FORMAT(915) 116 FORMAT(/8H NERROR=, 15//15, 1 52H TH. ELEMENT HAS MORE THAN ONE NODE WITH THE 1/62H SAME NODAL NUMBER 1/2117 FORMAT(/8H NERROR=) 15// INSUFFICIENT SFACE TO ASSEMBLE NEXT ELEMENT INCREASE NMAX'> /> 2.1 7944 12845 418 FORMAT(/8H NERROR=, 15// 1 62H THERE ARE NO MORE ROWS FULLY SUMMED, THIS MAY BE DUE TO---3847 1/624 (1) INCORRECT CODING OF NOP OR NK ARRAYS (2) INCORPECT VALUE OF NMAX . INCREASE NMAX TO PERMIT 1762H 3847: 3848. 1752H WHOLE FRONT TO BE ASSEMBLED 3849. 1/> 420 FORMATK/6H KRON=,15/6H LCOL=,15/) 3850:

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ED//) ចាំ សេ ប្រ FIW07=, CALL 17 ũ, **UBNCI** H. E Ē ~. 64 ~ . To G; 77. COLUMN=, IS CONDIT 1111 11. 5. NCP **ENE** tri ug 5 IMPLICIT DOUBLE PRECISION (A-H, 0-Z) COMMON/CONTP/ COMMON/CONTP/ COMMON/CONTP/ Z XY V. CONDF. BETA. CPF. RHD. HCDFX. HCDFY. 2 GPF. GPG. GFH. EMU. NG(3). DS. DX. DY. 3 NP. NH. NE. NEW NDF. NCN. NEW. IT1. ND1. MTRD 3 NFT. MHGA. NNF. NTR. I. TIM. MTRIT. NCARDS. NSTD. NAXI 5. NTTME. HFR. NTR. LTIM. HTRIT. NCARDS. NSTD. NAXI 5. NTTME. HFR. NTR. LTIM. HTRIT. NCARDS. NSTD. NAXI 5. NTL MHGA. NNF. NELL. NTRA. NGAUSS. NPR. NCR. NLP. NC 6. NCOPP. IG. NG. NEV. NET. NEWTON. ITURE. ICOND 7. TEMP(461). CORD(461. 2). RSPEC(461. 6) 7. NLV(560). AVARTICISSID. NAPRICISSID. NAPRACISSID. RC 1. TEMP(461). NDF(461). NCOD(1553). VARACISSID. LP 3. VALV(560). AVARTICISSID. NOPV(560) 7. NOPP(461). MDF(461). NCOD(1553). NODV(560) 7. SK(40000). ESTIFM(28. 28). GISH(600). INTEG(2760) 7. SK(40000). ESTIFM(28. 28). GISH(600). INTEG(2760) **H**U. ~ -1 2).(5 r. F any . 03 -1 m: 15 ÷ ÷ -1 4 -mi THION. =, 13/) ЧÖ Э́ FULL Q; BRNDONED, H FRONTWID RONTWID EINGULA -NU a. /4H KR=, 13/6H ROW=, 14, 16H VECTOR/ H LDEST/) PIX ELEMENT 4 FORMAT(/SH KHED, SH LHED/)
6 FORMAT(216)
7 PORMAT(216) KDEST, EH LDEST/)
6 FORMAT(/EH KDEST, EH LDEST/)
7 PORMAT(/2H LC=, 13, /4H KR=, 13
7 PORMAT(/2H PIVOTAL ROW=, 14, 1
4 )
6 FORMAT(/12H PIVOTAL ROW=, 14, 1
4 )
6 FORMAT(/12H PIVOTAL ROW)
6 FORMAT(/12H PIVOTAL ROW)
7 PORMAT(/12H PIV ÷., \*0\* \*0\* \*5\* ·安安安安安安安安安安安安安安安安安安安安 (348) · BNILNO48005  $\sim$ (CONT. Û --ŭ Z Ω. U, -70541 ្នាល់ស្ថិតស្ថិត អាមារដែល ស្ថិត សំលាក់ស្ថិត សំលានស្ថិត សំលានស្ថិត សំលាន អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមា សំពេច អាមារដែល ស្ថិត សំលាស់ ហាត់សំណាង អាមារដែរ អ្នវអន្តរាល់ អាមារដែល អាមារដែល អាមារដែល សំពេច អាមារដែល សំពេច សំលាស់សំណាង អ្នវអន្តរាអនុសារអន្តរាម អាមារដែល អំណាម អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមារដែល អំណាម អាមារដែល អំណាម អាមារដែល អំណាម អាមារដែល អំណ អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមារដែល អាមារដែល អំណាម អាមារដែល អំណាម អាមារដែល អំណាម អាមារដែល អំណ u L. 23

FETHSOL VAC CONT.

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 $\sim$ С С TT(8) (IN. VKON 8) IV(250), LPIV(2 ~ 6.1 S. 8. -. -~. 1 15 1. 11 1001 -82.81.82.015(3.461) 2.8).0N8(2.72).0NP( .VAVE(2).1UPWIN.IWT 1 - - + V トーンン W HC M NK CIT ۰. No. च्न || τς. ~ ~, ---1 80) 90) 90) 505 505 ۳, ~~ (7)00 COMMUNICATION COMMUNICATION COMMUNICATION COMMUNICATION COMMUNICATION CONTRACTORY NAME (2), VAVE 575 IT CI KR0, LCOL, LPI (LHED(L), L=1 (00(L), L=1, L (00(L), L=1, L 7, 0)60 T0 24 T: ~. · · 1 m 3-1-HED'L ENT Ú) Ú) 1<sub>m</sub> 2 2 αá L. CONTI -4N= 11 F~~q ~~ L'i 之近 107 ÷. ÷ • n n n n n n ٠. 0.24 -KRU). ن ريا DO 4 I=1.NP SK(I)=BC(I) IF(MWGR.E0.0) NP DO 32 IV=1.NP BEDCKSFACE ND1 BEDCKSFACE ND1 BEDCKSFACE ND1 BECKSFACE ND1 BECKSFACE ND1 WRITE(NLP, 403) WRITE(NLP 1 ~ 5 ŵ Cq. ÷ NHHN= + ÷ \*\*\*\* ACK (武安天王) U. ÷ 4 \*\* 14 (5) MEGH ÷. ÷ ٣ ιړ. \*\*\* -4. 4. 4 ÷ السنة المسنة ŝ なんたいし 3 

(CONT.) -FETHSOLVAC 1 e: 3951 : END 1 3952:0 1 2952:0 2952:0 3954:0 3955 0 1 3956:C 1 3957:C 2952.0 7965 C FRONTAL ELIMINATION ROUTINE USING FULL PIVOTING 3955 0 3 3967-0 3963 IMPLICIT DOUBLE FRECISION (A-H, 0-Z) 3623 COMMON/CONTE/ 1979 1 X, Y, V, CONOF, BETA, CPF, RHO, HCOFK, HCOFY, 2 GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 3971 3972 3 NP, NH, NE, NE, NDF, NCN, NEN, IT1, ND1, MTR0 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI 3973. 3974-5, NRT, MWGA, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP 3975 6, NCORO, IG, NG, NEY, NET, NEHTON, ITURB, ICOND 3976 COMMON/GEP/ 7977 1 TEMP(461),CORD(461,2),RSPEC(461,6) 3978. 2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) 2, VALV(SE0), AVAFI(1551), NOP(122, 8), NDN(122), LPR(122) 7079: 7990. 1991 4,N0PP(461).MOF(461),NCCD(1553),NODV(560) COMMON/GUAPO/ 1 SK(40000).ESTIFM(28.28).GISH(600).INTEG(2700) 3992 COMMON/UFWIN/ 3983. 1 AP1,AP2,A1,A2,BB1,E82,B1,B2,DIS(3,461) -054 2,WP(8),MDEL(2,8),WB(2,8),DWB(2,72),DWP(72),TT(8) 3955. 3,UU(8),VV(8),UAVE(2),VAVE(2),IUPWIN,IWT5,VKIN,VKON ನದದಿಗೆ DIMENSION 3997: 1 LDEST(28), KDEST(28), NK(28), AR(28,28) 3958: 2, EQ(200, 200), LHED(250), KHED(250), KPIV(250), LPIV(250) 2000 7000 3,JMOD(250),QO(250) 4, NBOUNDA(28) 3991 3063 EQUIVALENCE 3997. 1 (SK(1),EQ(1,1)),(GISH(1),QQ(1)) 3994 2, (ESTIFM(1,1), AA(1,1)), (INTEG(1), LDEST(1)) ١ 2005 3,(INTEG(30),KDEST(1)),(INTEG(60),NK(1)) 4, (INTEG(90), LHED(1)), (INTEG(180), KHED(1)) 3004 5, (INTEG(270), KPIV(1)), (INTEG(360), LPIV(1)) 2007 E, (INTEG(450), JMOD(1)) 2000. 3000 0 4000 NMAX=200

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\*\*\* \*\* FETHSOLVAC (CONT.) 1 ≥\_>4001÷C 34002·C PREFRONT NA 4005 ( C - 400e: NCRIT=80 1997 NELL=0 WRITE(NLP, 400) 14008:CC IF(NTRA. EQ. 0)60 TO 14 🖓 ជាពូចុង -35 **4010**10 FIND LAST APPEAREANCE OF EACH NODE \$ 4012:0 1 101 d C NLSST=0 1 4615. 00 12 I=1, NH 3 4016: (1) 4047; 00 8 N=1, NE JON=NDN(N) 1 4018: DO 4 L=1.JDN 1 4019 IF(NOP(N,L), NE, I)GO TO 4 (\* 4920 NLAST1=N ) 4021: 1 4922: IF(NLAST. NE. NLAST1)G0 TO 3 NERROR=1 4023 // WRITE(NLP,416)NERROR,N 4024; STOP 4025 3 CONTINUE () 4년25. († **4**927 NLAST=N L1=L ः ४९२२ : 4 CONTINUE 40.29 4929 60 WRITE(NLP) 404) I, NLAST S CONTINUE 4071. 4072+ 4072+ NOP(NLAST, L1)=-NOP(NLAST, L1) NLAST=0 4074 12 CONTINUE 5 4075 00 WRITE(NLP, 408) ì 4929-20 WRITE(NLP, 412)(N, (NOP(N, L), L=1, NBN), N=1, NE) . 4027:0 `` 4028, Cxxxxxxxxxxxxx 4029:0 ASSEMELY s,对赵国道: Conserver a server a server server server a server server server server server server server server ser 4041.0 1 4042 14 CONTINUE 4947 LCDL=0 \$ 4924 KROW=0 1915. 00 16 I=1, NMAX 1 4005 DO 16 J=1, NMAX EQ(J, I)=0.4247 1 1020 15 CONTINUE 1000 18 NELL=NELL+1 4050 CALL ABFIND

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FETHSOLVAC (CONT.)

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N=NELL 4051 : JDN=NDN(NELL) 4052. KC = 04053 IF(MMGA.EQ.0)60 TO 21 1951 DO 20 I=1, JDN 4055: NK(I)=NOP(N, I) 4056 20 CONTINUE 4057: KC=JDN 4058 60 TO 23 4959 CONTINUE DO 22 J=1, JON 1050 -21 4951 : · NN=NOP(N.J) 4982: M=IA85(NN) 4963: K=NOPP(M) 1964 TDF=MDF(M) 4065. 00 22 L=1, IDF 4066 KC=KC+1 14067 : TI = K + L - 14868: IF(NN.LT. 0)II=-II 1050 NK(KC)=II 4070 22 CONTINUE 4071: 23 CONTINUE 4072: 4972:C 4月74、15米米米米米米米米米米米米米米米米米米米米米米米米米米米米 SET UP HEADING VECTORS 4075:0 14076、12\* 4077:0 IF(NTR. EQ. 1) WRITE(NLP-420) KROW, LCOL 4078:00 EO. 1) WESTE(NLP, 424) IF (NTE. 4079:00 (KHED(K), LHED(K), K=1, LCOL) TE(NTR. ED. 1) WRITE(NLP. 425) 4988:00 IF (NTF. EQ. 1) WRITE (NLP) 432) 4081:00 IF (NTP EO. 1) WRITE/NLP, 428) (KDEST(K), LDEST(K), K=1, KC) 4092:00 DO 52 LK=1, KC 4083: NODE=NK(LK) 4034 IF(LCOL. E0. 0)60 TO 28 4085 00 24 L=1, LCOL 4985 LL=L 4087 -IF(IAB5(NODE), EQ. IABS(LHED(L)))00 TO 32 1983: 24 CONTINUE 1089 28 LCOL=LCOL+1 1999: IDEST(LK)=LCOL 1001 LHED (LCOL) =NODE 4892 -1993: GO TO 36 4094 32 LDEST(LK)=LL LHED(LL)=NODE 4095: 36 IF(KROW.EQ.0)80 TO 44 4096: DO 42 K=1, KROW 4097: KK=K 4898: IF(IABS(NODE).EQ.IABS(KHED(K)))GO TO 48 4099: 42 CONTINUE 4100:
LDEST(KN, K=1, KC) ) S4 , LHED(K), K=1, NMAK) SUMMED -4 "我有这个不是我的,我不是我的,我们的这些我的,我们也不能能有什么?" CNEWN 10 177711 1 (KDEST(K).L NMAK)60 TO  $\mathbb{C}^{2}$ \* -. mi C ÷Ę > WRITE(NLP, 420)KROW, LCOL > WRITE(NLP, 424) > WRITE(NLP, 425) (KHED(K). > WRITE(NLP, 425) (KHED(K). > WRITE(NLP, 425) (KDE5T(K). > WRITE(NLP, 428) (YDE5T(K). WAX, AND, LCOL, LE, NMAX)60 T ii +--KHED(K) ÷. 4 \* ng T. NEYBO કે પા ગુપા \* (Ľ ÷ NEWTH 1, 436)NELL 1, 436)NELL 1, 448)(168(1, J), J=L, 1 1, NORIT, AND, NELL, LT, 4 CONTINUE KROW=KROW+1 KROW=KROW+1 KROW=KROW>=NODE G0 T0.52 G0 T0.52 G0 T0.52 G0 T0.52 CONTINUE KHED(KK)=NODE KREST(LK)=KK KHED(KK)=NODE CONTINUE CONTINUE FF(NTP.E0.1) WEITE(NLP.420) FF(NTP.E0.1) WFITE(NLP.420) FF(NTP.2000 FF(NTP.420) FF(NLP.420) FF(NTP.2000 FF(NTP.420) FF(NTP.2000 FF ~ С); ЧО \* LI 5 . . 1 71 ક પો ≯ 10 10 4 × 4 × 4 × 1260 \$ **O**() ELEN HOTHN -09(0 10 10 NF. , KROW LC=0 DO 64 L=1, LCOL IF(LHED(L), GE. LC=LC+1 LC=LC+1 LC=LC+1 LPIV(LC)=L CONTINUE IF(LHED(L), GE. RR=0 KR=0 KR=KP+1 KR=1 KR COL GE. ÷~. 007 CCONT. --JNI -安安有天子 法天下子 FETHSOL WAS 50 50 4 00 ស ហ די ריז 71 1-0 الد الد 000000 55 1. 1.4 ۴., ۱ 1. L 

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HRITE(NLP, 448)/LC, KP

HRITE(NLP, 428)/LPIV(K), KPIV(K), K=1, NMAN)

HFITE(NLP, 426)

DO 70 IFR=1, IR

K=JHOP(IFR)

N=JHOP(IFR)

H=ITE(NLP, 428)K

KH=IRES(KHED(K))

DO 69 L=1, LCOL

E0(K, L)=0.

LH=IRES(KHED(K))

IF(LH EQ KH)EQ(L))

IF(LH EQ KH)EQ(L)

CONTINUE

IF(CH, EQ KH)EQ(L) =1.

CONTINUE

NEPPOP=5

NEPPOP=5

NEPPOP=5

NFITE(NLP, 448)NERROR

STOP

NFITE(NLP, 468)

CONTINUE

NFITE(NLP, 468)

CONTINUE

NFITE(NLP, 468)

STOP

NFITE(NLP, 468)

LTE(NLP, 468)

STOP

NFITE(NLP, 468)

STOP

NFITE(NLP, 468)

NFITE(NLP, 468)

STOP

STOP

NFITE(NLP, 468)

STOP

STOP

STOP

NFITE(NLP, 468)

STOP

STOP
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3 (6)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                NCOD(KRO)=2
R1(KFO)=8C(KRO)
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PIV07=0.

