CESAREO DE LA ROSA SIQUEIRA

# RESOLUÇÃO DE ESCOAMENTOS BIDIMENSIONAIS VISCOSOS TURBULENTOS E INCOMPRESSÍVEIS EM REGIME PERMANENTE ATRAVÉS DA UTILIZAÇÃO DE MECÂNICA DOS FLUIDOS COMPUTACIONAL

(VOLUME 2 - ANEXOS)

Dissertação apresentada à Escola Politécnica da Universidade de São Paulo para a obtenção do título de Mestre em Engenharia

São Paulo

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Área de Concentração:
Engenharia Naval

Orientador:
Prof. Doutor Kazuo Nishimoto

São Paulo

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## LISTA DE ABREVIATURAS

CFD - Computacional Fluid Dynamics

NACA - National Advisory Committee for Aeronautics

RAM - Random Access Memory

EDO - Equação Diferencial Ordinária

MDF - Método das Diferenças Finitas

MEF - Método das Diferenças Finitas

MVF - Método dos Volumes Finitos

CHAM - Concentration, Heat and Moment

BFC - Body-Fitted Coordinates

MB - Megabytes

Mips - Milhões de informações por segundo

CPU - Central Processing Unit

## LISTA DE SÍMBOLOS

A - área de uma célula computacional

$A_E$ - coeficiente de $\phi_E$ no ponto E

Ae - área da face e

$B_P$ - termo fonte no ponto P

$C_D$ - coeficiente do modelo de energia turbulenta de Bradshaw

$C_d$ - coeficiente de arraste viscoso

$C_{fe}$ - convecção da propriedade considerada através da face e

Cp - calor específico a pressão constante

Cp - coeficiente de pressão

Ctotal - corda total

$C_{1\varepsilon}$ - constante do modelo de turbulência K-$\varepsilon$

$C_{2\varepsilon}$ - constante do modelo de turbulência K-$\varepsilon$

$C_\mu$ - constante de Kolmogorov-Prandtl

$C_\mu'$ - constante do modelo de turbulência K-$\varepsilon$

D - domínio computacional da solução

D - drag D por unidade de largura

$D_{fe}$ - difusão da propriedade considerada através da face e

Dh - diâmetro hidráulico

Diff $\langle u_i u_j \rangle$ - difusão provocada pelas interações viscosas turbulentas

dl - elemento diferencial de comprimento

dt - elemento diferencial de tempo

dV - elemento diferencial de volume

$d\vec{S}$ - elemento de superfície

E - energia total

EP - taxa de dissipação da energia cinética turbulenta no programa **PHOENICS**

e - número neperiano

e - energia interna

$\vec{F}$ - vetor fluxo total

$\vec{F}c$ - contribuição convectiva do vetor fluxo $\vec{F}$

$\vec{F}d$ - contribuição difusiva do vetor fluxo $\vec{F}$

$\vec{f}e$ - forças de volume externas

$\vec{f}i$ - forças internas

$\overline{\overline{F}}$ - tensor F

Gij - produção realizada pelas forças de empuxo

Hdegrau - altura do degrau no problema do ressalto hidráulico

h - altura do degrau no problema do ressalto hidráulico

IX - posição da célula computacional na coordenada x no programa **PHOENICS**

IY - posição da célula computacional na coordenada y no programa **PHOENICS**

IZ - posição da célula computacional na coordenada z no programa **PHOENICS**

$\overline{\overline{I}}$ - tensor unitário

K - energia cinética turbulenta

KE - energia cinética turbulenta no programa **PHOENICS**

k - coeficiente de condutibilidade térmica

L - comprimento

$L_m$ - livre caminho médio

$L_S$ - comprimento característico do escoamento turbulento

$L_t$ - escala de comprimento para a turbulência

l - escala de comprimento viscoso

lt - comprimento de mistura

$\dot{m}_{fe}$ - fluxo de massa através da face e

NX - número de células na direção X

NY - número de células na direção Y

NZ - número de células na direção Z

$N_I(x)$ - funções de interpolação no método dos elementos finitos

P - pressão

P1 - valor da pressão no programa **PHOENICS**

$P_{absoluta}$ - Pressão absoluta em Pascal

$P_{atmosférica}$ - Pressão atmosférica em Pascal

Pe - número de Peclet

Pij - processo de produção realizado pelo escoamento médio

Pr - Número de Prandtl

$P_{referência}$ - Pressão de referência em Pascal

p - flutuação da pressão

pij - distribuição das flutuações de pressão

Qs - fonte superficial

Qv - fonte volumétrica

Q1 - arquivo de entrada de dados do programa **PHOENICS**

q - raiz quadrada da intensidade turbulenta total

R - resíduo da solução

R - constante universal dos gases

RESREF($\phi$) - valor de referência no programa **PHOENICS** para avaliação de resíduos

Re - número de Reynolds

$r_i$ - fração de volume da fase i

S - variável que representa os termos fonte na equação de Navier-Stokes

$S^{\phi}$ - termo fonte da propriedade transportada em consideração (taxa de geração de $\phi$)

T - temperatura absoluta

t - tempo

$t_m$ - tempo entre colisões moleculares

$t_{novo}$ - instante atual

$t_t$ - escala de tempo para a turbulência

$t_{velho}$ - instante anterior

U - velocidade do escoamento não perturbado (escoamento médio)

$U_I$ , I = 1,2...n, - coeficientes da função de interpolação

Uie - velocidade em x da fase i armazenada na face e

$U_R$ - velocidade paralela resultante próxima à parede

U1 - velocidade na direção x

$U*$ - velocidade de fricção

u - componente de velocidade na direção x

$u_i$ - componente de velocidade na direção i

$u_j$ - componente de velocidade na direção j

$u_k$ - componente de velocidade na direção k

$u_x$ - valor da derivada da função no ponto x

$\tilde{u}$ - valor aproximado de u(x)

V - velocidade do escoamento ao longe

VO - volume de controle

$V_P$ - volume da célula

$V_S$ - velocidade característica do escoamento turbulento

Vx - velocidade de entrada na direção x

Vy - velocidade de entrada na direção y

V1 - velocidade na direção y

v - componente de velocidade na direção y

$X_E$ - coordenada em x do ponto E

Xr - posição de realinhamento do fluxo no problema do degrau

$x_2$ - direção normal ao escoamento

W - peso molecular

Wf - trabalho das forças de volume externas

w - componente de velocidade na direção z

w - função peso

$\alpha$ - fator de relaxação

$\alpha_N$ - ângulo de ataque

$\alpha_e$ - coeficiente de interpolação linear de $\phi_e$

$\alpha_f$ - ângulo do flap

$\alpha 1$ - variável auxiliar

$\beta_e$ - coeficiente de interpolação linear de $\phi_e$

$\delta_{IJ}$ - delta de Kronecker

$\delta^*$ - espessura de deslocamento da camada limite

$\gamma$ - relação entre os coeficientes de calor específico a pressão e volume constantes