D0 75 L=1.LC

LPIVC=LPIVCL)

KPIVR=EPIVR

PIVR=EQ(KPIVR)

LPIVCT=PIVR

LPIVC0=LPIVR

KPIVR0=KPIVR

CONTINUE

CONTINUE
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🔅 FETHSOLVAC (CONT.) ) () 4291 () 4292 . KRO=IABS(KHED(KPIVRO)) LCD=IAES(LHED(LPIVCO)) - 1207 -IF(NTP. EQ. 1)WRITE(NLP,452)KRO,LCO,FIVOT,NELL IF(RES(PIVOT), LT. 1E-08)WRITE(NLP) 476) 14204: 34205 D0 80 L=1, LCOL 3420E. QO(L)=EQ(KPIVR0.L)/PIVOT SO CONTINUE 14297 : 14208: RHS-R1(KR0)/PIVOT R1(KED)=PHS Si 42699 ; WEITE(NLE, 468) \$4219:00 WRITE(MLP, 440)(00/L), L=1, LCOL) 94211-00 54212:0 ELIMINATE THEN DELETE PINDTAL ROW AND COLUMN 04214:0 a 4522 - Carranan ana ang mananan na mananana na mananana na manana na manana na manana na manana na manana na Na manana na <u> 4216</u>, c 14217 IF(KPIVPO, EQ. 1)GO TO 104 KPIWP=KPIVP0-1 5 4218 DD 100 K=1 KPIVR 1 4219 § 4220 KPM=TABS/KHED(KV) ğ 4<u>221</u> FAC=EQ(K, LPIVCO) 0 4222 : 00 9 4223 : WRITEKNLA, 480 YEAC IF(LPIVCO. EQ. 1. OR. FAC. EQ. 0. )60 TO 88 LPIWC=LPIWCO-1 9.422d ; DO 84 L=1,LPIVC 4225: 4226 £0(K,L)=E0(K,L)-FAC\*90(L) S4 CONTINUE § 1227 : SE IF(LPIVCE ER LCOL)GO TO 96 9 **4**229: a <u>155</u>9 -LEIVE=LEIVED-1 DØ 92 L=LPIVC, LCOL 1 4239 EQ(K, L-1)=EQ(K, L)-FPC+QQ(L) 4231: 4232 4233 92 CONTINUE 96 P1(KRW)=P1(KRW)-FAC\*PH5 1274 100 CONTINUE 4235: 194 IF(KPIMPO, EQ, KRONNGO TO 128 4275. 4277) KFIVF=KFIVF0+1 DO 124 K-KEIVE, KEOW KPM=IABS(KHED(K)) 4278 42297 FAC=ER(K LPIVCO). WRITE(NLR, 490)FAC IF(LRIMCO E0, 1)6C 12240,00 TØ 112 4242. 4242. LEINC=LEINCO-1 4243. 00 108 L=1 LPIVC 1244 EQ(K-1) し>=EQ(K) し>-FAC\*QQ(L) 1245 105 CONTINUE 424E IF(LFIVCO EN: LCOL)GO TO 120 112 1217 LFIVC=LFIVC0+1 00 116 L=LPIVC.LCOL 1248 1249; EQ(K-1, L-1)=EQ(K, L)-FRC\*QQ(L) 1250 116 CONTINUE

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\*\*\*\*\*\*\*\*\*\*\* -5 + 第第第第第第第第第第第第第第第第第第第第第第第第第第 **U**, KSUPS 1 4. C.) \* Û \* Û \* Û (NHWW ٠ ---EL, NMAN) (1007 (T=1) 7- j 11 WEITE(ND1) 2. KROHLDOL, LETVOD, (LHED(L), QQ(L), L=1 2. KROHLDOL, LETVOD, (LHED(L), QQ(L), L=1 00 129 K=1, KROM EG(K, LCOL)=0 EG(K, LCOL ٤., HEDKKNOK 1.5 8 ÷ 50 64 \*\* 1 \*\*\*\*\*\*\* **x-1** ~ { \*\*\*\*\*\*\*\*\* <u>–</u> 2 E. -- 1 LCOL=LCOL-1 IF(LPIWCD, EQ,LCOL+1)60 T 00 122 L=LPIVCO.(COL 00 122 L=LPIVCO.(COL 20011NUE CONTINUE CONTINUE CONTINUE CONTINUE MRITE(NLP, 420) (KHED(C) MRITE(NLP, 420) (KHED(C) MRITE(NLP, 420) (KHED(C)) (KHED(K)) CKRW>-FAC+FHS T. NCRIT)GO T. NESIT)GO T. 2960 TO T. 2960 TO 6 э. Т \*\*\* IFCKROM. 37. IFCNELL. 17. IFCKROW. 37. LECO=IABSCLHB KPIVRO=1 R1(KRW)=R1( CONTINUE CONTINUE CCONT. -161 THEELWAC \* \* \* 지 이 이 이 이 이 이 이 도 거 이 이 С. Г-1 919 1919 <u>ि</u> म भ भ ¥, ŋ, \$ 计减子 ..... ſ., ٠, 4 3 1 1 1 \*\* -\*1 \*\*1 L. LL 17

**C**25 rt) Cij 1.1.3 4 -10Mld F ... ŀ... F. .. Hill. Σ 41 0 К¥, U. 1.11 CONDITIONED ЧĽ. ٤1. II: 12 1 Cr. 1. ..... F--. E. **باربر** э. KPIW// ur: ŀ- ---41 - I --Ξ. T: h. ; 412 Ū. 14 Hill 1.1 T 6.15 --1 1-1.113 2 \$---20 37 -\_\_]  $\mathbb{R}^{n}_{0}$ 0 5 FULLY SUMMED F NOF OR WK 92 NCFIT, INCREA SSEMBLED --1 FIVUT. (76) ing Li t NOP ~. ŭί Π 101 fri Ing **UND** 77ſ<sub>Ľ</sub> in the second se F-4 11 Æ. -۰. ų, 12,066 INGUL ML N 1.4 9 1.4 9 1.4 9 1.4 9 1.4 9 1.4 9 1.4 9 1.4 9 tr) Nah CC) E (N \$-1-n-1 EMENT. LE: HTC/8H NEREOR= IS// THERE ARE NO MORE ROWS P ( 14)INCORRECT CODING OF N (2)INCORRECT VALUE OF N (2)INCORRECT VALUE OF N E N 14 24 ULJAN UNCH 11 -1 h- $v_1$ 1 202 and they (F) (F) 1-4 7781 204/) [NG-MATRIX [20, 10) 50 G. -II In Ur 70--, 15//15 7 /15 #076 NUMBER 111 27 С: Х **EWNN** н <u>К</u> 3. 0. NS - - - - -+ ... VCO, LI <u>. u</u> T: U  $\mathbb{S}_{\geq}$ 15 10 110 110  $\mathbf{T}$ ' C ' I स्तुति जिस N 1----10.  $\pi_{1} u_{2}$ PIYOTHEO(1) PIYOTHEO(1) PROVINELS PROVINE 中國共產 (CONT JEN JOSHI 1-1 74 1340401.00 -77 たいたいたい 111 - Manager Manager and States States

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FETHSOLVAC (CONT.) 1 \*\* 4351:0 <u>14757:</u>Č 28425420 284255420 284255 4259 -1 は「日日日」の BACK-SUBSTITUTION FOR FULL PIVOTING ್ಯ ತನ್ನಕನ ಗ್ರ IMPLICIT DOUBLE PRECISION (A-H, G-Z) 1.42431 COMMON/CONTE/ ð 1365 1 X, Y, V, CONDE, EETA, CPE, RHO, HCOEX, HCOEY, **]**+257: 2 GFF, GFG, GFH, EMU, XG(3), CG(3), DS, DX, DY, \*\* **#**765 2 NP-NH, NE, NE, NOF, NCN, NEN, IT1, ND1, HTED ti dire a 4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAMI <u>a 1779</u>; 5, NRT, MWGA, NMP, NELL, NTRA, NGAUSS, NPR, NCP, NLP, NCP 4271 6, NCOFD, IG, NG, NEY, NET, NEWTON, ITURE, ICONO 4372 ir 4375 COMMON/GEP/ 1 477a · 1 TEMP(461), CORD(461, 2), RSPEC(461, 6) 2/R1(1553), R2(1553), VAFI(1553), VARA(1553), BC(1552) 4375/ 3, VALV(560), AVARI(1553), NOP(122, 8), NDN(122), LPR(122) 1427F of 4377 -4, NOFF(461), MDF(461), NCOD(1552), NODV(560) COMMON/GUPRD/ 4373 <u>1</u> SK(40000), ESTIFM(28, 29), BISH(500), INTEG(2700) 1772 COMMON/UPWIN/ 1 1 A B S 4793 2, WF(8), MDEL(2, 8), WB(2, 8), DWB(2, 72), DWP(72), TT(8) 4353 3,UU/8),VV(8),UAVE(2),VAVE(2),IUFWIN,IWTS,VKIN,VKON 4383 DIMENSION 479a 1 LDEST(28), KDEST(28), NK(28), AR(28, 28) 1397 7 2, EQ(200, 200), LHED(250), KHED(250), KPIV(250), LPIV(250) 4255 2, JMOD(250), QO(250) 475-EQUIVALENCE 1785 1 (SK(1),EQ(1,1)),(GISH(1),QQ(1)) 4284 2, (ESTIFM(1,1), AA(1,1)), (INTEG(1), LDEST(1)) 1740 439 3, (INTEG(30), KDEST(1)), (INTEG(60), NK(1)) £. 4352. 4. (INTEG(90), LHED(1)), (INTEG(180), KHED(1)) ķ 5, (INTEG(270)/KPIM(1)), (INTEG(360), LPIM(1)) 17= 4794 4395-2 E, (INTEG(450), JNOD(1)) ì 47-5 NMAX=200 ł 4297:0 ł 4399 C BACK SUBSTITUTION 1 11日13日,13日本水水水水水水水水水水水水水水水水水

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🗢 FETHSOLYAC (CONT.) 1 34401 C 00 4 I=1, NP 4 SE(I)=BC(I) 34407 00 32 IV=1, NP 1404 14405 EACKSPACE ND1 READ(ND1) :1440£. KRO, LCOL, LPIVCO, (LHED(L), QQ(L), L=1, LCOL) 14417 2, KROW, PIVOT, KPIVRO, (KHED(K), K=1, KROW). : 4409 -BACKSPACE ND1 14200 WEITE(NLP, ded) 34 4 d 1 19 - D.C. WRITERNLP, 408> KRO, LCOL, LPIYCO 14411.00 144<u>7</u>3 00 WFITE(NLP, 408) (LHED(L)) L=1, LCOL) WFITE/NLP, 412> (QQ(L), L=1, LCOL) 14412:00 IF(NCOD(KED) GT. 0)GD TO 24 法日日复办 GASH=0 144:5: DQ(LFIVCO)=0 00 15 L=1. LCOL 24417: GASH=GASH-QQ(L)\*SK(IABS(LHED(L))) St 4 4 1 8 : 16 CONTINUE 111:3. SK(KRO)=R1(KRO)+GASH 1 1120 GD TO 32 이 역 역 등 두 24 CONTINUE 3 d d 2 2 NCOD(KED)=1 \* 1 1423 32 CONTINUE ा नयद्वित् 404 FORMAT(144 DIEC CONTENTS) 11125 · 108 FORMAT(1015) 1425 412 FORMAT(5E20, 10) 1 3427 a dd25. FETURN ENG : dd 🗄 🖹 : ા નવા 🗄 🖗 🖓 4477 2 4 a \_ 2 . . 1423:1 الم الم الم 5.0 144 لىك ]; 1 J J J SUBROUTINE RESOL 3479: IMFLICIT DOUBLE FRECISION (A-H, 0-Z) ت ت ال RESOLUTION FOR FULL PIVOTING S Jad : COMMON/CONTP/ 🗟 444 🔮 : 1 X, Y, Y, CONDE, BETA, CPE, RHO, HCOEX, HCOEY, Aaaa. 2 GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, 3 NP, NH, NE, NB, NDF, NCN, NEN, IT1, ND1, MTRD े नेपत्र . 4. NTIME, MARK, NTR, LTIM, MTRIT, NCAROS, NSID, NAXI \$ 4447. 5, NPT, MWGP, NNF, NELL, NTRA, NGAUSS, NPR, NCP, NLP, NCP 1443 E, NCOPD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND े प्रवेदन COMMON/GEP/ \$ 4459

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14451

🕦 FETHSOLVAC

2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) 4452. 3, VALV(560), AVARI(1553), NOP(122, 8), NON(122), LPR(122) 14457 4, NOFP(461), MDF(461), NCOD(1553), NODV(560) 11454. COMMON/GURED/ S. 1155. 1 SK(40009), ESTIFM(28, 28), GISH(600), INTEG(2700) 3 4455 COMMON/UPWIN/ A 4457 1 AA1, AA2, A1, A2, EB1, BB2, B1, E2, DIE(2, 461) 1458 2, MP(8), MDEL(2, 8), MB(2, 8), DMB(2, 72), DMP(72), TT(8) 2, UU(8), VV(8), UAVE(2), VAVE(2), IUPWIN, IWTS, VKIN, VKON ्र बंदल्ले : DIMENSION 3 ddf 1 1 LDEST(28), KDEST(28), NK(28), AA(28, 28) ⊴a 44€2 2, En(200, 200), LHED(250), KHED(250), KPIV(250), LPIV(250) 32 dd F 7 3, JMOD(250), QO(250), PVKOL(250) ेः संसम्ब 4, NEOUNDR(29) Sa 44-77 -EQUINALENCE 11--1 (EK(1),EQ(1,1)),(GIEH(1),QQ(1)) S 4467 2, (ESTIFM(1,1), RR(1,1)), (INTEG(1), LDEST(1)) 1 1122 3, (INTEG(30), KDEST(1)), (INTEG(50), NK(1)) ្ន ៨៨៩៩ A, (INTEGISE), LHED(1)), (INTEG(180), KHED(1)) ु 107-7 5, (INTEG(270), KPIV(1)), (INTEG(360), LPIV(1)) S 1471 E, (INTEG(450), JMOD(1)) 5 4472 S 4474:0.... RESOLUTION \$4477 REWIND ND1 4477 00 2 NX=1, NE CALL ASFIND 8 4479: 2 CONTINUE > 1179. NU#=29 S dated : CALL TIMER(K1) 1 da 5 1 . WFITE(9,476)81 S 20-27 WRITE(9,472) a 4493:0 00 4 I=1, NP 1 ALEN : WRITE(9,464>NCOD(I),BC(I) Jader. C TE(NCOD(I), LT. 1) GO TO 4 -्र वेवर्न् R1(I)=EC(I)14407. 4 CONTINUE 1 4450 00 12 NLL=1, NP 3 2252 READ(ND1) . 4d = 10 1 KPO, LCOL, LPIVCO, (LHEO(L), QO(L), L=1, LCOL) 1 da 21

2, KPCH, PIVOT, KPIVRO, (PVKOL(K), KHED(K), K=1, KROW)

S 1197: PVKOL(KPIVEO)=0. NAI91: NRITE(9,408)KROW, KPIVRO

(CONT.)

1 TEMP(461), CORD(461, 2), RSPEC(461, 6)

4494 C WRITE(9, 408)KRUW, KPIVRU 4495:C WRITE(9, 412)(PVKOL(K), K=1, KRUW)

WRITE(9, 416) (KHED(K), K=1, KRO W)

S 1497: RHS=R1(KR0)/PIVOT

2 4400 R1(KR0)=PHS 2 4400 D0 8 K=1, KR0M

¥ 4492.