$\Delta_{TF}$ - intervalo de tempo para falso time-step

$\Delta t$ - intervalo de tempo

$\Delta x$ - variação de comprimento na direção x

$\Delta y$ - variação de comprimento na direção y

$\varepsilon$ - taxa de dissipação da energia cinética turbulenta

$\phi$ - qualquer variável de interesse conservada

$\phi_P$ - valor da variável $\phi$ no ponto P

$\phi_{SC}$ - variável escalar qualquer

$\vec{\phi}_{SC}$ - variável vetorial qualquer

$\phi_e$ - valor da variável $\phi$ na face e

$\phi_{novo}$ - novo valor da variável $\phi$

$\phi_{velho}$ - antigo valor da variável $\phi$

$\phi_{P,velho}$ - valor da variável $\phi$ resultante da iteração anterior no ponto P

$\tilde{\phi}$ - aproximação do valor exato de $\phi_P$

$\phi^*$ - valor da variável $\phi$ resultante da iteração atual

$\Gamma$ - variável que representa os termos difusivos na equação de Navier-Stokes

$\Gamma_l$ - coeficiente de troca laminar

$\Gamma_t$ - coeficiente de troca turbulenta

$\Gamma^{\phi}$ - difusividade da propriedade transportada em consideração (coeficiente de troca de calor)

$\eta, \zeta$ - curvas que definem o plano computacional de um problema de CFD

$\eta$, $\xi$ - curvas que definem o plano físico de um problema de CFD

$\mu$ - viscosidade dinâmica

$\mu_t$ - viscosidade do vórtice ou *eddy viscosity*

$\nu$ - viscosidade cinemática

$\rho$ - densidade do fluido

$\rho_P$ - densidade do fluido no ponto P

$\rho_i$ - densidade da fase i

$\sigma_k$ - constante do modelo de turbulência K-$\varepsilon$

$\sigma_\varepsilon$ - constante do modelo de turbulência K-$\varepsilon$

$\sigma_l$ - número de Prandtl/Schmidt para transferência de calor e massa laminar

$\sigma_t$ - número de Prandtl/Schmidt para transferência de calor e massa turbulenta

$\overline{\overline{\sigma}}$ - tensor das tensões internas

$\tau_w$ - tensão de cisalhamento

$\overline{\overline{\tau}}$ - tensor das tensões viscosas

$\vec{\nabla}$ - vetor gradiente

$\nu_l$ - viscosidade cinemática laminar

$\nu_t$ - viscosidade cinemática turbulenta

$\Theta$ - flutuação da grandeza $\phi$

$\otimes$ - produto tensorial

$\chi$ - constante de Von Karman

$\psi$ - constante de difusividade

# RESUMO

Nos últimos 30 anos, a Mecânica dos Fluidos Computacional ou CFD (Computacional Fluid Dynamics) deixou de ser uma ciência de aplicação meramente acadêmica para se tornar uma importante ferramenta no projeto e análise de equipamentos ou corpos na presença de fluidos. O CFD pode ser usado para reduzir o número de experiências as quais são necessárias para otimizar um projeto ou mostrar determinadas características do escoamento em estudo. Tal análise torna-se bastante interessante pois custos de desenvolvimento de projeto podem ser reduzidos.

Esta dissertação tem por objetivo mostrar e discutir a resolução de alguns escoamentos bidimensionais viscosos turbulentos e incompressíveis em regime permanente, através da utilização da Mecânica dos Fluidos Computacional. Os resultados foram obtidos via programa **PHOENICS**, programa que emprega o Método dos Volumes Finitos para a discretização das equações de conservação, utilizando as equações completas de *Navier-Stokes* em todo o domínio de interesse e o processo de *Time Averaging Method* para a modelagem matemática do escoamento turbulento. Optou-se pela utilização do modelo de turbulência K-ε para os casos analisados.

Este trabalho procura fornecer ainda uma revisão dos conceitos e formulações básicas ligadas à Mecânica dos Fluidos Computacional ou CFD (*Computacional Fluid Dynamics*), além dos estudos de validação através do programa **PHOENICS** para alguns escoamentos bidimensionais, cujos resultados estão disponíveis na literatura, e para estudos paramétricos de casos de interesse com solução não conhecida.

## ABSTRACT

In the last 30 years, the Computacional Fluid Dynamics (CFD) has heft its original role of being a merely academic science to become an important tool for design and analysis of equipment or bodies in the presence of fluids. The CFD can either be used to reduce the hughe number of experiments which are necessary to optimize a design or to show particularities of some fluid flow. Such analysis are very interesting nowadays because the development coasts for a new design might be strongly reduced.

This dissertation aims to show and discuss the solution of some bidimensional viscous turbulent flow in steady state, by utilization of Computacional Fluid Dynamics. The results were obtained via **PHOENICS**, a CFD code which uses the Finite Volume Method for the discretisation of conservation equations. The *Navier-Stokes* complete equations and the Time Averaging Method were employed to make the mathematical model of the turbulent viscous flow. The turbulence model K-ε was chosen for the considered cases.

This work still tries to give a review of concepts and formulations related to CFD. It will be shown some validation studies using **PHOENICS** code comparing its results to the well-know values available in the literature. Finally, the **PHOENICS** software was also used to make parametrical studies for special problems which solutions are still unknow.

# ANEXO A

## CONCEITOS BÁSICOS SOBRE DIFUSÃO NUMÉRICA OU FALSA DIFUSÃO

Os coeficientes $\alpha$ e $\beta$ que fazem parte das equações (3.44) e (3.45) necessitam de uma fundamentação física para a sua determinação pois os mesmos serão responsáveis pelo tipo de função de interpolação para cada malha.

Conforme foi discutido no capítulo 3, os *efeitos difusivos* (influência da pressão, por exemplo) se transmitem no fluido em todas as direções não existindo uma direção preferencial, segundo MALISKA [2]. Dessa maneira são termos *elípticos* que, caso sejam dominantes no processo, admitem uma função de interpolação linear sem causar problemas de oscilações ou divergência do processo de resolução das equações. Já os termos *convectivos* (influência da velocidade, por exemplo) são *parabólicos*, cujos efeitos propagam-se em uma determinada direção (direção do vetor velocidade) e admitem funções de interpolação do tipo **upwind**, onde os efeitos a jusante não interferem a montante.

Parece natural portanto que quando os efeitos difusivos e convectivos estiverem simultaneamente presentes e com pesos variáveis em determinadas regiões do escoamento nem a interpolação linear nem a do tipo **upwind** sejam adequadas. Nesses casos recomenda-se, segundo MALISKA [2], uma interpolação que possa medir os efeitos da convecção e da difusão ponderando cada um dos processos. Estes pesos, que são exatamente os coeficientes $\alpha$ e $\beta$, devem ser obtidos a partir da solução de um problema difusivo-convectivo.