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L 1499. DO 8 K=1,KROM L 1500 KRW=IABS(KHED(K))

<sub>3)</sub> 4500: KRW=IABS(KHED(K)

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FETHSOLVAC

(CONT. )

501

1 IF(NCOD(KEW), GT. 0. AND, KHED(K), GT. 0) GO TO 8 -1 4501 : R1(KEW)=R1(KRH)-PVKOL(K)\*RH5 ay 4502) S CONTINUE a 4503 WEITE(9,400) 3 4504 ; WRITE(9,404)(I,R1(I),I=1,NP) : 4505; 12 CONTINUE -) 4506. CALL BAKSUB \$ 4507 CALL TIMER(K2) ા 4508 WRITE(9,477)K2 - 1200 400 FORMAT(/18H RIGHT HAND VECTOR/) 7; 1519· ADJ FORMATKIS, E20. 10) 31 4511 408 FORMAT(14H DISC CONTENTS/6H KROW=, IS, 7H PIVOT=, E20, 10 er 4512.C 1,8H KPIVRO=,15) =1 4512:0 412 FOPMAT(5E20, 10) 31 4514 C 416 FORMAT(1015) 34 **4515**, 0 ARA FORMAT(IS, E20, 10) N 4516 472 FORMAT(20H BOUNDARY CONDITIONS) 3 4517 0 476 FORMATKZ, 2%, "RIGHT HAND SIDE PROCESSING STARTS AT ्र 4519 1CPU-TIME OF\*, 110, 2X, 'SECONDS') <u> 7519</u> FORMAT(2,2%, 'RIGHT HAND SIDE PROCESSING FINISHED 31 4529 377 1AT CPU-TIME OF', 15, 2%, 'SECONDS') 34 45<u>21</u> a 4522 RETURN a 4522 END =r, 4524÷l Sk 4525 / 4527 (C 2: 4528.1 1 15:5 31 **45**79. 3 A 1531 SUBROUTINE PSICALC 28 4532 3 4574 7 CALCULATES STREAM FUNCTION FROM A VELOCITY FIELD 1525 0 153E 4527 4539 IMPLICIT DOUBLE PRECISION (A-H, 0-Z) 4550 COMMON/CONTE/ 1 X, Y, V, CONDE, BETR, CPE, RHO, HCOEX, HCOEY, 4549 1 1 3 - GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY, ta 4541. 3 NP, NH, NE, NE, NDF, NCN, NEN, IT1, ND1, MTRD ii 4542 4. NTIME, MAFK, NTR, LTIM, MTRIT, NCARDS, NEID, NAXI VE 4542 5, NRT, MWGP, NNP. NELL, NTRA, NGAUSS, NPR, NCR, NLP. NCP 1514 5, NCOPD, IG, NG, NBY, NBT, NEWTON, ITURB, ICOND 4545 COMMON/GEP/ 4548: 1 TEMP(461), CORD(461, 2), RSPEC(461, 6) \$4547: 2, R1(1553), R2(1553), VARI(1553), VARA(1553), BC(1553) 1 4548 3, VALV(560), AVARI(1553), NOP(122, 8), NDN(122), LFR(122) a 4549: 4, NOPF(461), MDF(461), NCOD(1553), NODV(560) - 4550

<CONT JHA TOSH1

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 $\gtrsim 0$ BOON 日に見 F IRUTO=0) SPECIFYING STREAM FUNCTION BOUNDARY VALAES NOT 1000-0) SPECIFYING STREAM FUNCTION BOUNDARY VALUES NB. . . TOTAL NUMBER OF BOUNDARY NODES. NOP. . NODE NUMBER. 金子子 金子 医子子 法法法法法法 COMMON/GURPD/ SK(49600), ESTIFM(28, 28), 015H(600), INTEG(2700) COMMON/UPAIN/ COMMON/UPAIN/ 1 RALARS, REAR, B2, BR2, BR2, B1, B2, D15(3, 461) 2, HP(\$), HP(2, 28), HP(2, 8), DHF(72), TT(8) 2, HP(\$), HP(2, 28), HP(2, 8), DHF(72), TT(8) 2, HP(\$), WC(\$), UAVE(2), VAVE(2), IUPHIN, IMT5, VKIN, VKON COMMON/PSIN/ 1 PSI(1000), VALM(200), ALEN(40), BLEN(40), KINZ(40), KOUZ(40)) 21 EST(1000), VALM(200), ALEN(40), LFRON 1 PSI(1000), VALM(200), ALEN(40), LFRON 1 PSI(1000), VALM(200), ALEN(40), LFRON 21 ESTIFMON 22 PSI(1)=0 24 PSI(1)=0 26 C(1)=0 27 PSI(1)=0 27 PSI(1) -Ъл ĮК يد 1 E. ir, Li S u -5 TO COMPUTE OUNDAFIES. \* \* FUNCTION VALUES AT -医安全血管 医马克斯曼 医马克斯曼 医马克斯曼 医马克斯曼 医马克斯曼 പ്പ CALLEI THE FUNCTION 00 54  $c_0$ FECTAUTO.E0.1>G0 T0 28
REAP(NCR.122> NB
NEF=NB
NEF=NB
D0 25 I=1.NP
REAP(NCR.124) N0D, VAL
NCOD(NOD)=1
NCOD(NO Ċij. 3 19070=0 <del>~1</del> 11 IPUTO-オチチ 「東京寺寺寺寺寺 チチチ - $\sim$ Ing сл гд 53 \* tr, 5.1 ×4 --

NALUE FUNCTION STREAM 125 PO 20 1=1, NEP NOD=NODP(I) NCOD(NOD)=1 BC(NOD)=49LP(I) CONTINUE CONTINUE CONTINUE *ITEP=ITER+1 CALL PUTOEC CONTINUE REWIND 10 REWIND 10 NCB=ITER* (CONT. ) ムショード FETHEOL VAC \* 14 (1) (1) Сц Г. 1 \* (3) [4] チャッチ いらい 444 664 4663 11

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40 14 10  $\frac{1}{2}$ 6 NV=NCF LQ=NCN NDF=NF NDF=NF NDF=1 NCN=1 NC . . \* \* . . \* .

10 [1]

 $\frac{1}{2}$ 

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<u>(</u>) ()

NTRA=0 REWIND

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(CONT.) FETHSOLVAC 1 : a 465<u>1</u> : WRITE(NLP) 126> 4652 : DD 40 N=1,NH NCOD(N)=0 - BC(N)=0. e 14654 : PSI(N)=SK(N) : ::: 4655 : WRITE(NLP, 152)PSI(N) : -:= **4656**: IF (NCARDS, NE. 0) WRITE (NCP, 130) N, PSI(N) 👾 4657 : C 40 CONTINUE - 8 · , **4653 :** tal 4659 : C CALLING VORTICITY COMPUTING ROUTINE 4661 : C CALL NCALC 4664 : EEWIND 10 -4565: -----NF=NF 4667 NOF=NW 4563: NCN=LQ МЫСЯ=0 4669; NFRH=9 4679: 3. 4671 : CALL TIMER(IT3) ITIME2=IT3-IT1 L 1972: 3: 4673; WRITE(NLP, 102)NCA, ITIME2 4674 : IF(ITER. EQ. 1) 60 TO 101 GO TO 15 ni 4675) 4675: 101 4677:C CONTINUE 9 4E79 : 102 FORMAT(//51H STREAM FUNCTION/VORTICITY CALCULATIONS CASE NUMBER, IS 5 4E79) 1, 7, 1H , 22H EXECUTION FINISHED AT, 14, 6H SECS. //> 116 FORMAT(IS,36H STREAM FUNCTION BOUNDARY CONDITIONS) :. *4ese* 122 FORMAT(IS) . *4631*. 124 FORMAT(110)F20.10> in 4652 126 FORMAT(2/16H STREAM FUNCTION/2) 4653: 129 FORMAT(TH IAUTO=, 12) .. 1534. 4685 130 FORMAT(I10,E20.10) 152 FORMAT(30X, E15. 7) RETURN : 4637: END 4638. 1629.0 14699:0 1691.0 3 *4692:0* 4693:0 1694.1 12695 SUBROUTINE WCALC AFPE 4697:0 1633.0 CALCULATES A MORTICITY FIELD FROM A VELOCITY FIELD 

• <b>4</b> 5 ∺	FETH	OLVAC (CONT.)	
t			
<u>_</u>	701:		
5=4	792:		
	703:	IMPLICIT DOUELE PRECISION (R-H, O-Z)	
1	704	COMMON/CONTR/	
्रिङ्क <b>स्</b> चार्ड्स्ड <b>स्</b>	185). Mari	1 XIYIYICUNUFIDEIHICFFIKHUIHCUFXIHUUFYI B RDE RDR RDU.EMU YRYFY RRYFY RE RY RU	
9 % L &:	7051 707 -	Z NP, NH, NE, NE, NCE, NCN, NEN, IT1, ND1, MTRD	
ः न ः <b>न</b>	708 -	4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI	
4	709	5, NRT, MWGR, NNP, NELL, NTRA, NGAUSS, NPR, NCR, NLP, NCP	
. 1	710:	6, NCORD, IG, NG, NEV, NET, NEWTON, ITURE, ICOND	
9 <b>4</b>	744	COMMON/GEF/	
ş 4	712:	1   EMP(461);UUKU(461;2);K5PEU(461;6) 	
્યે અને ગાઉ ની	1121. 74.4	2) RELIEUD// RELIEUD// TREILIUUD// TREALUUD// TREALUUD// DUCLEUD// 7. WALWC569), AVARI(1557), NDP(122, S), NDN(122), LPR(122)	
че <b>н</b> 11 <b>л</b>	715	-4, NOFF(461), MDF(461), NCOD/1553), NODV(560)	
4	715	COMMON/GURFD/	
14	717:	1 SK(40000),ESTIFM(28,28),GISH(600),INTEG(2700)	
1.1	718	COMMON/UPWIN/	
1 4	719 -	1 HH1/HH2/H1/H2/661/662/61/62/015(3/461/ a up/an upper/a an up/a an bup/a fan bup/fri tt/pn	
1 <b>-</b>	720 -	2,MEREJEMUELRZEBJEMBRZEBJEUMBRZEFZJEUMERRZZETER 3 mmres dures haueros daueros induin inte,MVIN.MVDN	
18 <b>4</b> 18 <b>5</b>	ビビゴー アウウィー	SJOCKSJYYKSJJOHYEKEJJYHYEYEYEJJICHAINJIAJSYKINJKAN COMMONJESTMI	
4	727 -	1PSI(1000), NODP(200), VALP(200),	
4	724	2NODW(200), VALW(200), ALEN(40), BLEN(40), KINZ(40), KOUZ(40),	
} 4	725	SITER, NCR, JAY, KINL, KOUT, PSIF, NBP,	
14	726:	4NEW, NLE, NUE, NERA, JERON, KERON, LERON	
14	727 :-	REWIND ND1	
4	728:	THER.G. IF GUIDE	
; # : A`	(ビス ) ママロー・	****	;
ંત	インビーム アフィーイ	READING IN VORTICITY BOUNDARY CONDITIONS (FOR EVERY NODE	•
	772 - (	ON THE BOUNDAPY)/	
: 4	723.0	NB TOTAL NUMBER OF BOUNDARY NODES	
1	734 (	NOD NODE NUMBER:	
4	735/(	VALVORTICITY VALUE:	
• 4 •	736:1	<b>**</b> **********************************	
ر اس ۲۰۰۰ - ۲۰۰۰ - ۲۰۰۰	(1/.) 770.	READINGR. 400 NR	
ید در الد	(10. 770)	WEITERNIE, 11ENRE	
	7357	NEW=NB	
، مو	7.1 1	IF(NR. EQ. 0) 60 TO 4	
<b>.</b>	742;	DO 1 I=1. NB	
1	747.	READ(NCR, 124)NOD, VAL	
, 11. ,	<44 · 7.1⊂	WEITETNLETTETNUDTVEL NCODTNODI-1	
। स्रिंग् स्रि	(파종) 7년교 -	NUCLIPTOLIZEL DC/NDCX-UDI	
يىد ئىرى	747	ΝΠΡΨ(Ι)=ΝΠΡ	
; ;	743	VALW(I)=VAL	
<b>.</b>	5 J J	1 CONTINUE	
47	750	GO TO 4 .	

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🔅 FETHSOLVAC (CONT.) 1 4751. 2 IF(NEW.EQ.0)G0 TO 4 -14752 -DD 3 I=1 NEW 4753 NOD=NODM(I) NCOD(NOD)=1 14754 BC(NOD)=VALW(I) 4755 3 CONTINUE 175A ·54757 · 4 CONTINUE -14758 00 5 I=1, NP 5 R1(I)=0. MNGA=1 X:4760; IF(NPRA, EQ. 0)00 TO 6 \$ 4751 : 5x4762;C CALLING FRONTAL ROUTINE -147EA (D \*\*4765:0 CALL FRONT 4757: JFRON=LFRON 4759 00 TO 8 \* 4769 : 5 CONTINUE 04779· LERON=JERON :3*4771*. ti 4772 : C CALL RESOL \*+4773+0 OUTFUTING VORTICITY VALUES (R2(I)) S 4775 ( D) 8 WRITE(NLF, 100) \* 477<u>9</u> ; 00 12 N=1 NF : 1779 R2(N)=SK(N) . 1780 -WPITE(NLP, 153)R2(N) × 4791 · 12 CONTINUE . 1792: IF(NCARDS.EQ.0) GD'TO 16 : 4783: 00 14 I=1, NP : 4794. WRITE(NCP, 130)I, R2(I) 14785-0 14795 CONTINUE 11 16 CONTINUE 4737 14788:0 100 FORMATC/10H MORTICITY/Y 1700. 116 FORMATCIS, 30H VORTICITY BOUNDARY CONDITIONS> 17=0: 122 FORMAT(15) 1791 124 FOFMAT(110, F20, 10) 4793 120 FORMAT(110,E20.10) 152 FORMATCIS, 3E18, 10, 15) 153 FORMATC30X, E15, 7) 17=1 1705. 179E. 200 FORMAT/ FIGHT HAND VECTORS FOR VORTICITY CALCULATIONS() 202 FORMAT(1N, 3E20, 6) 4797: 1798.0 RETURN 4700 END 1800

FETI	SULVHU (CUNT.)
ł	
4801	$\mathcal{C}$
1802	
<b>490</b> 2	$\mathcal{C}$
4604	
4805	
4802	
4997	
4808	SUBRUUTING HUTURS
<b>A</b> BHH	1. 1
4819	SETERMINE POUNDARY VALUES FOR THE STREAM FUNCTION FIELD
	C DETERMINE COORTS TO ECLETEN THE ETHER THE ETHER
1012	1211111111111111111111111111111111111
- 1011 - 1011	
्र <b>क</b> ्ष्ट्रा संदेश र र	
1315	TIMPLICIT DOUBLE PRECISION (8-H/0-Z)
11917	COMMON/CONTR/
2212	1 X, Y, Y, CONDE, BETA, CPE, RHO, HCOEX, HCOEY,
ີ ປີເລີຍ	2 GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DN, DY,
4820	3 NF, NH, NE, NE, NOF, NCN, NEN, IT1, ND1, MTRD
4824	1, NTIME, MARK. NTR. LTIM, MTRIT, NCARDS, NSID, NAKI
4822	5, NRT, MWGA, NNP, NELL, NTRA, NGAUSS, NPR, NCP, NLP, NCP
4822	6,NCORD,IG,NG,NEV,NET,NEHTON,ITURE,ICOND
S4224	COMMON/GEP/
୍ୟିଟ୍ଟଟ୍ର ମ	1 TEMP(461),CORD(461,2),RSPEC(461,6)
ે482ન	2, R1(1552), R2(1552), VARI(1553), VARB(1552), BC(12942)
\$4827	2, VALV(560), AVARI(1552), NOP(122, 8), NDN(122), LPR(1447
:4828	a, NOFF(451), MDF(461), NCOD(1553), NUUV(560)
્યક્ટ્રવ	COMMON/GUBPO/
ৢ৾৶ঢ়৾৾ৢঢ়৾	<u>1 SK(40909), ESTIFM(28,28), BISH(600), IN(EG(2700)</u>
J871	COMMON/UFHIN/
J972	1 <u>881,882,81,82,82,82,82,82,81,82,015(3,461)</u>
ş48II	2.MP(8),WDEL(2,8),WB(2,8),DMB(2,72),DWF(72),T(897 
`J.?_d	·
<b>V</b> 915	·
4574	- <u>1</u> PSI(10007)NOUF(2007)NHLK(2007) Subburboon Holykobon olehkidan plenkidan kimizidan, komz(40),
्यस्तृत	· <u> </u>
្រទទ្ធម	· <u>Зіјер, Мельсату К</u> імер Корсь поіг, Магь Тари на анна мара Теран Усарм 3 Тари
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्दहुनभु	18(1)=K, 19, 17, 19, 17, 20, 19, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20
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اي تەچرى د مىرى د	() TERPINELI AND DETELI ANDER IN ORDER DE INDREDIGNE TELE
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् <del>भ</del> तमः -,1⊂10	, μεταγγής με το μμα το βαθλαστουν του
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្រមួយជា ស្រុកព្រ	KINL- NUMBER OF ELEMENTS ON INLET EQUNDARY.
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	4804		- WE1121 - DO 2-1	NLF: 182 =1, KINI	PKINL						
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	1957	`; <b>€</b> .а.а.а.а. 	مېر کې لېږ کې لې کې	*******	*****	ng n	***	, de de de de de de . E	a da da da da da da da	(*************************************	يغر يغر <u>ا</u> غ
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- 3	49-75	્યું સાહ્ય વ્યવસાય	ા હતા હતા હતા હતા હતા હતા. આ ગામ આ ગામ આ	يغريها بهر يوريور هاريد. 	يىيا بىيا يەر بەر بەر بەر يەر	un de la companya de	ne de necherne de nec	و الله الله الله الله الله	र अन्य भर अन्य भेर भूत भेर जन्म	مى ھىر بىيا ھە تىپ بۇر بۇر بۇر بىل بىد	<
***	दङ्ग्रीम् जन्मन्त्र		KGUT=	NUMEER	OF = ELE	MENTE	<u> 20 2171</u> 4.4.4.4.4.4.4	ET EOUX	lDaet Maet	الساب محمد السامين المارين	الحد سوانا
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FETHEOLVAC (CONT. ) ł as **1901** 1 FALEN(I+1)\*((5. \*VARI(J1)-VARI(J2))/24 +VARI(J2)/2 > 1502 RICKINZ(I+2))=RICKINZ(I)) : 4907 1 +ALEN(I+1)\*((VARI(J1)+VARI(J3))/6.+2.\*VARI(J2)/3.) **,** • 14963 6 CONTINUE 14405 . 0 Diagoe, R1(KOUZ(1))=PSIF :: 1907 KOU=KOUT-2 49999 DO 8 I=1,KOU,2 11995 J1=NOPP(KOUZ(I)) . 1310. J2=NOFF(KOUZ(I+1)) 1211-JS=MOFF(KGUZ(I+2)) a<u>191</u>2. R1(KOUZ(I+1))=R1(KOUZ(I)) 1 +ELEN(I+1)\*((5.\*VARI(J1)-VARI(J3))/24.+VARI(J2)/3.) 14457 R1(HOUZ(I+2))=P1(HOUZ(I)) ې له او که د او د 4217 +ELEN([+1)\*((VFRI(J1)+VAPI(J3))/6,+2,+VAPI(J2)/5,) 4714 E CONTINUE 4917 GREH=(R1(KINZ(KINL))+R1(KOUZ(KOUT)))/2. 13515 WRITE(NLP,124)R1(KINZ(KINL)), P2(KOUZ(KOUT)) IF(ITER.GT.1) G0 T0 25 1012 4928.0 4721 / 第次使复展生业和 林皮质是 那些女孩 体才像 使没有的 使使无法的 经未定定法 法法保持 法法法法 医达德德德 医斯德德德 医卡里耳 医骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨骨 4922-0 REFOING BOUNDARY NODES ON FIXED DETUM EQUNDARY 4922 : 0 AND SETTING UP BOUNDARY CONDITIONS; 4524 ( ) NLB= TOTAL NUMBER OF EQUNDARY NODES ON FIXED SOUNDARY, 4923 NOD= NODE NUMBER. 4927 0 4925-READ(NCR, 100 NLE 1070. MRITEKNLE, 115) MLE 4973 00 15 I=1 NLE FEADYNCR, 100)NDO HFITE(NLP, 100)NOD 4677 NCOD(NOD)=1 4574. EO(NOD)=FSIF 4975 NOOP(I)=NOO 15 CONTINUE 4549:0 AND SETTING UP CODING FOR BOUNDARY CONDITIONS: **4**54<u>1</u>.0 NUE= TOTAL NUMBER OF BOUNDARY NODES NOT AN FINED BOUNDARY. 4542:0 NOD= NODE NUMPER. 4943:0 4944 1 4945 REFORNCE, 100>NUE 4945 NRITEANLP, 120) NUS 4947. 00 20 I=1, NUS 4949. READ(NCR/100)NOD 4949 -HEITEKNLP, 100)NOD 1 4529. NCOD(NOD)=1

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к. н. Па ма	FETH	ISOLVA	ic (cont.)
	4951 4952 4955 4955 4955 4955 4955 4955 4955	20	EC(NOD)=GASH L=NLB+I NODP(L)=NOD CONTINUE GO TO 40 CONTINUE DO 30 I=1, NLB NOD=NODE(I)
	4959 4959 4951 4952 4952 4952 4952	39	NCOD(NOD)=1 SC(NOD)=PEIF CONTINUE DO 35 I=1,NUB L=NLB+I NOD=NODF(L) NCDO(NOD)=1
$ \left\  f_{i}^{2} \left( f_{i}^{2} - f_{i}^{2} \right) - f_{i}^{2} \left( f_{i}^{2} - f_{i}^{2} - f_{i}^{2} \right) - f_{i}^{2} \left( f_{i}^{2} - f_{$	4955 4957 4958 4959 4979 4974 4972 4973 4973 4973	25 40 50 102 102 106 106	EC(NOD)=GAEH CONTINUE DO 50 I=1,NH R1(I)=0 FORMAT(I5) FORMAT(6H KINL=,I3) FORMAT(6H KINL=,I3) FORMAT(21STREAM FUNCTION INLET/OUTLET NODE NUMBERS(,/) FORMAT(110,F20.10)
and a start of a start of the s		198 418 418 418 418 418 418 418 418 418 41	FORMAT(F20.10) FORMAT(11H PSI VALUE=,F20.10) FORMAT(11H PSI VALUE=,F20.10) FORMAT(2,I5,'STREAM FUNCTION SPECIFIED BOUNDARY CONDITIONS',Z) FORMAT(Z,I5,'STREAM FUNCTION CALCULATED BOUNDARY CONDITIONS',Z) FORMAT(Z'STREAM FUNCTION CALCULATED BOUNDARY VALUES'Z2E20.10Z) RETURN END
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# FETHSOLVAC (CONT.)

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	5002:	IMFLICIT DOUBLE PRECISION (A-H, 0-Z)
	5002 .	COMMON/CONTR/
	5004	1 X, Y, V, CONDE, BETA, CPE, RHO, HCOEK, HCOEY,
	5005:	2 GPF, GPG, GPH, EMU, XG(3), CG(3), DS, DX, DY,
	500F	3 NP, NH, NE, NB, NDF, NCN, NEN, IT1, ND1, MTRD
	5007	4, NTIME, MARK, NTR, LTIM, MTRIT, NCARDS, NSID, NAXI
	5009:	5, NRT, MHGR, NNP, NELL, NTRR, NGRUSS, NPR, NCR, NLP, NCP
	5000	6, NCORD, IG, NG, NEY, NET, NEWTON, ITURE, ICOND
	5010:	COMMON/GEF/
	5011:	1 TEMP(461),CORD(461,2),RSPEC(461,6)
5 . 	5012:	2,R1(1552),R2(1553),VARI(1552),VARA(1552),BC(1553)
	5013:	], VALY(560), AVARI(1553), NOP(122, 8), NON(122), LPR(122)
	5014;	4,NOPF(461),MDF(461),NCOD(1553),NODM(560)
:1	5015	COMMON/GUERE/
	501 E.	1_5K(40000),ESTIFM(28,28),GISH(600),INTEG(2700)
5	2017:	COMMON/UFWIN/
	2018:	1 881,882,81,82,881,682,61,82,DIE(3,461)
	2412	2,WP(8),WDEL(2,8),WB(2,8),DWB(2,72),DWP(72),TT(8)
	50291	I) UU(8), VV(8), UHVE(2), VRVE(2), IUPHIN, IMTS, VKIN, VKDN
÷	2022.1	CUMMENZASIGZ
1	2422	1P51(1000),NODP(200),YALP(200),
		2NUDW(200), VHLW(200), ALEN(40), BLEN(40), KINZ(40), KUU2(40),
	2년214 () 도망가도	SITER, NCH, JHY, KINL, KUUT, PSIF, NSP,
Зį.	2422	ANDH; NLE; NUE; NFRH; JERUN; KERUN; LERUN
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ŝ <b>₽</b>	2023	1H11(12),H12(12),F(12),DEL(2,12),B(2,12),HB(12,12),
	2028,	20072/20001(2/20)6M(2/2)FF(30)FG(30)E(HELE(10)30)
4.4 83	CCLM) Foto	3881/28/28/28/28/28/28/28/28/28/28/28/28/28/
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1	50-50. 5024	AP/I.JY=0
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		1 N.NG.II. ((DBCL.I).L=1.2).DBCTY.L=1.NGY.(DDA/LY.L=1.II.).NGG
)	7,245	2, ((CB(L,I),L=1,2),CP(I),I=1,NGR)
	Gde -	DO 20 NG=1.LL
Ċ	5047	DA=DDA(NG)
, ,	pas ·	DD S I=1.NEN
ù e		NJ=(NG-1)*NEN+I
į	1050	P(I)=DP(NJ)
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🖘 FETHSOLYAC (CONT.) 5051 : 00 6 L=1,2" \$5052: E E(L, I)=DE(L, NJ) æ. 5057 S CONTINUE 5054 G1=0 $G \mathcal{L} = \mathcal{Q}$ 15055 505E: 00 12 L=1, NSN 5057. K=IAES(NOP(N,L)) 5059. M1=NOPP(K) 15059 M3=M1+MDF(K)-JA 15060: G1=G1+B(1,L)\*VARI(M3)-E(2,L)\*VARI(M1) 62=62+CORD(K, 2)\*P(L) 5061 : 5062. 12 CONTINUE 63=JAY/62 5062. 50Ed : 64=(62-1)\*JAY+1 5065.0 5057 0 RIGHT HAND SIDE 5] 5050.0 5070 DO 14 I=1, NEN 5071 *PI1(I)=AI1(I)+P(İ)\*DA\*G1* 17 5972: AI2(I)=AI2(I)+A(I)\*0A\*G1\*G4 i, 5073: *14 CONTINUE* 9] -5074÷C 5 5075.0 FORM FLUID MATRICES 5078,0 5070. IF(NCA.GT.1) G0 TO 18 5050 DO 16 I=1, NEN DO 16 L=1.N5N 5081. 5002. 5002: AA(I,L)=AA(I,L)+(B(1,I)\*B(1,L)+B(2,I)\*B(2,L))\*DA 1 +P(I)\*G3\*E(2,L)\*DA 5094 AE(I,L)=A8(I,L)+P(I)\*P(L)\*DA 5895. 16 CONTINUE 5006 18 CONTINUE Seer. 20 CONTINUE 2668 IFKMWGALLT.0200 TO 30 5200. DO 25 I=1, NEN 5050 NI=IABS(NOP(NELL, I)) 5091. R1(NI)=R1(NI)+AI1(I) 5092: DO 25 J=1, NBN 5092. FP(I, J)=AB(I, J) 5.794. 25 CONTINUE 15095 GO TO 40 30 DO 35 I=1, NBN 7896 ( 5097: NI=IRBS(NOP(NELL, I)) 5098. R1(NI)=R1(NI)+AI2(I) 5000-35 CONTINUE. 40 CONTINUE 5100:

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## FETHEOLVAC (CONT. )

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5101 : C 5102 5102 : 5103 : 5104 :	100	WRITE(NLP) FORMAT(8E1 RETURN END	100)( 0.2)	'(AA(I	· £>,	I=1,NBN>,L=1,NBN>	
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### APPENDIX III

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### PROGRAM INPUT/OUTPUT

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### LOUGHBOROUGH UNIVERSITY

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### VERSION 4

INFUT/OUTPUT

PROGRAMMER : Mohammed J. K. Alshatam DATE : 11 . 01 . 1985 TIME : 13:53



### INPUT/OUTPUT

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LAMINAR AND TURBULENT RECIRCULATING, CONVECTIVE, BUOYANT FLOWS AND HEAT TRANSFER ANALYSIS OF SOLAR POWERED VENTILATION AND AIR-CONDITIONING SYSTEM USING THE FINITE ELEMENT METHOD (F.E.M.) 0 0 1

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OUTFUT40DEG This is the output file for the coupled solution.

FINITE ELEMENT PROGRAM IN INCOMPRESSIBLE VISCOUS LAMINAR AND/OR TURBULENT FLOW INCLUDING HEAT TRANSFER. IT SOLVES N-S, CONTINUITY, AND THE GENERAL ENERGY EQUATIONS FOR STEADY STATES. IT ALSO CALCULATES VARIOUS FLUID FLOW AND HEAT TRANSFER PARAMETERS.

0 EXECUTION STARTED AT 0 SECS.

LAMINAR AND TURBULENT RECIRCULATING, CONVECTIVE, BUOYANT FLOWS AND HEAT TRANSFER ANALYSIS OF SOLAR POWERED VENTILATION AND AIR-CONDITIONING SYSTEM USING THE FINITE ELEMENT METHOD (F.E.M<sub>.</sub>).

CONTROL DATA AND PHYSICAL QUANTITIES :

FREE OR MIXED CONVECTION, CARTESIAN COORDINATE SYSTEM. NOEMAL VELOCITY GRADIENTS BOUNDARY CONDITIONS

CONDF BETA CPF 0.0262400000 0.0033160000 1005.7000000000 MARK= 3 NAXI= 0 NEWTON= 0 IUPWIN= 0 ITURB= 1 VISCOSITY= 0.19830E-04 DENSITY= 0.11774E+01 X BODY FORCE= 0.00000E+00 Y BODY FORCE=-0.10000E+01 KINEMATIC VISCOSITY= 0.16842E-04

DENSITY=RHO=(kg/m\*\*3) SPECIFIC HEAT CAPACITY FOR CONSTANT PRESSURE=CPF= CP=[w/sec/kgK (J/kgK)] DYNAMIC VISCOSITY=NU=[kg/m sec(N sec/m\*\*2)] KINEMATIC VISCOSITY=NU=(m\*\*2/sec) THERMAL CONDUCTIVITY=CONDF=K=(w/mK) COEFFICIENT OF CUBICAL EXPANSION=BETA=(m\*\*3/K) ELEMENT DATA NH=461

MTRO= 0 NCAPOS= 1 MTRIT= 0 LTIM=108005ECS. NNP=170 NCN= 28

IRREGULAR COORDINATES-READ IN DATA

IRREGULAR MESH-READ IN NODAL DATA

NE=122

ELEMENT NODE NUMBERING

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### 515 ECUNDARY CONDITIONS

JACOBIAN AND DERIVATIVE CALCULATIONS COMPLETE AT 34 SECS.

DATA GENERATION COMPLETE AT 19 SECS.

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SOLUTION ROUTINE ENTERED AT 36 SECS.

EXIT FROM SOLUTION ROUTINE AT 475 SECS.

LARGEST RELATIVE CHANGE IN ANY WARIAELE= 0.1152832589E-02

ITERATION NO. = 1

NODE	U-VELOCITY	PRESSURES	V-VELOCITY	TEMPERHIUEE
1	0.000000000000000000000000000000000000	0. 0000000000E+00	0.000000000000000000000000000000000000	0.2300000000E+02 0.2274645930E+02
4124	0,1227422869E-02 0,1226616398E-02	0. 0000000000E+00	0, 00000000000000000000000000000000000	0.2313433390E+02 0.2357744548E+02
្រភ្លេទ	0,1280795176E-02 0,8299484984E-03	0. 0000000000E+00	0, 00090000000E+00 0, 000000000E+00	0 2405095725E+02 0 2515746222E+02
7 8	9, 000000000000000000000000000000000000	a. eaeeeeeeeeE+ee	8, 9889989898855+89 8, 98899998995+89	0_2600000000E+02 0_2600000000E+02 0_0500000000E+02
9 19	-a. aaaaaaaaaaaaE+aa -a. aaaaaaaaaaaaaE+aa	-0.1299101813E-01	0.000000000000000000000000000000000000	0,2600000000000000000000000000000000000
11 12	<i>₽. ₽₽₽₽₽₽₽₽₽₽₽₽₽₽</i> ₽. ₽₽₽₽₽₽₽₽₽₽₽₽ ₽. ₽₽₽₽₽₽₽₽₽₽	-0.7130260618E-02	0,000000000000000000000000000000000000	0.2600000000000000000000000000000000000
13 14	0, 00000000000000000000000000000000000	-0.7440685429E-02	0,00000000000E+24 0,000000000E+24	0.2600000000E+02