A seguir será mostrado um desenvolvimento que utilizará funções de interpolação unidimensionais no problema de convecção-difusão para a determinação dos coeficientes $\alpha$ e $\beta$. Têm-se, portanto, utilizando a figura 11 do capítulo 3 para a discretização do problema:

$$\frac{\partial}{\partial x}(\rho u \phi) = \Gamma \frac{\partial^2 \phi}{\partial x^2} \qquad \text{(A.1)}$$

Com as seguintes condições de contorno:

$$\phi = \phi_P, \text{ em } x = x_P \quad \text{e} \quad \phi = \phi_E, \text{ em } x = x_E \tag{A.2}$$

Para este problema são definidas as seguintes variáveis adimensionais:

$$\xi = \frac{x - x_P}{\Delta x} \left( \rho \frac{u \Delta x}{\Gamma} \right) \tag{A.3}$$

$$\phi^* = \frac{\phi - \phi_P}{\phi_E - \phi_P} \tag{A.4}$$

O problema fica portanto reduzido a:

$$\frac{\partial \phi^*}{\partial \xi} = \frac{\partial^2 \phi^*}{\partial \xi^2} \tag{A.5}$$

E com as seguintes condições de contorno:

$$\phi^* = 0 \text{ em } \xi = 0 \quad \text{e } \phi^* = 1 \text{ em } \xi = P_e \text{ (número de } \textit{Peclet}) \tag{A.6}$$

O número de *Peclet* baseado em $\Delta x$ é dado por:

$$P_e = \frac{\rho u \Delta x}{\Gamma} \tag{A.7}$$

A solução do problema dado pela equação (A.5) com as respectivas condições de contorno é dada por:

$$\phi^* = \frac{e^{\xi} - 1}{e^{P_e} - 1}, \text{ onde } \mathbf{e} \text{ é o número } \textit{neperiano} \tag{A.8}$$

A figura A.1 mostra a família de soluções obtida com a equação (A.8), onde a curva 1 representa o problema de difusão pura e a curva 2 o problema de convecção pura.

Substitui-se $\xi$ por $P_e/2$ (média do valor de $\xi$ no intervalo $\Delta x$) na equação (A.8) e obtém-se uma equação para o coeficiente $\alpha$:

$$\alpha = \frac{1}{2} - \frac{e^{Pe/2} - 1}{e^{Pe} - 1} \qquad (A.9)$$

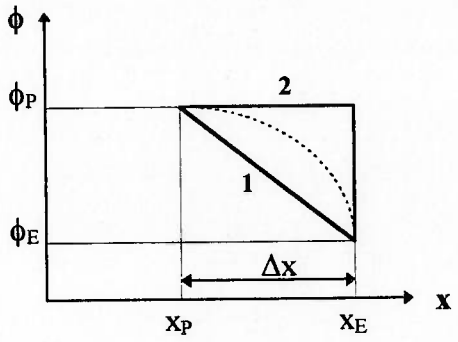



**Fig. A.1. Solução do problema unidimensional de convecção/difusão**

A expressão para o coeficiente $\beta$ será de maneira análoga dada por:

$$\beta = P_e \frac{e^{Pe/2}}{e^{Pe} - 1} \qquad (A.10)$$

Observando o campo de variação de $\alpha$ e $\beta$ chega-se a expressões mais simples encontradas em MALISKA [2]:

$$|\alpha| = \frac{P_e^2}{10 + 2P_e^2} \qquad (A.11)$$

$$\beta = \frac{1 + 0.005\, P_e^2}{1 + 0.05\, P_e^2} \qquad (A.12)$$

Considera-se agora segundo MALISKA [2] uma interpolação entre os pontos W e P da figura A.2 avaliando-se a convecção através da face oeste usando-se diferenças centrais. Obter-se-á portanto:

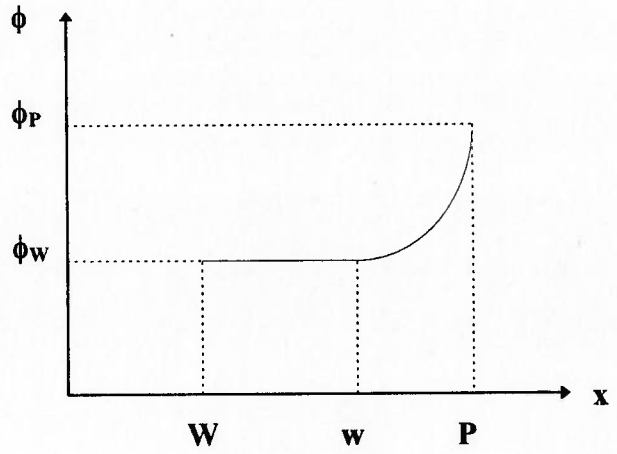



**Fig. A.2. Análise de difusão numérica**

$$C_{fw} = \rho_W u_W (\phi_W + \phi_P)/2 \qquad (A.13)$$

Utilizando-se agora diferenças para trás, tem-se:

$$C_{fw} = \rho_W u_W \phi_W = \rho_W u_W \phi_W \qquad (A.14)$$

Expandindo-se agora os valores de $\phi_P$ e $\phi_W$ em séries de Taylor e utilizando-se as equações (A.13) e (A.14) chega-se na expressão abaixo válida para a convecção na face oeste, usando diferenças centrais:

$$C_{fw} \approx \rho_W u_W \phi_W + 0(\Delta x) \qquad (A.15)$$

E utilizando-se diferenças para trás, tem-se:

$$C_{fw} \approx \rho_w u_w \phi_w - 0.5\rho_w u_w \Delta x(\partial\phi/\partial x)_w \qquad (A.16)$$

Observa-se que o segundo termo do lado direito da equação (A.16) é um termo análogo ao termo de difusão da propriedade $\phi$ onde $\rho_w u_w \Delta x(\partial\phi/\partial x)_w$ seria o coeficiente de falsa difusão.

Nota-se que esta falsa difusão não está relacionada somente ao uso de esquemas **upwind** mas também ao fato do vetor velocidade não estar alinhado com as direções coordenadas e pelo uso de funções de interpolação unidimensionais. Como pode ser visto na figura 11 do capítulo 3 é incorreto dizer, utilizando o esquema **upwind**, que $\phi_P = \phi_W$, quando pelo vetor velocidade mostrado $\phi_P$ terá influência de $\phi_{SW}$. Dessa maneira o uso de funções bidimensionais resolve o problema da difusão numérica junto com a especificação correta dos pesos convectivos e difusivos do problema.

Outras soluções para a difusão numérica são o refinamento da malha e o alinhamento do vetor velocidade com os eixos coordenados. A primeira delas muitas vezes torna-se proibitiva e a segunda requer um esquema numérico com malhas adaptativas pois o sistema de coordenadas deve ser a própria função de corrente.

# ANEXO B

## ARQUIVO DE DADOS DO PROBLEMA DO RESSALTO HIDRÁULICO PARA A SEGUNDA CONFIGURAÇÃO (DEGRAU4.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=VGAMOUSE
IRUNN    =        1 ;LIBREF =        0
**********************************************************
 Group 1. Run Title
TEXT(DEGRAU                                              )
**********************************************************
 Group 2. Transience
STEADY  =    T
**********************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,95,40,1,1.000E-05)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,7.000E-01,1.010E-02,1.000E+00)
   * Set objects: name  x0       y0        z0
   *                   dx       dy        dz
RSET(B,BLOCK    , 0.000E+00, 0.000E+00, 0.000E+00                    , $
2.000E-01, 4.900E-03, 1.000E+00)
RSET(B,ENTRADA , 0.000E+00, 4.900E-03, 0.000E+00                    , $
0.000E+00, 5.200E-03, 1.000E+00)
RSET(B,B3       , 0.000E+00, 0.000E+00, 0.000E+00                    , $
0.000E+00, 1.010E-02, 1.000E+00)
RSET(B,SAIDA    , 7.000E-01, 0.000E+00, 0.000E+00                    , $
0.000E+00, 1.010E-02, 1.000E+00)
RSET(B,WALL2    , 2.000E-01, 0.000E+00, 0.000E+00                    , $
5.000E-01, 0.000E+00, 1.000E+00)
RSET(B,WALL1    , 0.000E+00, 1.010E-02, 0.000E+00                    , $
7.000E-01, 0.000E+00, 1.000E+00)
RSET(B,VORT     , 2.000E-01, 0.000E+00, 0.000E+00                    , $
4.900E-02, 4.900E-03, 1.000E+00)
   * Modify default grid
RSET(X,1,25,-2.150E+00)
RSET(X,2,40,1.500E+00)
RSET(X,3,30,1.550E+00)
RSET(Y,1,20,-1.300E+00)
RSET(Y,2,-20,2.000E+00)
**********************************************************
 Group 6. Body-Fitted coordinates
**********************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(46) =NPOR ; NAME(47) =EPOR
NAME(48) =VPOR ; NAME(49) =DEN1
NAME(50) =ENUT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(ENUT,DEN1,VPOR,EPOR,NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
**********************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
**********************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
```

```
ENUL    = 1.000E-05 ;ENUT    = GRND3
PRT   (EP  ) =  1.314E+00
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
FIINIT(NPOR) =  1.000E+00 ;FIINIT(EPOR) =  1.000E+00
FIINIT(VPOR) =  1.000E+00

CONPOR(BLOCK    ,  0.00,VOLUME,-#1,-#1,-#1,-#1,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,95,1,40,1,1,1,1)
COVAL (KESOURCE,KE   , GRND4     , GRND4     )
COVAL (KESOURCE,EP   , GRND4     , GRND4     )

INLET (ENTRADA ,WEST   ,#1,#1,#2,#2,#1,#1,1,1)
VALUE (ENTRADA ,P1   , 1.429E+01)
VALUE (ENTRADA ,U1   , 1.429E+01)
VALUE (ENTRADA ,KE   , 4.084E-02)
VALUE (ENTRADA ,EP   , 1.501E+00)

PATCH (SAIDA    ,EAST   ,#3,#3,#1,#2,#1,#1,1,1)
COVAL (SAIDA    ,P1   , 1.000E+00, 0.000E+00)
COVAL (SAIDA    ,KE   , 0.000E+00, SAME      )
COVAL (SAIDA    ,EP   , 0.000E+00, SAME      )

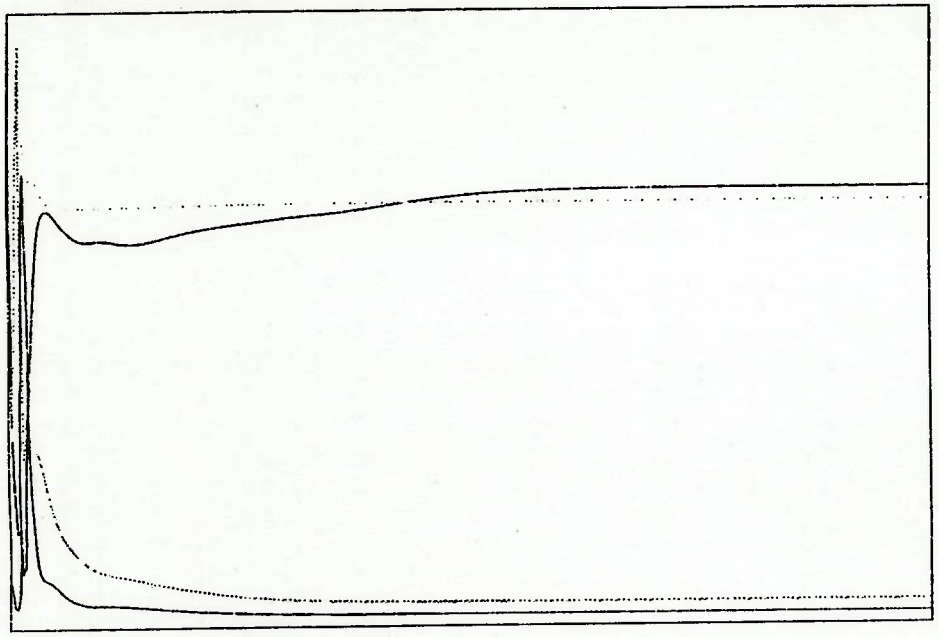
PATCH (WALL1    ,NWALL ,#1,#3,#2,#2,#1,#1,1,1)
COVAL (WALL1    ,U1   , GRND2     , 0.000E+00)
COVAL (WALL1    ,KE   , GRND2     , GRND2     )
COVAL (WALL1    ,EP   , GRND2     , GRND2     )

PATCH (WALL2    ,SWALL ,#2,#3,#1,#1,#1,#1,1,1)
COVAL (WALL2    ,U1   , GRND2     , 0.000E+00)
COVAL (WALL2    ,KE   , GRND2     , GRND2     )
COVAL (WALL2    ,EP   , GRND2     , GRND2     )

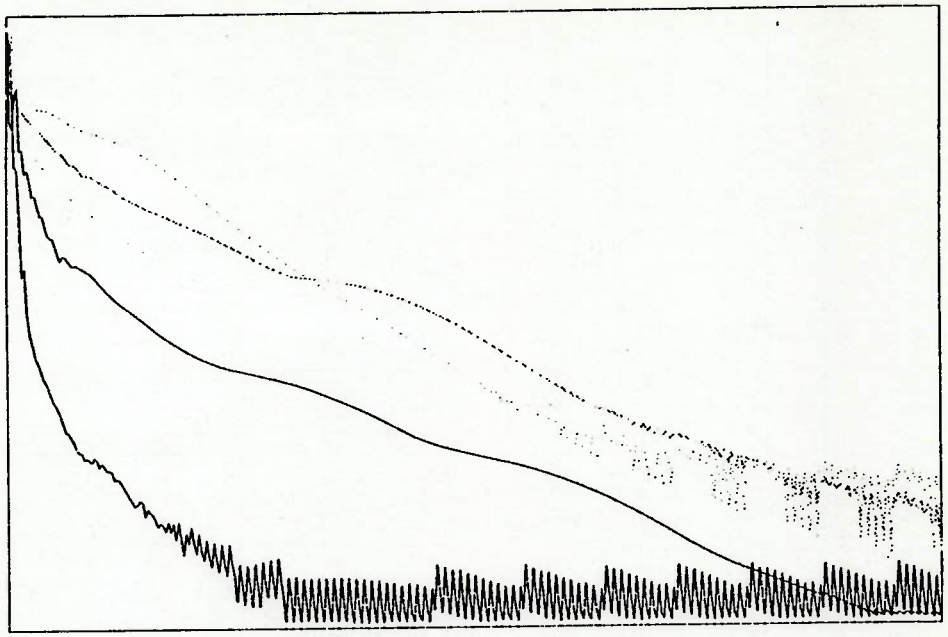
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP  =      300
LITHYD  =        3
SELREF  =    T
RESFAC  = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E+00)
RELAX(U1   ,FALSDT, 2.525E-05)
RELAX(V1   ,FALSDT, 2.525E-05)
RELAX(KE   ,FALSDT, 2.525E-05)
```