15	Ø.	_0000000000E+00	-0	61925625655-02	0.	808888888888888888888888888888888888888	Ø.	2600000000E+02	
16	Ø	0000000000E+00			Ð.	0900900000E+09	0.	269999999992+92	
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27	- <del>U</del> .	11991524986-92			<u>.</u>	26932146445-03	41	23101028235708	
28	- Q.	12380746688-02			्री.	40852845885-42	<u>е</u> Г.	2490020022TH2	•
22	- <del>U</del> .	78107647692-92			<i>₽</i> .	87119701962-92	÷.	25555520207EFU2	
20	-13.	10666725566-03			Р.	8879301083E-03	- ET	28/138/1/26+02	
21	Ð.	1426442804E-04			Θ.	7919527068E-03	Θ.	29381882275+02	•
32	-17	17127156565-04			Ū.	8378618650E-03	मि	2953129340E+02	
33	e.	4941125967E-05			Ю.	82471778595-03	Ð	29528938125+02	:
71	7	17087979235-05			Ø.	81964993375-03	Ð	2952482298E+02	•
75		R2764956025-05	,		a.	8572169672E-03	Θ.	2945192859E+02	
72	ឆ	1111267514F-04			ភ	ERIATEAGTEE-03	શે.	2832181272E+92	:
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20	- い. 	54570770455-04			ບ. ເອີ	01705316775-0R	ā	25162665295+92	•
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47	_ <i>P</i> _	39109582965-03	<b>-</b> 0.	9900347480E-02	<i>.</i>	51192468912-02	£1.	234337213355784	
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45	Q.	56390644946-03	-0.	92664711196-02	Ð.	94395151745-03	년.	591/5853815+05	
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18	-17	98238596675-94			Ø	112328686555-02	27	32505115158+02	
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51	-3	2001417795E-04	-0	71560871845-02	Ū.	11400105075-02	8	33049495945+02	
57	-0	10171705055-01	·•·•	<ul> <li>Production from the from and radii that 100 and the factors</li> </ul>	- A	4174784926F-92	A	3305958502E+02	
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1/2	-4	29222692555-64			- 41	20333416185-04	<u>e</u> r.	20430300105782
173	- 8	22442829165-94			<i>.</i> .	32436491798-04	А,	81669334195+92
174	17	5097235670E-04			A	11146582376-03	9	21615382095+02
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107	-9.		.5		e.	29393200020-07	5	10055077272107
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212	-9	<u> 26424545862-04</u>			A	24951863895-95		18038705282+02
217	-0	29489759275-04	-17	77774977676-04	្លា	52851271815-85	4	1804959920E+02
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201 _0 1714884825F-05	-17	16106540686-01	a	11022409145-04	Ð.	<u>1809142419E+02 - </u>
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225 -0 27718064256-04			£?.	2200722202242	е. Э	
226 -0.2985160501E-04			મું.	29572353735-46	М.	
227 -0.35384366885-04			-9	2840155594E-06	41	<u>3</u> 9037777055+02
228 -0 54252886695-05			17	1753221362E-04	÷7	18000012822-02
222 D IDJE22422E-04			Ð	12123826882-04	Ð.	18080735485402 :
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- 218 - 2. 14.44.45.47.7000ELAd			<u>ہ</u>	1058107055F-05	ē.	19047279625+02 -
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523 8 6666666666E+66	- 0	85000403%45-01	₫.		19 13	100027770255400
- 234 -0 1297579416E-04			- 1	12751364286-86	<u>.</u>	100000101002706 1000001010002706
215 -0 24906334345-04	-0	7919386161E-01	7	22112154255-96	ŧ.	18413471125742
276 -0 26103472368-04			-8	47645540538-06	년.	<u> </u>
277 La 26922505595-0d	-17	78497696985-01	-17	\$677733229E-06	Ø.	19015169655+02 -
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- 210 - FEL 114676-1146 - VE - ARA - A REFERRANCESCON RELAK	_ 3	77755765765_0/	ມ. 	10717077705-05	3	18025352655+02
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241 -0.10271267672-04	- 1	54321221086-01	<u></u>		- Er.	100070004/021400
242 0.32461657538-05			- <del>1</del>	222222224245-45	25.	10000000000000000000000000000000000000
- 243 - 0.1354477126E-04	-0	3528196598E-01	ે.	42812894615-95	÷.	280548520287782
244 0 15715839902-04			, P	27913611265-85	9.	<u> 김유민가원464 공가부구락</u> :
215 0 16107100585-04	-0	22521304235-01	ø	12980185002-05	Ð,	19946566795+92
our a trassuagrafiad	•		-0	74797298965-06	<b>.</b> ]	18037850325+02
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- 247 - <u>0.1104</u> ,100,-0.00	· · ·	يني المراجع		5201280784 <b>2</b> -86	A	19024115052+02
- 246 - M. DIGE/UITC/ETV/ - A/A - A ADADAGAGAAAT/AA		AAAAAAAAAA AA	<u>1</u> 7.	aaaaaaaaaa <b>aaaaaaaaaaaaaaaaaaaaaaaaaaa</b>	3	120000000000000000000000000000000000000
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251 -0.22691558145-04			-9	11566391545-93	£7.	1000072020000000
252 -0.25158727965-04			- 47	10913709152-05	÷.	150110335745792
277 -0 20842092675-04			-17	<u>19199480007-05</u>	÷.	189722184-5+65
254 -0 12686702755-04			7	91427725785-85	Ð	18038660916+42
255 a 17707247525-ad			-3	504000005-5-05	Ð,	19949716738+92
- 200 - 0. 2000 - 0. 200 - 0. 			- 2	27/25/02775-45	9	1802795735E+02 :
- 205 - 0.1054740010E-04				10017000075-85	ភ	1861811779E+02
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260 -0.1225155223E-04			-9	16712182655-06	41.	
261 -0.1859575737E-04	-0	7916227912E-01	-17	14107094085-05	Ð.	786648801775184
262 -0.1871739217E-04			7	15689925315-05	Ŀ,	18002180555+05
263 -0. 1937113876E-04	-0	7843577289E-01	-9	11152497355-05	Ø.	1800547731E+U2
264 -0. 20722179995-04			-0	23753247405-05	О.	180074 <u>4</u> 379E+02
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267	-년,	95340303048-05	-Ы	24712622955-61		122112022045777	- ಬ ವಿ	10025419775+02
263	<u>0</u> .	92217046905-04	-		- <del>1</del> 1.	149299132225-24	ย เมื	10020100075402
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271	₽.	12419878265-84	-0.	2252/4/6/26-01	- 61.	400002710755-055	117. 117	10015800515+02
272	母.	1135210758E-94	-		-97.	<u>299819787777787</u>	ет. 13	40045050475402
273	9.		-13	16568254848-01			е. Л	10022200120
274	Ð.	64327042115-05			Ð.	2000/6/20000000	- <u>1</u> 7.	10000000000000000
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281		64888780095-05			-0	12805412312-04	년. - 5	
282	Ð,	8471971982E-05			-0.	45554629628-45	- ET	- <u>1991</u> 899/775794 
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284	-27	A747575094E-05			Ū,	37167254385-95	년.	1999992222-402
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42.2				al an		15747641545-64	Ø,	18912455635+82
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282	<i>.</i>		- 67.	779+526794E-47	19. 13		â	12000000005-02
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	224	Ø.,	62401631238-05			-6	11067947795-93	ET.	「近日村村の中村につけたていた」」
	725	Ð.	38641934635-96	-9	16307339728-01	-9	50315210795-06	<i>.</i> .	1
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	225	-년,	71700884855-07		·	- 47	120/81144/8-00	<u>e</u> .	
	374		<i></i>			Ð,	8858988666868-86	1.1	<u> </u>
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Ð	ELEMENT	120	FRONTWIGTH=	70
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	ELEMENT	122	FRONTNIDTH=	74

EXIT FROM SOLUTION ROUTINE AT 311 SECS.

D LARGEST RELATIVE CHANGE IN ANY VARIABLE= 0.8627822107E-01

ITERATION NO. = 1

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## APPENDIX V

## CONVECTIVE HEAT-TRANSFER CORRELATIONS AND HEAT FLOW BY RADIATION IN SOLAR COLLECTORS

The mechanism of energy transfer by natural convection involves the motion of a fluid past a solid boundary which is the result of a density difference resulting from the energy exchange. Because of this it is quite natural that the heat-transfer coefficients and their correlating equations will vary with the geometry of a given system<sup>(1)</sup>.

The natural convection system most amenable to analytical treatment is that of a fluid adjacent to a vertical wall.



## FIGURE AV.1: SOLAR COLLECTOR

Shown in the figure above is the configuration and nomenclature pertinent to rectangular enclosures. These cases have become much more important in recent years due to their application in solar collectors. Clearly, heat transfer will be affected by the angle of tilt,  $\theta$ ; by the aspect ratio, H/L; and by the usual dimensionless parameters,  $P_r$  and  $R_a$ .

The hotter of the two large surfaces is designated  $T_1$ , and the cooler surface is at temperature  $T_2$ . Fluid properties are evaluated at the fluid temperature  $T_f = (T_1 + T_2)/2$ . Convective heat flux is expressed as:

$$\frac{q}{A} = h (T_1 - T_2)$$
 (AV.1)

## Case 1: Horizontal Collectors, $\theta = 0^{\circ}$

With the bottom surface heated a critical Rayleigh number has been determined by several investigators to exist. For cases where:

$$R_{a} = \frac{\beta_{g}L (T_{1} - T_{2})^{3}}{\alpha v} > 1700$$

conditions within an enclosure or a solar collector are thermally unstable and natural convection will occur. A correlation for this case has been proposed by Globe and Dropkin<sup>(2)</sup> in the form:

Nu = 0.069 (
$$R_a$$
)<sup>1/3</sup> (Pr)<sup>0.074</sup> (AV.2)

for the range 3 x  $10^5 < R_a < 7 \times 10^9$ .

When  $\theta = 180^{\circ}$ , that is, the upper surface is heated, or when Ra < 1700, heat transfer is by conduction: thus, Nu = 1.

## Case 2: Vertical Collectors, $\theta = 90^{\circ}$

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This is the case of our experimental system. For aspect ratio of less than 10,  $Catton^{(3)}$  suggests the use of the following correlations.

$$Nu = 0.18 \left(\frac{Pr}{0.2 + Pr} R_{a}\right)^{0.29}$$
 (AV.3)

when 1 < H/L < 2,  $10^{-3} < Pr < 10^5$ ,  $10^3 < R_a Pr/(0.2 + Pr)$ . This condition of aspect ratio, Pr, and  $R_a$  is the one applicable to our convective channel (solar collector), and

Nu = 0.22 
$$\left(\frac{Pr}{0.22 + Pr} R_a\right)^{0.28} \left(\frac{H}{L}\right)^{-\frac{1}{4}}$$
 (AV.4)

when 2 < H/L < 10, Pr <  $10^5$ , Ra <  $10^{10}$ .

For higher values of H/L, the correlations of MacGregor and  $Emery^{(4)}$  are recommended, which are:

$$Nu = 0.42 (R_a)^{\frac{1}{4}} (Pr)^{0.012} (H/L)^{-0.3}$$
 (AV.5)

For 10 < H/L < 40,  $1 < Pr < 2 \times 10^4$ ,  $10^4 < R_a < 10^7$ , and

$$Nu = 0.46 (R_a)^{1/3}$$
 (AV.6)

For 10 < H/L < 40, 1 < Pr < 20,  $10^6 < R_a < 10^9$ .

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## Case 3: Tilted Vertical Collectors, $0 < \theta < 90^{\circ}$ :

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Numerous relatively recent publications have dealt with this configuration . Correlations for this case, when the aspect ratio is large (H/L > 12), are the following:

$$Nu = 1.0 + 1.44 [1.0 - \frac{1708}{R_a \cos \theta}] [1.0 - \frac{1708}{R_a \cos \theta}] [1.0 - \frac{1708}{R_a \cos \theta}]$$

+ 
$$\left[\left(\frac{R_a \cos\theta}{5830}\right)^{1/3} - 1.0\right]$$
 (AV.7)

when H/L > 12,  $0 < \theta < 70^{\circ}$ . In applying this relationship any bracketed term with a negative value should be set equal to  $zero^{(1)}$ . Equation (AV.7) was suggested by Hollands et al<sup>(5)</sup> with collectors nearing the vertical. Ayyaswamy and Catton<sup>(6)</sup> suggested the relationship:

$$Nu_{L} = Nu_{LV} (Sin \theta)^{\frac{1}{4}}$$
 (AV.8)

For all aspect ratios, and  $70^{\circ} > \theta > 90^{\circ}$ . The value  $\theta = 70^{\circ}$  is termed the "critical" tilt angle for vertical collectors with H/L > 12. For smaller aspect ratios the critical angle of tilt is also smaller. A review article on the subject of inclined rectangular cavities is that of Buchberg, Catton and Edwards<sup>(7)</sup>.

### Heat Flow by Radiation:

The process of heat transfer through fluids between two solid walls of different temperature may, and probably will, involve all three modes of heat transfer, namely conduction, convection and radiation.

In the computer program only the first two modes were considered. When the fluid in a duct, channel, or cavity between the walls is itself non-absorbing, the radiation occurs independently of the presence of gaseous conduction and convection. Therefore to find the heat flux across the duct or channel (solar collector), the radiative component must be added to conductive/convective components.

The zero method described by Hottel and Sarofim<sup>(8)</sup> can be used to determine the amount of heat transfer by radiation in a duct or a solar collector. Consider the case where the solar collector of Figure AV.1 can be divided into four surfaces. Two walls at different temperatures  $(T_1)$ ,  $(T_2)$  and two adiabatic or known temperature walls at temperature  $(T_a)$  as shown in Figure AV.2. It is assumed that each surface is uniform in emissivity ( $\varepsilon$ ) and temperature (T).

For a given solar collector geometry, temperature distribution and walls properties, the following matrix equation is valid:



where:

F<sub>ij</sub> = configuration factor of the areas
 relative to one another, where
 suffixes i and j represent the areas
 concerned



FIGURE AV.2

After solving the above matrix equation for  $(N_i)$ , the net radiant flux at surface  $(A_i)$  may then be found by:

$$Q_{i} = \frac{\varepsilon_{i}}{\rho_{i}} (E_{i} - W_{i}) A_{i}$$
 (AV.10)

Configuration factors of the areas relative to one another are calculated according to the geometry (9).

The quantity of heat lost from inside the heated area  $(A_1)$  to the outside area  $(A_2)$  by radiation must be added to the heat flux across the solar collector. Radiation losses at different temperatures were similarly computed and tabulated by Sadhu<sup>(10)</sup>. For fixed geometry and material properties, the radiative heat transfer increases with increasing temperature difference.

The assumption of uniform surface temperature is not realistic, but the theory given gives a fairly good physical approximation. Probert<sup>(11)</sup> used an experimental technique, "vacuum analysis", to distinguish the convective/conductive components at the steady-state heat exchange through gases.

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### APPENDIX VI

# LIMITATIONS OF SCALE MODELS AND TURBULENT WALL JET VELOCITY PROFILES

#### VI.A: Scale Models Limitations

It is a fundamental law in the ventilation/air-conditioning technique that a ventilation/air-conditioning installation can never be better than the air diffusion in the space concerned<sup>1</sup>.

The aim of the ventilation/air-conditioning model system utilised in this work and portrayed in Chapter 4 is the assessment and analysis of:

- i) the air flow rates required and dimensional parameters optimisation;
- ii) the direction and velocity of air in the various regions of the system;
- iii) the admissible temperature difference between the room inlet and exit to allow for an acceptable air temperature variation;
- iv) the admissible inlet velocity to the room to allow for an acceptable ventilation/air-conditioning without causing draughts used in keeping with the acceptable temperature variations mentioned in (iii) above.

For a non-isothermal flow in a room, it is sufficient, besides geometrical similarity, to maintain equality of the Archimedes number in the model and the original in order to obtain the same flow features<sup>2</sup>. On a fluid element the Ar-number is:

Ar = 
$$\frac{buoyancy force}{inertial force} = \frac{\rho g \, l^3 \, \beta \Delta \theta}{\rho \, l^2 \, u^2} = \frac{g l \, \beta \Delta \theta}{u^2}$$
 (VI.1)

where: 
$$g = gravitational acceleration$$
 m/sec<sup>2</sup>  
 $\& = characteristic length$  m  
 $u = characteristic velocity$  m/sec  
 $\beta = coefficient of cubical expansion$  1/K  
 $(for air \beta = \frac{1}{\theta_{(abs)}})$   
 $\rho = characteristic density$  kg/m<sup>3</sup>  
 $\Delta \theta = characteristic temperature difference$  K  
between two points

It has not yet been proved experimentally that the above condition is also sufficient for quantitative similarity of both temperature and velocity distribution. This is why the differential equations of continuity, motion and of energy, which, together with the boundary conditions, govern the flow and temperature distribution, were solved in this thesis. Using the same equations and boundary conditions for both model and real situations will result in similar solutions. The equations are similar if the variables are made dimensionless.

Since these equations equally describe laminar and turbulent flow, similarity between model and original is valid whether the flow is turbulent or not. The introduction of the turbulent viscosity and

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turbulent conductivity are not a requirement for similarity, but are the result of the particular geometry used and values of Re, Ar and Pr.

It is not possible to obtain Re(m) = Re(o) and Ar(m) = Ar(o) in the same time if both the model and original gases are air. (m) is the model and (o) is the original system. In fact it is very difficult to find a useful fluid as a medium that will simultaneously fulfil the requirements of Re, Ar and Pr with workable velocities and temperature differences in both (m) and (o).

For flow condition which is most general in ventilation/air-condioned rooms, namely non-isothermal turbulent flow, equality of (Ar) is much more important than equality of (Re)<sup>1</sup>.