```
RELAX(EP   ,FALSDT, 2.525E-05)
KELIN    =        0
**************************************************************
 Group 18. Limits
**************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK     =     T
**************************************************************
 Group 20. Preliminary Printout
ECHO     =     T
**************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
**************************************************************
 Group 22. Monitor Print-Out
IXMON    =       27 ;IYMON   =       18 ;IZMON   =        1
TSTSWP   =    12345
**************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
**************************************************************
 Group 24. Dumps For Restarts
NOWIPE   =     T
**************************************************************
MENSAV(S,RELX,DEF,2.5250E-04,1,1.0000E-01)
MENSAV(S,PHSPROP,DEF,200,0,1,1.0000E-05)
MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 27, 18, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| -9.00E+01 | 3.00E+01 | -4.32E+00 | 1.29E-03 |
| 0.00E+00 | 2.00E+09 | 2.17E-01 | -3.29E-07 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| 0.00E+00 | 2.00E+05 | 1.44E+03 | -3.30E-03 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+02 | 8.04E-01 | -3.14E-01 |
| U1 | 1.00E+04 | 1.09E+00 | -1.79E+00 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| EP | 1.00E+06 | 9.51E-01 | -2.64E-02 |

| NX | NY | NZ | | ISWEEP | 1100 | Time now | 1:42 |
|---|---|---|---|---|---|---|---|
| 95 | 40 | 1 | | IZSTEP | OFF | (h:m) est | 1:42 |

# ANEXO C

## ARQUIVO DE DADOS DO PROBLEMA DO PERFIL NACA0012 COM ÂNGULO DE ATAQUE DE 9.86 GRAUS (NACA12.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS PARA AS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=VGAMOUSE
IRUNN    =        1 ;LIBREF =        0
**********************************************************
 Group 1. Run Title
TEXT(NACA12                                          )
**********************************************************
 Group 2. Transience
STEADY  =     T
**********************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,55,62,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
**********************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,3.0000E+00,3.0000E+00,0.0000E+00)
GSET(P,P2,3.0116E+00,3.0122E+00,0.0000E+00)
GSET(P,P3,3.0230E+00,3.0165E+00,0.0000E+00)
GSET(P,P4,3.0349E+00,3.0195E+00,0.0000E+00)
GSET(P,P5,3.0465E+00,3.0218E+00,0.0000E+00)
GSET(P,P6,3.2325E+00,3.0246E+00,0.0000E+00)
GSET(P,P7,3.4650E+00,3.0006E+00,0.0000E+00)
GSET(P,P8,3.2325E+00,2.9754E+00,0.0000E+00)
GSET(P,P9,3.0460E+00,2.9784E+00,0.0000E+00)
GSET(P,P10,3.0350E+00,2.9800E+00,0.0000E+00)
GSET(P,P11,3.0233E+00,2.9835E+00,0.0000E+00)
GSET(P,P12,3.0116E+00,2.9878E+00,0.0000E+00)
GSET(P,P15,3.3255E+00,3.0170E+00,0.0000E+00)
GSET(P,P16,3.3255E+00,2.9830E+00,0.0000E+00)
GSET(P,P17,3.4185E+00,3.0067E+00,0.0000E+00)
GSET(P,P18,3.4185E+00,2.9933E+00,0.0000E+00)
GSET(P,P37,3.0058E+00,2.9912E+00,0.0000E+00)
GSET(P,P38,3.0058E+00,3.0088E+00,0.0000E+00)
GSET(P,P90,3.1395E+00,3.0279E+00,0.0000E+00)
GSET(P,P91,3.0930E+00,3.0267E+00,0.0000E+00)
GSET(P,P92,3.0930E+00,2.9736E+00,0.0000E+00)
GSET(P,P93,3.1390E+00,2.9720E+00,0.0000E+00)
GSET(P,P39,6.7500E-01,6.5850E-01,0.0000E+00)
GSET(P,P40,5.7900E+00,6.5850E-01,0.0000E+00)
GSET(P,P43,5.7900E+00,5.3410E+00,0.0000E+00)
GSET(P,P45,6.7500E-01,3.0000E+00,0.0000E+00)
GSET(P,P46,6.7500E-01,3.0060E+00,0.0000E+00)
GSET(P,P47,6.7500E-01,5.3410E+00,0.0000E+00)
GSET(P,P48,3.0460E+00,5.3410E+00,0.0000E+00)
GSET(P,P51,3.0460E+00,6.5850E-01,0.0000E+00)
GSET(P,P34,5.7900E+00,3.0070E+00,0.0000E+00)
GSET(P,P36,5.7900E+00,2.9930E+00,0.0000E+00)
GSET(P,P44,3.3260E+00,5.3410E+00,0.0000E+00)
GSET(P,P49,3.3260E+00,6.5850E-01,0.0000E+00)
   * Set curved lines
GSET(V,V16,P17,P7)
GSET(V,V17,P18,P7)
GSET(V,V7,P38,P1,P37)
GSET(V,V9,P37,P12,P11,P10,P9)
GSET(V,V12,P38,P2,P3,P4,P5)
GSET(V,V8,P9,P92,P93,P8,P16)
GSET(V,V10,P5,P91,P90,P6,P15)
```

```
GSET(V,V11,P16,P18)
GSET(V,V13,P15,P17)
   * Set lines/arcs
GSET(L,C91,P17,P7,1,1.2,CRV,V16)
GSET(L,C92,P18,P7,1,1.2,CRV,V17)
GSET(L,C85,P38,P37,2,1.0,CRV,V7)
GSET(L,C86,P37,P9,5,1,CRV,V9)
GSET(L,C88,P38,P5,5,1,CRV,V12)
GSET(L,L21,P45,P39,30,1.5)
GSET(L,L29,P47,P46,30,-1.5)
GSET(L,L30,P46,P45,2,1.0)
GSET(L,L38,P39,P51,25,1.0)
GSET(L,L40,P17,P34,17,1.6)
GSET(L,L42,P45,P37,20,-1.6)
GSET(L,L44,P38,P46,20,1.6)
GSET(L,L45,P51,P9,30,-1.5)
GSET(L,L49,P48,P5,30,-1.5)
GSET(L,L28,P43,P34,30,-1.5)
GSET(L,L31,P34,P36,2,1.0)
GSET(L,L32,P36,P40,30,1.5)
GSET(L,L33,P51,P49,10,1.0)
GSET(L,L34,P16,P49,30,1.5)
GSET(L,L35,P48,P44,10,1.0)
GSET(L,L36,P15,P44,30,1.5)
GSET(L,L37,P49,P40,20,1.0)
GSET(L,L39,P44,P43,20,1.0)
GSET(L,L41,P18,P36,17,1.6)
GSET(L,L27,P47,P48,25,1.0)
GSET(L,C29,P9,P16,10,1.0,CRV,V8)
GSET(L,C30,P5,P15,10,1.0,CRV,V10)
GSET(L,C31,P16,P18,3,1.2,CRV,V11)
GSET(L,C32,P15,P17,3,1.2,CRV,V13)
   * Set frames
GSET(F,F3,P45,-,P37,-,P38,-,P46,-)
GSET(F,F16,P39,-,P51,-,P9,P37,P45,-)
GSET(F,F4,P51,-,P49,-,P16,-,P9,-)
GSET(F,F5,P5,-,P15,-,P44,-,P48,-)
GSET(F,F1,P47,-,P46,P38,P5,-,P48,-)
GSET(F,F2,P49,-,P40,-,P36,P18,P16,-)
GSET(F,F6,P43,-,P44,-,P15,P17,P34,-)
GSET(F,F7,P36,-,P34,-,P17,P7,P18,-)
GSET(F,F8,P38,-,P37,P9.P16,P18,P7,P17,P15.P5)
   * Match a grid mesh
GSET(M,F3,+I+J,1,31,1,TRANS)
GSET(M,F16,+I+J,1,1,1,TRANS)
GSET(M,F4,+I+J,26,1,1,TRANS)
GSET(M,F5,+I+J,26,33,1,TRANS)
GSET(M,F1,-J+I,1,63,1,TRANS)
GSET(M,F2,+I+J,36,1,1,TRANS)
GSET(M,F6,-I-J,56,63,1,TRANS)
GSET(M,F7,+J-I,56,31,1,TRANS)
GSET(M,F8,-J+I,21,33,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,55,1,62,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
```

```
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1   ,U1   ,V1   ,KE   ,EP   )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1   ,Y,Y,Y,N,N,N)
IVARBK  =       -1 ;ISOLBK =        1
************************************************************
 Group 8. Terms & Devices
TERMS (KE   ,N,Y,Y,Y,Y,N)
TERMS (EP   ,N,Y,Y,Y,Y,N)
NEWRH1  =     T
NEWENT  =     T
ISOLX   =         0 ;ISOLY  =         0 ;ISOLZ  =         0
************************************************************
 Group 9. Properties
RHO1     = GRND3
RHO1A    = 3.170E-04 ;RHO1B  = 7.128E-01 ;RHO1C  = 0.000E+00
PRESS0   = 1.000E+05
EL1      = GRND4
ENUL     = 1.589E-05 ;ENUT   = GRND3
DRH1DP   = GRND3
PRT    (EP   ) =  1.314E+00
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
RESTRT(ALL)

CONPOR(FOLIO    ,   0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =     F

INIADD  =     F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

INLET (BFCE1    ,WEST   ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1    ,P1   , GRND1     )
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 2.100E+00)
VALUE (BFCE1    ,EP   , 2.497E+03)
VALUE (BFCE1    ,VCRT, 1.781E+01)
VALUE (BFCE1    ,UCRT, 1.025E+02)

INLET (BFCE2    ,SOUTH ,#1,#5,#1,#1,#1,#1,1,1)
VALUE (BFCE2    ,P1   , GRND1     )
VALUE (BFCE2    ,U1   , GRND1     )
VALUE (BFCE2    ,V1   , GRND1     )
VALUE (BFCE2    ,KE   , 6.343E-02)
```

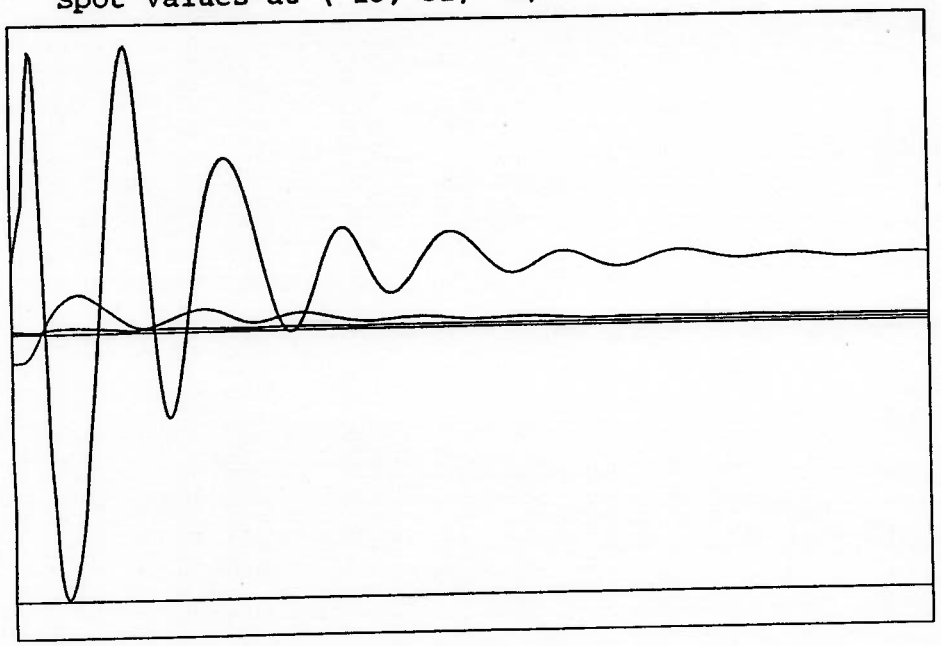
```
VALUE (BFCE2    ,EP   , 2.279E+00)
VALUE (BFCE2    ,VCRT, 1.781E+01)
VALUE (BFCE2    ,UCRT, 1.025E+02)

PATCH (S1       ,NORTH ,#1,#5,#4,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

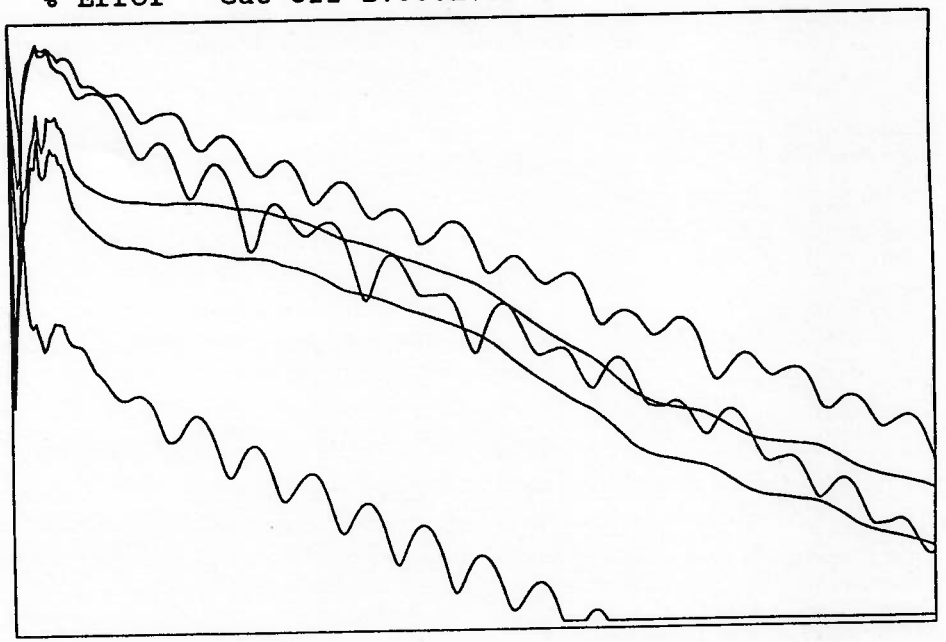
PATCH (S2       ,EAST  ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S2       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S2       ,KE   , 0.000E+00, SAME     )
COVAL (S2       ,EP   , 0.000E+00, SAME     )