Müllejans<sup>2</sup> has shown that the general form of the flow in a series of model tests was similar at different (Re) and only dependent on buoyancy and (Ar). Wall jets such as the inlet duct to our ventilated/air-conditioned room are also an example of flows which can be similar at different (Re)<sup>3,4</sup>. Due to the variety of the inlet air duct conditions and variable geometry a fixed value for (Re) above which the flow will be (Re) independent cannot be given.

The numerical model shows that when changing the convective channel air inlet velocity, and hence (Re), the ratio of the velocity measured at different places in the solar room to the convective channel air inlet velocity remained constant. The experimental measurements seem to agree with this, but probably more elaborate measurements are required.

Temperature distribution similarity requires radiant heat to be equal. Heat transfer correlations and heat flow by radiation in solar collectors is described in Appendix V.

Local velocities cannot be predicted very accurately, although in the solar room deviations can be less than 17%. Small differences in inlet geometry lead to large differences in attachment point and recirculation size. Velocity measuring instruments used, namely hotwire anemometers, must be used in the same way in the original system as in the model because of their directional dependence.

Non-isothermal scale model experiments are only possible for restricted scale ratios up to 1:8 for good insulated models. If radiation can be neglected, or if only the higher velocities such as inlet/outlet velocities, are of interest, then higher scale factors are attainable<sup>1</sup>, see Figure VI-1 (overleaf).

Model experiments do not give a 100% reliable solution, this is why the solar ventilation/air-conditioning system was designed with variable dimensional parameters. This, for instance, makes the inlet duct flexible in delivering air quantity so that adjustments can be carried out easily. Similar design features were incorporated for temperatures.



FIGURE V1-1: Relation between velocity ratio  $u_m/u_0$  and temperature difference ratio  $\Delta \theta_m/\Delta \theta_0$  for various scale factors S

## VI.B: Turbulent Wall Jet Longitudinal Velocity Profiles

The experimental investigation on plane wall jets was started by Förthmann<sup>5</sup>, who reduced all mean velocity data to a single profile, by normalising them by the jet thickness and the maximum longitudinal velocity. The similarity of radial and plane wall jets was studied later<sup>6,3</sup>. Schwarz and Cosart<sup>3</sup> deduced the following expressions for the maximum velocity across the jet  $(U_{max})$ , and length scale  $\delta_{u}$  [thickness of the jet at  $(U_{max}/2)$  in the outer layer]:

$$\frac{U_{\text{max}}}{U_0} = c_u \left(\frac{x - x_D + x_0}{h}\right)^{e_u}$$
(VI.2)

and

$$\delta_{u} = c_{\delta u} \quad (x - x_{D} + x_{o})$$

where  $x_{D}$  and  $x_{o}$  are the coordinates of the inlet plane and the virtual origin of the jet - see Figure VI:2.

Current practice in the design of ventilation/air-conditioning systems is to assume that different inlet arrangements originate selfsimilar turbulent jets which may still be fitted by a suitable set of values  $x_0$ ,  $c_u$ ,  $e_u$  and  $c_{\delta u}$ .

Works by Schwartzbach<sup>8</sup> and the ASHRAE Handbook of Fundamentals<sup>7</sup> support this assumption for several types of inlets and diffusers.



FIGURE VI-2: Parameters used in wall jet assumptions for the inlet duct to the solar ventilated/air-conditioned room

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#### APPENDIX VII

### VALIDATION AND FURTHER CALCULATIONS

#### VII.1 Validation of the Computational Model

The procedure used in this thesis and in the turbulent validation problems is that of implementing zonal turbulence modelling.

The central question to be considered here is whether a universal model for turbulent flows can be created or whether it is preferable to undertake zonal modelling, as in this work, in order to obtain results of engineering accuracy for the practical flows in hand. This question was addressed to a group of active researchers and government monitors at the NASA Langley Research Centre in May 1980, and resulted in a sharp and relatively even division of opinions.

The inspection of universality of turbulence models is a crucial one because it influences the central strategy of how one models turbulent flows. All man-made models of laws of nature are with some limits of range of domain and also with some residual uncertainties. This limit can be either broad or narrow to the relevant class of systems.

"The question is not whether a model is totally universal; none are adequate for all systems. The relevant question becomes (what is the domain over which this particular model gives adequately accurate predictions about nature?). This is precisely the question that confronts turbulence modelling" (4)
There are advantages obviously for a universal model. It would allow turbulent flows to be modelled once and for all. It might be constructed more easily and quickly than a variety of models each fitted to special circumstances. It would assure true predictive rather than postdictive computations. A universal model would also appeal to the sense of mathematical fitness and elegance. However, the test is not elegance or seeming fitness, nor is it some desire to emulate Newton or Einstein. The only proper test is the practical one which is a fundamental requirement of design.

When the Navier-Stokes equations are time-averaged, information is lost which are inherent in the Reynolds stresses. For incompressible flow, these stresses are symmetric second-order tensor that is in general a multipoint function of four variables (4). Such a tensor is a complex quantity mathematically. For compressible flows we must deal with a number of different variables each of which has this complexity even if simpler forms of the equations are used.

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A geometric analogy would be to consider the nature of a model that might describe the topography of a complex terrain. Would a simple algebraic or differential equation with few adjustable constants describe such a task?

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Turbulence is not a single or even a simple set of states; it is a very complex and variable set of states that often react in unanticipated ways to a great variety of circumstances. The results in the 1980-1981 AFOSR-HTTM-Stanford Conference relevant to the question of universality of modelling<sup>(4)</sup> were:

- i) No single turbulence model is accurate over the entire range of flow cases, however limited they might be.
- ii) There is no correlation between sophisticated (i.e. level) of model and accuracy of results over the full range of usable models.

(In the conclusions of this thesis item 15 it was stated that numerical prediction accuracy is not proportional to the number of partial differential equations used in calculating turbulent viscosity and conductivity. It could well be true that the accuracy required for many design and engineering applications is obtainable from a simple well engineered model).

iii) Several times in discussions, individual computers reported success on some class followed by degradation of results when attempts were made to extend the range of domain using a single method.

"The lesson to be drawn from all this is that there is a definite trade-off between accuracy of output and the range of domains attempted"<sup>(4)</sup>. When we know enough about the physics, the structure of a given flow zone can be built into our model to obtain good accuracy.

To build separate models for various flow classes or applications is a hopeless task. There is an infinite number of scientific flow cases as well as an infinite number of geometries of practical and/or commercial importance. The task will be endless.

In most flows of interest there are only a limited number of identifiable structural flow zones where the flow field within each has roughly the same kind of flow structure. The computer has no particular difficulty in keeping track of where various zones lie throughout the computation, we know where we will need to patch or  $match^{(4)}$ .

The idea of zonal modelling tied to structural flow zones is not new. It is in fact central to the famous (1904) paper by Prandtl, to the analysis of isotropic flow and shocks. The concept of the boundary layer is a zonal model as well.

It will almost certainly accelerate progress if we iterate turbulence models with experiments on structure, not in general, but rather for particular structural flow zones one by one.

The evidence suggests that the profitable road for engineering calculations in the near and intermediate future is "systematic exploitation of zonal models tied directly to structure features of the  $flows''^{(4)}$ . This approach has been extended and the details have been perfected in the work done in this thesis and in the subsequent validation test cases.

An argument is sometimes made that zonal modelling will be more work and will proceed more slowly than universal modelling. This is certainly untrue because no single, simple, adequate turbulence model exists. "Nothing slower than a search for the non-existent"<sup>(4)</sup>.

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The work in this thesis has shown that the zonal approach holds promise, and that design needs compel us towards development of the simpler forms of such zonal models in parallel with further development of higher order models.

Merging the various zones can be handled on the basis of known or observed/visualised phenomena so as to adjust the zones as per the physics. When using a universal model known physical zonal readjustments are simply ignored and not incorporated in the models. Universal modelling has been almost the only recognised game in town $^{(4)}$ . The leaders of the theoretical and computational research on turbulence and perhaps all the "mathematicians" have been "universalists". The only users and friends of "zonalism" have been some experimentalists, engineers, and some individuals in leading companies "such as Boeing (USA), where the engineers were face-to-face with the need to make design decisions -sometimes with billions of dollars implications and therefore had urgent need to guarantee accurate results. These engineers, under these conditions. chose to use models that were known to be explicitly tailored to specific classes of flow situations in order to guarantee accurate results"<sup>(4)</sup>. It should not be surprising then that the zonal approach is correct, although universal modelling has been favoured and "oversold".

The governing differential equations contain all the physics and no more. Then any universal model that is simpler than the governing equations must represent less physics. This is the problem of universal modelling. If the model is adjusted to fit few flow classes, it will not fit in at least some other classes because the model does not represent all the physics. Suppose we now allow adjustment of the turbulence model from class to class i.e. zonal view, then the model can be fitted to the physics class by class with the gain of using more appropriate information on the physics for any given type of flow zone.

"The central purpose of zonal modelling is precisely to enable us to incorporate more physics into the total set of models while still keeping computation size within the limits of available computers. If we could get enough physics into a universal model!, we would not need to go to zonal representation" (4).

The zonal approach has been adopted and implemented successfully throughout this work where flow zones have been assigned different length scales of turbulence, while turbulence intensity was averaged and adjusted from measured values for each zone.

The author suggests in addition that efforts should be directed at this point towards deriving an empirical rule(s) for determining turbulence intensities in given flow situations, so as to use the current method with high degree of confidence in the absence of experimental results. This section describes in detail the calculation of various test problems that have been mentioned in Chapter 6 through which the program was tested for correctness. The problems have either theoretical of experimental solutions available to compare them with.

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In addition other relevant problems to the configuration which is the subject of this thesis as test and validation problems were imposed by Ref 1. Thus the test problems selected contain the ingredients of turbulent, buoyancy influenced flow with heat transfer across walls. References (5) and (7) and/or (8) were suggested. References (5) and (7) were chosen, and arecalled test cases (VII.1.9) and (VII.1.10).

## VII.1.1 <u>Developing Flow Between Parallel Plates Using a Natural</u> Velocity Gradient Boundary Prescription

As flow is expected to be symmetric about the film centre line, Figure VII-1 shows only half the flow domain. Boundary conditions on the fixed surface reflect a non-slip condition (U = V = 0) whereas a symmetric prescription is used at the mid-film position. Downstream conditions reflect a developed flow field with pressure specified at one point on an element corner node. Upstream prescription is the most difficult to apply, for the present solution a square axial velocity profile is used with a zero gradient on the cross-stream momentum equation is thought to be the most applicable. The finite element mesh for this problem is shown in Figure VII-4A and dimensions are shown in Figure VII-4B. The mesh assumes a weighted form with fine elemental discretisation in the developing flow region. Computation has been

#### \* \* <sup>\*</sup>

carried out at a Reynolds number of 100 where the distance between the plates is used for the chanacteristic length. Figure VII-5 shows the velocity vectors. Figure VII-6 shows the velocity contours. Figure VII-7 shows the pressure contours. The output was exactly as per the test case output<sup>(2)</sup> to within six decimal places.

#### VII.1.2 Developing Pipe Flow Using Stress Boundary Conditions

Figure VII-2 illustrates the boundary prescription for the developing pipe flow problem. As in VII.1.1 the specification reflects non-slip conditions on the bounding surface, centreline symmetry and a developed downstream profile. Similar to VII.1.1 a square velocity profile is used at the upstream edge. However the stress formulations obviate the need for pressure specification as this is coupled into the stress prescription. The solution is for a nominal Reynolds number of 100. Figure VII-8 shows the velocity vectors. Figure VII-9 shows the velocity contours. Figure VII-10 shows the pressure contours. The output was exactly as per the test case output<sup>(2)</sup> to within the same accuracy of VII.1.1.

#### VII.1.3 Forced Convection in Developing Pipe Flow

The boundary conditions for the fluid flow equations are identical to those discussed in VII.2. Temperature boundary conditions, see Figure VII-3, are applied to the energy equation in the form of a fixed surface and bulk inlet temperature, prescriptions on the pipe centreline and outflow reflect symmetry and fully developed conditions respectively. The mean Reynolds number for this solution was 100 and Prandtl number of





FIGURE VII-4A: Finite Element Mesh of Test Problems (VII.1.1), (VII.1.2), and (VII.1.3)



FIGURE (VII-4B) FINITE ELEMENT MESH DIMENSIONS FOR PROBLEMS OF FIGURES(VII-1)-to-(VII-3)

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FIGURE VII-5: Test Case (VII.1.1) Velocity Vectors. Developing Flow Between Parallel Plates





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# FIGURE VII-6: Test Case (VII.1.1) Velocity Contours (Isovels). Developing Flow Between Parallel Plates

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FIGURE VII-7: Test Case (VII.1) Pressure Contours (Isobars)
Developing Flow Between Parallel Plates



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FIGURE VII-9: Test Case (VII.1.2) Velocity Contours (Isovels)







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FIGURE VII-12: Test Case (VII.1.3) Velocity Contours (Isovels) Forced Convection in Developing Pipe Flow

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FIGURE VII-13A: Test Case (VII.1.3) Pressure Contours (Isobars) Forced Convection in Developing Pipe Flow



200. Figure VII-11 shows the velocity vectors. Figure VII-12 shows the velocity contours. Figure VII-13A shows the pressure contours; Figure VII-13B shows the temperature contours (isotherms). The output was exactly identical to the test case output<sup>(2)</sup> to within the same accuracy of VII.1.1 and VII.1.2.

#### VII.1.4 Free Convection in a Rectangular Cavity

Boundary conditions and domain discretisation for this problem may be found in Figure VII-14. The mesh used is shown in Figure VII-15. The boundary conditions on the momentum equations reflect non-slip conditions on fixed surfaces with pressure specification at one point.

For this problem type the energy equation is cast in temperature difference form and thus boundary values express a difference with respect to a reference value on the left and right hand sides of the cavity, linear interpolation on the bottom side and zero gradient on the top side. Figure VII-16 shows the velocity vectors. Figure VII-17 shows the axial velocity contours. Figure VII-18 shows the overall velocity contours. Figure VII-19 shows the pressure contours. Figure VII-20 shows the temperature contours. Again the program output was identical to the test case<sup>(2)</sup>.

### VII.1.5 Laminar Flow Past a Cylinder

Two dimensional laminar flow past a cylinder is one of the better documented problems of laminar flow. It provides a very useful practical model for verification of the program. This test case shows that it is



FIGURE (VII-14A) BOUNDARY PRESCRIPTION – FREE CONVECTION IN A RECTANGULAR CAVITY



FIGURE (VII-14B) FINITE ELEMENT REPRESENTATION OF CAVITY

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FIGURE VII-15:

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The mesh used for test case (VII.1.4) of free convection in a rectangular cavity

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FIGURE VII-16: Test Case (VII.1.4) Velocity Vectors. Free Convection in a Rectangular Cavity



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Test Case (VII-1.4). Axial velocity contours.  $(\sqrt{U^2}$  Isovels) Free convection in a rectangular cavity



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FIGURE VII-18: Test Case (VII.1.4) Overall Velocity Contours  $(\sqrt{U^2 + V^2} - Isovels)$ Free convection in a rectangular cavity



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FIGURE VII-19:

Test Case (VII.1.4) Pressure Contours (Isobars) Free convection in a rectangular cavity

Temperature contours (Isotherms) Free convection in a rectangular cavity Test Case VII.1.4) FIGURE VII-20:

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theoretically and numerically possible to obtain solutions which predict symmetric stationary zones of separation behind the cylinder. Such solutions can be used to check the validity of a computer based numerical model<sup>(3)</sup>. The parameters associated with the current example are:

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Reynolds number Re = 20 (based on the cylinder diameter) Molecular viscosity  $\mu = 0.1$ Fluid density  $\rho = 1.0$ Fluid for field velocity  $U_{\mu} = 1.0$ 

and subject to the boundary conditions shown on Figure VII-21. Body forces are assumed to be zero and, due to symmetry, only one half of the domain flow need be considered. The subdomain discretisation and correspondent element numbers are shown in the mesh in Figure VII-22.

Figure VII-23 shows the velocity vectors. Figure VII-24 shows a blown up view of the velocity vectors in the separation zone behind the cylinder. Figure VII-25 shows the velocity contours. Figure VII-26 shows a blown up view of the velocity contours in the separation zone behind the cylinder. Figure VII-27 shows the pressure contours. The program output was identical to the test case results of Ref. 3 exactly.