BFCA    = 1.161E+00
**********************************************************
 Group 14. Downstream Pressure For PARAB
**********************************************************
 Group 15. Terminate Sweeps
LSWEEP  =    2000
LITHYD  =       3
SELREF  =    T
RESFAC  = 1.000E-02
**********************************************************
 Group 16. Terminate Iterations
**********************************************************
 Group 17. Relaxation
RELAX(P1  ,LINRLX, 1.000E-01)
RELAX(U1  ,FALSDT, 1.000E-05)
RELAX(V1  ,FALSDT, 1.000E-05)
RELAX(KE  ,FALSDT, 1.000E-05)
RELAX(EP  ,FALSDT, 1.000E-05)
KELIN   =       0
**********************************************************
 Group 18. Limits
**********************************************************
 Group 19. EARTH Calls To GROUND Station
**********************************************************
 Group 20. Preliminary Printout
ECHO    =    T
**********************************************************
 Group 21. Print-out of Variables
**********************************************************
 Group 22. Monitor Print-Out
IXMON   =      13 ;IYMON  =      31 ;IZMON  =       1
TSTSWP  =   12345
**********************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
**********************************************************
 Group 24. Dumps For Restarts
NOWIPE  =    T
**********************************************************
MENSAV(S,RELX,DEF,1.6129E-02,1,1.0000E-01)
MENSAV(S,PHSPROP,DEF,200,0,1.1610E+00,1.5890E-05)
MENSAV(S,FLPRP,DEF,K-E,ISENTROPIC_GAS_LAW)
STOP
```

Spot Values at ( 13, 31, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| -5.00E+02 | 7.00E+02 | 2.33E+02 | -2.35E-01 |
| 0.00E+00 | 2.00E+02 | 1.01E+02 | 3.05E-05 |
| 1.00E+01 | 3.00E+01 | 2.02E+01 | -1.11E-04 |
| 2.00E+00 | 4.00E+00 | 2.10E+00 | 0.00E+00 |
| 2.00E+03 | 3.00E+03 | 2.50E+03 | 0.00E+00 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+03 | 1.34E-01 | -7.62E-04 |
| U1 | 1.00E+03 | 2.08E+00 | 4.18E-02 |
| V1 | 1.00E+03 | 9.43E+00 | -8.56E-01 |
| KE | 1.00E+03 | 5.35E+00 | -9.33E-02 |
| EP | 1.00E+03 | 2.36E+00 | -3.72E-02 |



| NX | NY | NZ | | | | | |
|---|---|---|---|---|---|---|---|
| 55 | 62 | 1 | ISWEEP | 2000 | Time now | 10:59 |
| | | | IZSTEP | 1 | (h:m) est | 10:59 |

# ANEXO D

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 5 GRAUS PARA A PRIMEIRA CONFIGURAÇÃO (LHR5.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=VGAMOUSE
IRUNN    =        1 ;LIBREF =        0
**************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 5 GRAUS                    )
**************************************************************
 Group 2. Transience
STEADY   =     T
**************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,70,62,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
**************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.7291E+03,3.2356E+02,0.0000E+00)
GSET(P,P15,3.1715E+03,2.1708E+02,0.0000E+00)
GSET(P,P16,3.6130E+03,1.0003E+02,0.0000E+00)
GSET(P,P17,4.0536E+03,-2.6970E+01,0.0000E+00)
GSET(P,P18,4.2735E+03,-9.4510E+01,0.0000E+00)
GSET(P,P19,4.4932E+03,-1.6504E+02,0.0000E+00)
GSET(P,P21,4.2630E+03,-2.1505E+02,0.0000E+00)
GSET(P,P22,4.0346E+03,-2.4335E+02,0.0000E+00)
GSET(P,P23,3.5787E+03,-2.9187E+02,0.0000E+00)
GSET(P,P24,3.1236E+03,-3.3044E+02,0.0000E+00)
GSET(P,P25,2.6694E+03,-3.5844E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
```

```
GSET(P,P46,2.7000E+04,-2.6970E+01,0.0000E+00)
GSET(P,P47,2.7000E+04,-2.4335E+02,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7500E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V4,P3,P4,P5,P6,P7)
GSET(V,V7,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V8,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V11,P3,P2,P1,P37)
GSET(V,V12,P37,P35,P33,P32)
GSET(V,V13,P13,P14,P15,P16,P17)
GSET(V,V14,P26,P25,P24,P23,P22)
GSET(V,V15,P17,P18,P19)
GSET(V,V16,P19,P21,P22)
   * Set lines/arcs
GSET(L,C4,P3,P7,5,1.0,CRV,V4)
GSET(L,C7,P7,P13,10,1.0,CRV,V7)
GSET(L,C8,P32,P26,10,1.0,CRV,V8)
GSET(L,L12,P38,P42,30,-1.5)
GSET(L,L13,P42,P43,2,1.0)
GSET(L,L14,P43,P39,30,1.5)
GSET(L,L15,P39,P44,30,1.0)
GSET(L,L16,P44,P45,10,1.0)
GSET(L,L17,P45,P40,30,1.0)
GSET(L,L18,P40,P46,30,-1.5)
GSET(L,L19,P46,P47,2,1.0)
GSET(L,L20,P47,P41,30,1.5)
GSET(L,L21,P41,P48,30,1.0)
GSET(L,L22,P48,P49,10,1.0)
GSET(L,L23,P49,P38,30,1.0)
GSET(L,L24,P42,P37,25,-1.6)
GSET(L,L25,P43,P3,25,-1.6)
GSET(L,L26,P44,P7,30,-1.5)
GSET(L,L27,P45,P13,30,-1.5)
GSET(L,L28,P46,P17,20,-1.4)
GSET(L,L29,P47,P22,20,-1.4)
GSET(L,L30,P48,P26,30,-1.5)
GSET(L,L31,P49,P32,30,-1.5)
GSET(L,C29,P3,P37,2,1.0,CRV,V11)
GSET(L,C30,P37,P32,5,1.0,CRV,V12)
GSET(L,C31,P13,P17,10,1.2,CRV,V13)
GSET(L,C32,P26,P22,10,1.1,CRV,V14)
GSET(L,C33,P17,P19,1,1.2,CRV,V15)
GSET(L,C34,P19,P22,1,1.2,CRV,V16)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P37,P42,-)
GSET(F,F2,P42,-,P37,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P17,P46,-,P40,-)
GSET(F,F6,P17,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P37,P32.P26,P22,P19,P17,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,31,1,TRANS)
GSET(M,F3,-J+I,1,63,1,TRANS)
GSET(M,F4,-J+I,31,63,1,TRANS)
GSET(M,F5,-J+I,41,63,1,TRANS)
```

```
GSET(M,F6,-J+I,51,33,1,TRANS)
GSET(M,F7,+J+I,41,1,1,TRANS)
GSET(M,F8,+I+J,31,1,1,TRANS)
GSET(M,F9,-J+I,26,33,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,70,1,62,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
IVARBK  =      -1 ;ISOLBK =       1
************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
ISOLX   =       0 ;ISOLY  =       0 ;ISOLZ  =       0
************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
FIINIT(KE  ) =  5.292E-03 ;FIINIT(EP  ) =  2.506E-01
FIINIT(NPOR) =  1.000E+00 ;FIINIT(EPOR) =  1.000E+00
FIINIT(VPOR) =  1.000E+00 ;FIINIT(BLOK) =  1.000E+00
FIINIT(UCRT) =  0.000E+00

CONPOR(LHR5    ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

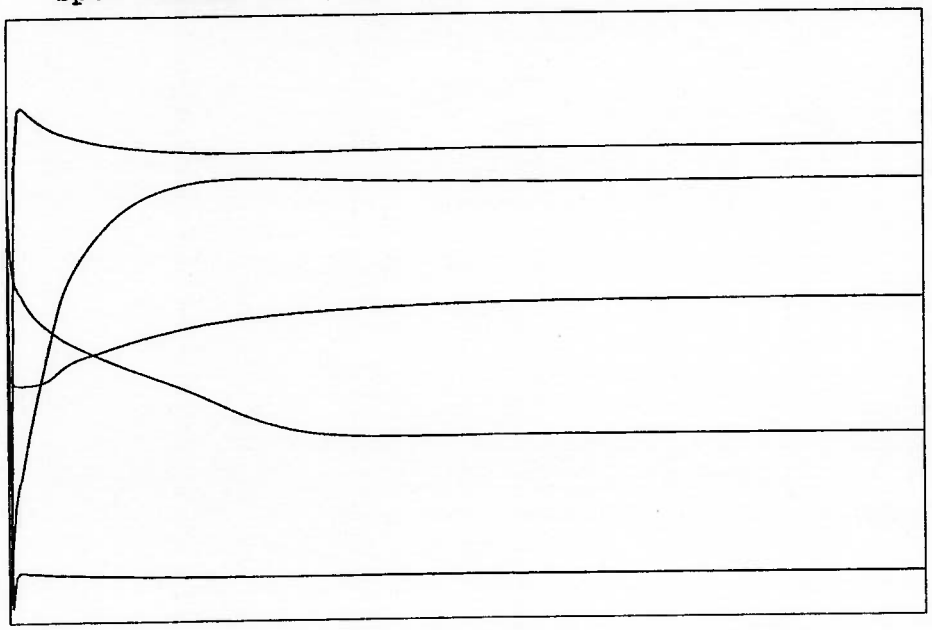
PATCH (KESOURCE,PHASEM,1,70,1,62,1,1,1,1)
COVAL (KESOURCE,KE  , GRND4    , GRND4    )
COVAL (KESOURCE,EP  , GRND4    , GRND4    )
```

```
INLET (BFCE1    ,WEST   ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1    ,P1   , GRND1     )
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

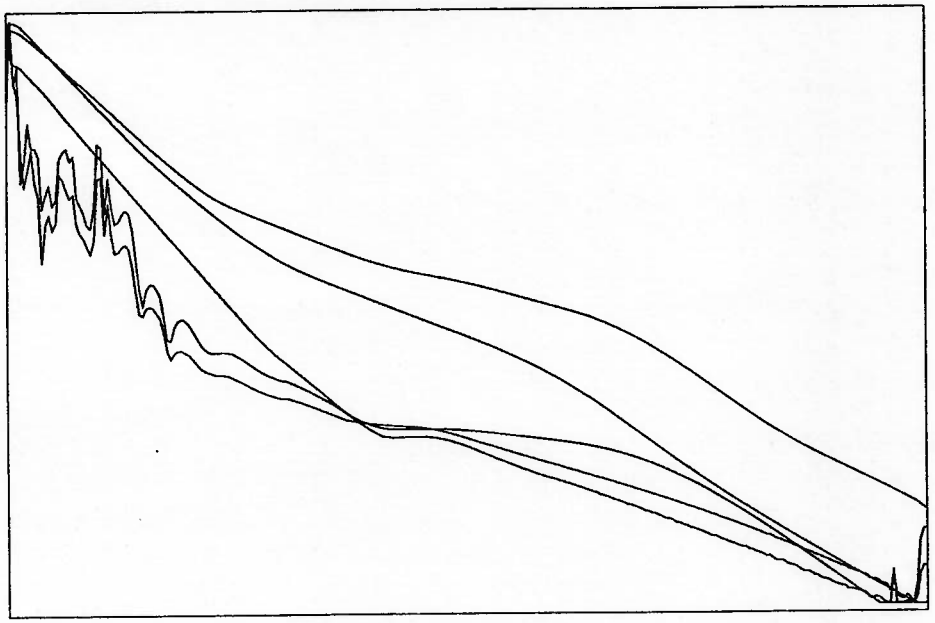
PATCH (S1       ,EAST   ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

BFCA    = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP  =    3000
LITHYD  =       3
SELREF  =    T
RESFAC  = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E-01)
RELAX(U1   ,FALSDT, 1.000E-02)
RELAX(V1   ,FALSDT, 1.000E-02)
RELAX(KE   ,FALSDT, 1.000E-04)
RELAX(EP   ,FALSDT, 1.000E-04)
KELIN   =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK    =    T
************************************************************
 Group 20. Preliminary Printout
ECHO    =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON   =      20 ;IYMON  =      31 ;IZMON  =       1
TSTSWP  =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
NOWIPE  =    T
************************************************************
MENSAV(S,RELX,DEF,1.3333E-02,1,1.0000E-01)
MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
```