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FIGURE VII-24: A blownup view of the velocity vectors in the separation zone behind the cylinder. Test case (VII.1.5) Flow past a cylinder

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IGURE VII-25: est case (VII.1.5) elocity contours Isovels) low past a cylinder

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FIGURE VII-26: Test Case (VII-1.5). A blown-up view of the velocity contours in the separation zone behind the cylinder (Isovels). Flow past a cylinder

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FIGURE VII-27: Test Case (VII.1.5). Pressure contours (Isobars). Flow past a cylinder
## VII.1.6 Two Dimensional Laminar Flow Over aBackward Facing Step

Separation occupies an appreciable portion of the flow domain. In such a flow the advection terms in the momentum equations have become significant. Separation has been shown to occur at very low values of Reynolds number. The particular parameters for this problem are: Reynolds number Re = 73 (based on the step height and average upstream

Molecular viscosity  $\mu = 0.00457$ 

Fluid density  $\rho = 1.0$ 



The extent of the physical domain taken for the numerical model is shown superimposed on the mesh used in Figure VII-28 and consists of 30 elements and 117 nodes. Figure VII-29 shows the velocity vectors. Figure VII-30 shows a blown up view of the velocity vectors at the separation (recirculation) zone. Figure VII-31 shows the velocity contours. Figure VII-32 shows the longitudinal velocity contours at the separation (recirculation) zone. Figure VII-33 shows a blown up view of the velocity contours at the separation (recirculation)



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FIGURE VII-30:

Test case (VII.1.6) A blown up view of the velocity vectors at the separation (recirculation) zone. Flow over a backward facing step



FIGURE VII-31: Test Case (VII.1.6), velocity contours (Isovels). Figure a backward facing step

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FIGURE VII-32: Test case (VII.1.6). A blown up view of the axial (<sup>7</sup>0<sup>2</sup>)

velocity contours (Isovels) in the separation (recirculation) zone. Flow past a backward facing step









FIGURE (VII-35) NON-DIMENSIONALISED VELOCITY PLOT FOR A BACKWARD FACING STEP.

zone. Figure VII-34 shows the pressure contours. Longitudinal dimensionless velocity distributions are shown in Figure VII-35 and are seen to compare exactly with those published in Reference 3.

## VII.1.7 Fully Developed Turbulent Flow in a Pipe

Flow in a smooth walled pipe comprises a transition from a boundary layer flow near the entrance, Figure VII-36, to fully developed turbulent flow some distance downstream. The manner in which the flow develops is governed by the gradually thickening boundary layer adjacent to the pipe wall whose displacement thickness varies from zero at the pipe entrance to half the pipe diameter at some distance downstream. Under such conditions the free stream flow is completely masked and fully developed flow is subsequently established.

For fully developed flow the boundary layer width can be assumed equal to the radius of the pipe (R).

Adjusting the turbulent intensity to give the same values of effective viscosity as per the entrance nodes for the known nodes velocities from Reference 3 and utilising Nikuradse length scale of turbulence for flow in pipes i.e.

$$\ell = R [0.14 - 0.08 (1 - \frac{y}{R})^2 - 0.06 (1 - \frac{y}{R})^4]$$
 (VII.1)

Fixing a density of unity, the only further requirement to define the pipe Reynolds number is the value of  $(\tau_{\omega})$  and  $(\mu)$ . This is achieved





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by manipulating the boundary conditions relating to the pressure since the wall shear stress is linearly dependent on the pressure gradient. For a specified section of pipe, length  $(L_e)$ :

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$$\frac{R}{2} \cdot \frac{P_u - P_d}{L_e} = \tau_o \qquad (VII.2)$$

in which  $(P_u)$  and  $(P_d)$  represent defined values of upstream and downstream pressure, respectively. The complete set of boundary conditions required to solve for fully developed flow Figure VII-37, are

$$V = \frac{\partial u}{\partial x} = 0, \quad x = 0, \quad x = L_e \quad 0 \le r \le R$$
$$V = \frac{\partial u}{\partial r} = 0, \quad 0 \le x \le L_e \quad r = 0$$
$$V = U = 0, \quad 0 \le x \le L_e \quad r = R$$

P = Pu [to give 4.5 x  $10^5$  depending on  $(L_e)$ ], x = 0, 0  $\leq$  r  $\leq$  R 

$$P = P_d = 0.0, \quad x = L_e \quad 0 \le r \le R$$

Initial values are not required since the non-linear convective terms are exactly zero for fully developed turbulent flow. The particular problem analysed is for  $Re = 4.5 \times 10^5$ .

A suitable finite element mesh consisted of eight elements across the pipe radius, and eight elements across the pipe length, each decreasing in thickness in a geometric progression using a geometric constant of 0.35. The widths are shown in the mesh Figure VII-37 and a corner blown up is shown in Figure VII-38. Figure VII-39 shows the velocity vectors. Figure VII-40 shows the velocity contours. Figure VII-41 shows the pressure contours. Figure VII-42 shows the length scale of turbulence contours. Figure VII-43 shows the kinetic energy of turbulence contours. Figure VII-44 shows the turbulent viscosity contours. The output of the program was absolutely identical to that of Reference 3. An error of 1.2% is due to the fact that the model of turbulence in Reference 3 feeds in the effective viscosity for each node in the element matrix and in the numerical integration, while in this work although the  $v_{e}$  is evaluated for each node but the average of elemental nodal  $v_e$  is fed for each element in the element matrix and in the numerical integration. This is what we meant when we said in the discussion of this thesis that there was a slight difference in the absolute values. However Figure VII-45 shows an absolutely identical plot, for the inormalised axial velocity at various normalised radius values at the pipe exit.

## VII.1.8 Developing Turbulent Flow in a Pipe

Reynolds number is limited here to  $Re = 1.0 \times 10^5$ , because above such values a special wall element will be needed as per the work of References 1,2. The boundary conditions are similar to those used in the previous section VII.1.7, except that the pressure is now defined





FIGURE VII-38: A blown-up view of the mesh of test case (VII.1.7) of fully developed turbulent flow in a pipe



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FIGURE VII-41: Test case (VII.1.7) pressure contours. (Isobars). Fully developed turbulent pipe flow

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FIGURE VII-42: Test case (VII.1.7) length scale of turbulence contours. Fully developed turbulent pipe flow.

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FIGURE VII-43: Test case (VII.1.7) kinetic energy of turbulence contours. Fully developed turbulent pipe flow.

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FIGURE VII-44: Test case (VII.1.7) turbulent viscosity contours. Fucure flow

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at the downstream section only where the flow has been assumed to be fully developed and the velocity is assumed to be uniform across the entry. The same mesh of VII.1.7 is used with the following boundary conditions:

 $V = \frac{\partial u}{\partial x} = 0, \qquad x = 0, \quad L_e = 40 \qquad 0 \le r \le R = 0.5$  $V = \frac{\partial u}{\partial r} = 0, \qquad 0 \le x \le L_e \qquad r = 0$ 

V = U = 0  $0 \le x \le L_e$  r = R

 $U = \overline{U} = 1.0 \qquad x = 0 \qquad 0 \le r \le R$ 

P = 0  $x = L_{e}$   $0 \le r \le R$ 

Figure VII-46 shows the velocity vectors. Figure VII-47 shows the velocity contours. Figure VII-48 shows the pressure contours. Figure VII-49 shows the length scale of turbulence contours. Figure VII-50 shows the kinetic energy of turbulence contours. Figure VII-51 shows the turbulent viscosity contours. Figure VII-52 shows the axial velocity distribution at various longitudinal distances for various pipe radii. X/D = 0 is the entrance, X/D = 10 is the seventh column of elements in the vicinity of the exit, due to the regression used in dimensioning the elemental distances. Figure VII-52 shows a perfect agreement with Reference 3. 656



FIGURE VII-46: Test case (VII.1.8) velocity vectors. Developing turbulent flow in a pipe



FIGURE VII-47: Test case (VII.1.8) axial velocity contours (Isovels). Developing turbulent flow in a pipe

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	,126E	1
	<b>.</b> 252E	1,
	.378E	1
	.501E	1
	.630E	1
	.756E	1
	.882E	1
	.101E	2
<u></u>	.113E	2
	.126E	2
	.139€	2
	.151E	2
	.161E	2
	.176E	2
	.189E	2
	.2025	2
	.21 1E	2
	:227E	2
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FIGURE VII-49: Test case (VII.1.8) length scale of turbulent contours.





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FIGURE VII-51: Test case (VII.1.8) turbulent viscosity contours. Developing turbulent flow in a pipe

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## VII.1.9 <u>The Velocity Characteristics of Ventilated Rooms:</u> Turbulent Jet Induced Flow in Rectangular Enclosures

Reference 5 has measured and calculated values of the velocity characteristics of a modelled room with ventilation arrangements. The measurements were obtained by laser Doppler anemometry and the calculations by a  $(K-\varepsilon)$  finite difference model. The geometrical arrangements used are shown in Figure VII-53.



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The model was constructed from perspex with a height (H = 89.3 mm). Other dimensions correspond to:

$$\frac{L}{H} = 3.0, \quad \frac{h}{H} = 0.056, \quad \frac{t}{H} = 0.16$$

Two values of the width of the inlet slot were used to assist the determination of the extent of influence of a three dimensional inlet flow on the velocity characteristics of the room. However, in this test case we are only considering the value of the inlet width that equals the width of the room, since our analysis is twodimensional. The parameters used in the wall jet assumptions are those mentioned in Appendix VI of this thesis. The measured mean velocity profiles were done at Re =  $\frac{\rho U_0 h}{u}$  = 5000, where U<sub>0</sub> is the jet inlet velocity. The mesh used to represent this problem using the finite element zone technique together with the boundary conditions is shown in Figure VII.54. The flow domain has been subdivided into three flow zones. The first is the inlet with its extension throughout the length of the room. The second is the room itself, and the third is the exit duct. As was done in the thesis, Buleev's length scales were used in a straight channel flow for the inlet and exit, while the room was having the mean total horizontal and total vertical flows to simulate the flow separation. Figure VII.55 shows the inlet length scale for the wall jet flow Figure together with a blown up zoom view of the inlet details. VII.56 shows the length scale of turbulence distribution in the room Figure VII.57 shows the length itself for a totally horizontal flow. scale of turbulence distribution in the room for a totally vertical flow. Figure VII.58 shows the mean of the last two length scales of turbulence distributions of Figures VII.56 and VII.57. Figure VII.59

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	27	39	53	65	79	91	105	117	131	_113	157	169	183	195	209	221	235	217	261	273	287	239	313	325	339	
	26	9	52	17	78	25	181	33	138	41	156	49	182	57	288	65	231	73	260	81	286	89	312	97	338	U = V = 0
	25	38	51	61	77	90	183	116	129	112	155	168	181	191	287	228	233	215	259	272	285	298	311	321	337	
U = V = 0	21	8	50	16	76	24	102	32	128	40	154	48	180	56	296	64	232	72	258	80	281	88	310	96	336	
	73	37	19	63	75	89	181	115	127	111	153	167	<u>179</u>	193	285	219	231	215	257	271	283	297	309	323	, 335	·
	22	7	18	15	71	23	188	31	126	39	152	47	178	55	201	63	230	71	256	79	282	87	308	95	331 U	= V = 0
	71	3	7	52	F		58		125	140	151	198	177	182	2873 2872	218	778 778	<u>211</u>	235 251	278 70	281 280	<b>2%</b>	307		X3 348	100 256 XEI
	13	6 	8	11 	71	22 	87	30	123	38 138	149	ຳອ 	175	09 181	211	217	777	213	233	/8 26#	773	285	785	ี่ <u>ม</u> า	102	201 203 208
	1	5 	11 13	13 	63	21	35	29	172	37 138	117	45 161	173	53 150	139	61 	775	69 217	251	77 268	777	85 	383	93 <b>379</b>	701 223 346	103 m

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FIGURE VII.56: Test Case (VII.1.9) length scale of turbulence for a total horizontal fidered and the room

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FIGURE VII.58: Test case (VII.1.9) length scale of turbulence of the room as a means of FIGURE VII.58. IIV as of Figures VII.56 and VII.55



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FIGURE VII.59: Test Case (VII.1.9) length scale of turbulence for the room exit, with a blown up zoom view

shows the length scale of turbulence of the exit duct with a blown up zoom view. Figure VII.60 shows the length scale of turbulence distribution for the whole flow domain after assembly of the sublength scale zones. The turbulence intensity was set as a function of axial position, i.e.

For the jet length scale area:  $I_1 = (0.25 - \frac{x}{1.5})\%$ ,

and for the room itself:  $I_2 = (0.21 - \frac{X}{1.5})\%$ ,

While for the exit duct:  $I_3 = (1.2)\%$  was fixed as constant.

Figure VII.61 shows the velocity vectors, the height of the room is increased in order to clarify the flow mechanism (not to scale). In reality and computation the room length is three times its height as mentioned before. Figures VII.62 and VII.63 show the small recirculation zones in the top right hand corner and bottom left hand corners respectively. Ref. 5 confirmed the existence of these two small recirculation zones but did not show them. Figure VII.64 shows the velocity contours. Figure VII.65 shows the pressure contours. Figure VII.66 shows a blown up zoom view of the pressure contours at the room inlet. Figure VII.67 shows the kinetic energy of turbulence contours. Figure VII.69 shows a comparison of normalised axial velocity between the experiment and prediction of Ref. 5 and this work. The excellent agreement needs no further explanation.



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FIGURE VII.60: Test case (VII.1.9) length scale of turbulence of the whole flow domain after assembly of sub-length scale zones.

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FIGURE VII.61: Test case (VII.1.9) velocity vectors. Velocity in ventilated rooms

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FIGURE VII.62:

Test case (VII.1.9) velocity vectors at top right hand side corner of the room showing the small recirculation zone

Velocity in ventilated rooms

FIGURE VII.63:

Test case (VII.1.9) velocity vectors at bottom left hand side corner of the room showing the small recirculation zone. Velocity in ventilated rooms









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FIGURE VII.67: Test case (VII.1.9) kinetic energy of turbulence contours. Velocity in ventilated rooms



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FIGURE VII.68: Test case (VII.1.9) turbulent viscosity contours. Velocity in ventilated rooms



FIGURE VII.69: Test case (VII.1.9) comparison of normalised axial velocity with Ref. 5 experiment and prediction

## VII.1.10 <u>Buoyancy Effects on Turbulent Transport in Combined Free</u> and Forced Convection Between Vertical Parallel Plates

Ref. 7 investigated turbulent mixed flow of free and forced convection experimentally and theoretically. Experiments were carried out in the upward turbulent flow between vertical parallel plates at different wall temperatures. In this condition, the aiding and opposing flows arose simultaneously on the heated and cooled sides, respectively, and a fully developed condition was established.

Buoyancy effects on the mean velocity and temperature profiles were examined and confirmed. Figure VII.70 shows a schematic diagram of the flow and heat transfer.



FIGURE VII.70: A schematic diagram of the flow and heat transfer at the measuring station (fully developed flow)

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Ref. 7 noted that the concept of eddy diffusivity may become inadequate when the velocity or temperature gradient is zero, especially when the Reynolds stress is not equal to zero in spite of the zero velocity gradient. They expected these phenomena to appear in their flow configuration, since the distributions of mean velocity and turbulent properties are not symmetric at the plane of zero velo-These facts, however, did not cause a serious error city gradient. in Ref. 7 predicted mean velocity and temperature profiles. Thus it is assumed as Ref. 7 did, that eddy diffusivity has a zero value once the velocity gradient vanishes. The distribution of the Prandtl number was not influenced very much by the buoyancy force 7 so that the relation for the turbulent Prandtl number in nearly-isothermal flows was assumed applicable to the mixed convection. The experimental arrangement is shown for the parallel plates in Figure VII.71, which shows the test section (duct). The inlet length was about 100 times the equivalent diameter.

There were two jackets behind the heat transfer surface. Through one jacket, cooled water was circulated to maintain the cooled wall at constant temperature. Steam or heated water flowed through the other jacket to maintain the wall at higher temperature. Side walls were made of phenolic-resin plates 1 mm thick in order to prevent heat conduction through the walls. Air was introduced upwards into the duct and discharged from the duct into the atmosphere. The difference in the bulk temperature between inlet and outlet sections was adjusted to be as small as possible in order to establish the fully-developed

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FIGURE Vii.71: Schematic diagram showing (isometric) view of the duct with the test section (plane of measurements)

temperature distribution in a shorter entrance length. The measurements of velocity and temperature, both mean and fluctuating quantities, were made with wire anemometer probes. The experiments were made at Re = (4170 - 8270) and  $(\frac{Gr}{Re^2}) = (1.12 \times 10^{-3}) - (1.82 \times 10^{-2})$ . Two typical distributions of the mean velocity and temperature were shown:

i) For 
$$(\frac{\text{Gr}}{\text{Re}^2}) = 2.2 \times 10^{-3}$$
, and Re = 5870  
ii) For  $(\frac{\text{Gr}}{\text{Re}^2}) = 1.49 \times 10^{-2}$ , and Re = 5140

These two cases above were simulated using the current thesis model of turbulence utilizing the finite element technique. The mesh used together with the boundary conditions for both cases are shown in Figure VII.74.

For Case a:

$$Re = \frac{\rho u(2b)}{\mu} = 5870 = \frac{1.2494 \times U \times (0.02 \times 2)}{0.0000176416}, \quad U_i = 2.0721$$

 $\frac{\text{Gr}}{\text{Re}^2} = 2.2 \times 10^{-3} = \frac{(1.2494)^2 \times 9.81 \times 0.003534 \times \Delta T \times (0.02 \times 2)^3 / (0.0000176416)^2}{(5870)^2}$ 

 $\Delta T = 6.803$ , and since  $\Delta T = (T_H - T_C)$  where  $T_C = 0.0$ ,  $T_H = 6.803$ 

where: 
$$\rho_1 = 1.2494$$
  
 $\mu_1 = 0.0000176416$   
 $Cp_1 = 1006.06$   
 $K_1 = 0.024928$   
 $Pr_1 = 0.713$   
 $\beta_1 = 0.003536$ 

For Case b:

$$Re = \frac{u(2b)}{\mu} = 5140 = \frac{1.08528 \times U \times (0.02 \times 2)}{0.0000196722}, \quad \vdots \quad U_i = 2.3292$$

$$\frac{Gr}{Re^2} = 1.49 \times 10^{-2} = \frac{1.08528 \times 9.81 \times 0.003067 \times T \times (0.02 \times 2)^3 / (0.0000196722)^2}{(5140)^2}$$

$$\Delta T = T_{\rm H} = .72.8862$$

where: 
$$\rho_2 = 1.08528$$
  
 $\mu_2 = 0.0000196722$   
 $Cp_2 = 1008$   
 $K_2 = 0.03$   
 $Pr_2 = 0.701$   
 $\beta_2 = 0.003067$ 

The measured turbulence intensities varied in the following manner:



FIGURE VII.72

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FIGURE VII.73

These variations in intensities can be accommodated in a formula as a function of axial position i.e. I = f(x), varying as per the intensity figures (VII.72, 73).above. Due to lack of time and to follow in the footsteps of the work done in this thesis, this has been cut down to an average approximation as was done for zonal intensities in this thesis. Hence the right half of the duct had a different average intensity than the left half. The following plots are shown for Case (a):

Figure VII.75 shows the velocity vectors, case (a) Figure VII.76 shows the velocity contours, case (a) Figure VII.77 shows the pressure contours, case (a)

_									U = 0;	<b>,</b> p = 0	(at c	orne	er nodes	5),	$\frac{9\lambda}{9\Lambda} =$	0, <u>91</u>	- =	0		
					. 115	138		153	161	176 181	199_297			215	<u></u> 751	268 276	<b></b>	, <b>2</b> ,4.	۲٦	
	<b>,</b>	11	•21	7.0	• 35	128	<b>12</b> ·	152	19	<sup>175</sup> 56	198 63	721	70	211	77	<sup>757</sup> 84		18 74	, m2 m	
			<u>. 1</u>		. 111	120	137	151	169	174 183	197 296	728	779	213		766 275	-	zh	┉	
FIGURE VII.74:					- 74	127	A 1	150	40	173 55	196 62	219	<b>6</b> 9	212	76	<sup>265</sup> 83		<b>1</b> 7 ع	,	
Test case (VII.1.10).		ינה	-28		- 31		11	I	10	55	,									
Turbulent mixed convection flow					113	126	136	149	159	172 182	195 795	218	228	241	251	261_271	┢┍╡╸	₽	╞╍┥╸	
between vertical parallel plates. The mesh utilized and the boundary		<b>1</b> 1	-19	~	- 33	125	<del>1</del> 0	116	<del>1</del> 7	<sup>171</sup> 54	<sup>191</sup> 61	217	68	218	75	<sup>78</sup> 82	  -  -	96 7	л <b>т</b> о Г	
conditions						1.74	175	117	. 158	179 181	193 281	216		239_		777 277		<u>م</u> بع	-	ı
			-18		- 32	123	39	116	16	<sup>169</sup> 53	<sup>192</sup> 60	215	67	238	7 <del>1</del>	×81	_  	'95 <b>f</b> i	17 30 -	• U = V = O
$U = V = 0$ $T = T_c$						122	134	115		168_188	191 _ 283 _	211	276	277	213	251 277		مارون		$T = T_{H}$
	,		-17	2	r 3j1	121	38	111	<b>1</b> 5	<sup>167</sup> 52	<sup>138</sup> 59	213	66	735	73	<sup>254</sup> 80	~	'94 '7		,
. 🗸			١,		11	120	_133	113	156	166 179	189 282	212		735_	219	258 271	┾╃		╧╋╋	•
		<b> </b>	-16		- 30	119	37	112	, <b>11</b>	<sup>165</sup> 51	198 58	211	65	731	72	<sup>257</sup> 79	<b>h</b>	-93 F	<b>1</b>	
×							132		155	161 178	187 281	210	221	733	217	756 271		•••	╺╼┿╍┽	•
			-1	5 72	29	117	36	158	13	<sup>163</sup> 50	<sup>196</sup> 57	789	61	232	71	<sup>223</sup> 78	-	-92	99 - Car	-
						0 116	101	139	151	162 177	185 280	298	<u></u>	231	216	751 76	<u>مر او</u>		and	-
									v = v <sub>i</sub>	, U = O	$\frac{9\lambda}{5\lambda} =$	0,	$\frac{\partial \mathbf{y}}{\partial \mathbf{l}} =$	0						

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## FIGURE VII.75: Case (a). Test case (VII.1.10) velocity vectors Turbulent mixed convection (b.v.p.p)

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,††††† <b>†</b> ††	1	Î	1	1	1	11	Î	Î	1	<u> </u>	1
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₁†↑↑↑↑↑↑↑	Î 1	Î	Î	1	Î	11	Î	1	Î	<u> </u>	1
t î î î	ľ	1		1	1	1		Î		1 11 1 1	
,†††††††††	1	Î	1	1	` ↑	1 1	Ĵ	Î	1	<u> </u>	1
<b>↑</b> ↑ ↑↑	Ì	1		1	1	1		1		<b>î î</b> î <b>î î</b>	
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		1	1	1 1			1	1	Î	1 1 111111	





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FIGURE VII.77: Case (a). Test case (VII.1.10) pressure contours (Isobars). Turbulent mixed convection (b.v.p.p)



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Figure VII.78 shows the temperature contours, case (a)

Figure VII.79 shows the length scale of turbulence distribution contours, Cases (a) and (b)

Figure VII.80 shows kinetic energy of turbulence contours

Figure VII.81 shows turbulent viscosity contours

Figure VII.82 shows turbulent conductivity contours

## As for Case (b):

Figure VII.83 shows the velocity vectors, case (b) Figure VII.84 shows the velocity contours, case (b) Figure VII.85 shows the pressure contours, case (b) Figure VII.86 shows the temperature contours, case (b) Figure VII.87 shows the kinetic energy of turbulence contours, case (b) Figure VII.88 shows the turbulent viscosity contours, case (b) Figure VII.89 shows the turbulent conductivity contours, case (b) Figure VII.90 shows the mean velocity and temperature profiles of Ref.7 and compares them with the results of this work. The splendid correlation requires no further explanation.

The predictions (Figure VII.90B) do not agree very well with Ref. 7 (Figure VII.90A) at X/b = 0.1 and X/b = 0.9 where there is a transition from the boundary layer type of flow to a mean flow. This is where the peaks take place in Figures VII.72 & VII.73, i.e. highest turbulent intensities positions. This is to be expected since only the average intensities were taken as mentioned before, in order to demonstrate the validity and applicability of the zonal approach.

If the turbulence intensities were taken as functions of positions i.e. I = f(x) as was done successfully in test case (VII.1.9) and as per Figures VII.72 & VII.73 curves, very accurate agreement is foreseen.





(VII.1.10). Length Turbulent mixed Test case scale of turbulent contours. convection (b.v.p.p) Cases (a) and (b). FIGURE VII.79:



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Turbulent viscosity mixed convection (b.v.p.p) Test case VII.1.10. Turbulent Case (a). contours. FIGURE VII.81:

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Turbulent conductivity Turbulent mixed convection (b.v.p.p) Test case (VII.1.10). Case (a). contours. FIGURE VII.82:

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FIGURE VII.83: Case (b). Test case (VII.1.10) velocity vectors. Turbulent mixed convection (b.v.p.p)





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FIGURE VII.85: Case (b): Test case (VII.1.10). Pressure contours (Isobars). Turbulent mixed convection (b.v.p.p)







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Test case (VII.1.10). Turbulent viscosity contours. Turbulent mixed convection (b.v.p.p) Case (b). FIGURE VII.88:

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706b

## VII.2 Further Calculations

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Further calculations are to be performed on the solar-ventilation and air-conditioning experimental rig, aiming to capture the dominant driving force of the flow in the room. This is to investigate the natural convection layer on the room-side of the solar heated wall which was partly ignored because no measured temperature boundary conditions were prescribed on it; this implied no flux due to the absence of the contour integrals. This further simulation run will attempt to model the flow with the temperature distribution on the room-side surface specified.

## Two very important points ought to be mentioned here:

- i) The experimental measurements of velocities and temperature that have been performed on the rig are the true values regardless of any simulation or calculation done in this thesis.
- ii) These experimental measurements were only done at certain access positions and the solar collector back surface was not one of them and hence cannot compare with measured values. The flow zones in the model were made to simulate the information from access positions measurements and visualisation observations. Hence it is possible that certain zones were forced to aid in the flow mechanism role of the exit buoyancy flow as per visualisation observations. Hence agreement with access position values was maintained.

## VII.2.1 The Analysis of the Numerical Results

It was pointed out to the author<sup>1</sup> that in the second case of flow simulated in this thesis (taken as a typical case):

The maximum temperature of the convection channel black surface is  $56^{\circ}$ C, one third the distance from the top of the room and  $\simeq 46^{\circ}$ C át top and bottom. Looking at the experimental results, Ref. 1, noted:

a) The temperature in the inlet channel is generally above ambient, temperature falls from the wall adjacent to the test section towards the outer wall and the fluid temperature increases as it moves down the channel. This led to suppose that the fluid was being heated from the left hand (i.e. test section adjacent) wall. This in turn must be receiving heat presumably from the test section (radiation)?

It ought to be mentioned that these said temperatures were actually measured and fed in as boundary conditions to the program. The assumption of an indefinitely ideal ambient environment around the inlet channel can be found only in textbooks. One side of the channel that was facing the test section was also facing the laboratory lighting, while the other side was facing a spacious open surrounding. The average difference in temperature between the two faces is only  $\approx$ (0.25%C), and this argument is entirely explainable in these terms. b) From the comparison graphs of experimental and numerical values of temperatures it was seen that the fluid enters the room at  $\approx 22^{\circ}$ C, but that the temperature in the bulk of the flow is much higher  $\approx (24-25^{\circ}$ C). The temperature outside the wall jet is therefore  $\approx 3^{\circ}$ C higher than the jet itself.

Thus the fluid in the room is receiving heat from some source other than the inlet flow. Estimating the Richardson Number (known as the Archimedes number - see Appendix VI of this thesis) associated with the wall jet:

$$Ar = \frac{Lg \ \beta \Delta \theta}{u^2} \qquad (VII.2)$$

From Figure 560, page 270, peak velocity of inlet wall jet  $\approx 0.1$  m/sec and the height of the wall jet  $\approx 0.04$ m. From Figures 5.54 to 5.57  $\Delta \theta \approx 2^{\circ}$ C. Using a value of  $\beta = 3.316 \times 10^{-3}/{^{\circ}}$ C

Ar 
$$\simeq$$
 0.26

If the (L) of the wall jet is taken as the width of the room = lm, ... Ar  $\approx 6.5$ 

This indicates a mixed convection and not a solely dominant buoyancy driven natural convection. This is due to the entrainment role in the common chimney<sup>9</sup>.

However, dominant buoyancy effects do exist but are not so overwhelming as suggested<sup>(1)</sup>. Consider the heat transfer from the solar collector wall into the room by conduction:



If the heat flux through the wall is (q):

$$q = \frac{K_{\omega}}{b} (T_{b} - T_{s}) = h(T_{s} - T_{f})$$
$$T_{s} = (\frac{K_{\omega}}{hb} T_{b} + T_{f})/(1 + \frac{K_{\omega}}{hb})$$
(VII.3)

Thus

where  $K_{\omega}$  = conductivity of the wall h = heat transfer coefficient

values of quantities involved:

 $K = 0.125 \text{ W/m}^{\circ}\text{C}$  (Kaye and Laby - for homogeneous plywood)  $T_{b} = 56^{\circ}\text{C}$  (black surface temperature)

$$T_{f} = 25^{\circ}C$$
  
b = 0.018m

Let mean Nusselt number for heat transfer from the wall to the fluid layer on the room side be  $\overline{Nu}$ :

Then 
$$h = \frac{\overline{Nu} K_{(air)}}{L}$$
 (VII.4)

$$L = 1m, K_{(air)} = 0.026 W/m^{\circ}C$$

$$\overline{Nu} = 0.0246 (GrPr)^{0.4} [(Pr)^{1/6}/[1 + 0.494 (Pr)^{2/3}]]^{0.4}$$
(VII.5)

where: 
$$Pr = 0.7$$
, and  
 $Gr = \frac{g \beta \rho^2 L^3 (\Delta T)}{\mu^2} = \frac{9.81 \times (3.67 \times 10^{-3}) \times (1.1)^2 \times (1)^3 \times \Delta T}{(1.85 \times 10^{-5})^2}$   
 $= 12.7 \times 10^7 (\Delta T)$  (VII.6)

where  $\Delta T$  = temperature drop-wall to gas = (T<sub>s</sub> - 25<sup>o</sup>C)

Iterating around equations (VII.6) then (VII.5) then (VII.3)  $\rightarrow$  ( $\Delta$ T) converges to the following results<sup>1</sup>:

 $T_s = 46.98^{\circ}C$  (corresponding to 56°C on the convection channel black surface) Gr = 2.79 x 10<sup>9</sup>

$$Nu = 109.6$$

Thus:  $h = 2.85 \text{ W/m}^2 \text{ °C}$ whereas  $\frac{K_{\omega}}{b} = 6.94 \text{ W/m}^2 \text{ °C}$ 

These are beautiful calculations, however, the temperature corresponding to the 56<sup>0</sup>C on the convection channel black surface was measured utilising three different engineering methods:

- i) Thermocouples with calibrated microprocessor ( $\pm 0.01^{\circ}$ C),
- ii) Ordinary thermometer (±0.5<sup>0</sup>C),
- iii) Liquid crystal strip (±0.25°C).

The temperature was found to be  $38.8^{\circ}$ C. Now this can be explained since plywood homogeneity was assumed in the calculations, and not taken as a composite material. All the nodal temperatures on the exit wall were then measured and fed in the program as boundary conditions.

Figure VII.91 shows the velocity vectors of the old simulation without the newly measured wall temperatures prescribed. Figure VII.92 shows the old temperature contours. Figure VII.93 shows the old temperature/ velocity relationship indicating that the solar collector back wall flow is with no heat flux and is due solely to conduction i.e. velocity vectors perpendicular to the wall isotherms.

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FIGURE VII.93: Solar room, old temperature/velocity relationship indicating the type

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After prescribing the newly measured temperature values at the exit wall, Figures VII.94 and VII.95 show the velocity vectors and temperature contours respectively. It can be seen from the last figure that heat flux is varying up the exit wall now and convection is taking place. This resulted in an increase in the average flow velocities of about  $\approx 12\%$ . This was combatted by increasing the exit wall jet flow zone turbulence intensity by  $\approx (14.2\%)$ and the room exit part of the common chimney elements intensities by  $\approx (5.2\%)$ . This resulted in bringing the flow back to its original magnitude with an average velocity error of  $\pm 2.1\%$ .

Figure VII.96 shows the new temperature/velocity relation indicating the type of heat transfer at the exit wall is due to mixed convection with dominating buoyancy natural convection force. This confirms dominantly buoyancy driven boundary layer up the exit wall which is just in the turbulent regime. In the old velocity vectors/isotherm simulation agreement with experiment was achieved due to the prescription of zonal roles which forced the flow to act realistically. The transport of heat within the room was almost entirely by diffusion i.e. heat diffused back from the chimney into the room against the flow. This is further confirmed by examining Figure 5.79 (page 286) for turbulent conductivity and Figure 5.78 (page 285) for turbulent viscosity which implied turbulent Prandt] numbers ≈0.001.

The ability to manipulate zonal properties, not just turbulence intensities made it possible to counteract the high gravity forces in the floor inlet wall jet.

It is to be remembered that the old calculations and simulations are still correct and valid for all the access positions and as compared with experimental measurements.



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