Spot Values at ( 20, 31, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| -1.00E+06 | 2.00E+06 | 1.19E+06 | -6.88E+00 |
| 4.00E+03 | 6.00E+03 | 4.60E+03 | 4.88E-04 |
| 0.00E+00 | 2.00E+03 | 1.05E+03 | 1.34E-03 |
| 0.00E+00 | 5.00E-07 | 3.93E-07 | -2.27E-13 |
| 0.00E+00 | 3.00E-06 | 1.86E-07 | -7.11E-14 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+03 | 5.96E-01 | -2.84E-02 |
| U1 | 1.00E+04 | 9.76E-01 | -6.10E-03 |
| V1 | 1.00E+04 | 5.97E+00 | -3.03E-01 |
| KE | 1.00E+05 | 2.25E+00 | -3.76E-02 |
| EP | 1.00E+05 | 5.54E+00 | 2.08E-01 |



NX NY NZ ISWEEP 530 Time now 50:03

# ANEXO E

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 10 GRAUS PARA A PRIMEIRA CONFIGURAÇÃO (LHR10.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=VGAMOUSE
IRUNN    =        1 ;LIBREF =        0
**************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 10 GRAUS                    )
**************************************************************
 Group 2. Transience
STEADY   =    T
**************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,70,62,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
**************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.7568E+03,3.0238E+02,0.0000E+00)
GSET(P,P15,3.1878E+03,1.5778E+02,0.0000E+00)
GSET(P,P16,3.6174E+03,2.7500E+00,0.0000E+00)
GSET(P,P17,4.0453E+03,-1.6243E+02,0.0000E+00)
GSET(P,P18,4.2585E+03,-2.4856E+02,0.0000E+00)
GSET(P,P19,4.4712E+03,-3.3794E+02,0.0000E+00)
GSET(P,P21,4.2375E+03,-3.6772E+02,0.0000E+00)
GSET(P,P22,4.0076E+03,-3.7603E+02,0.0000E+00)
GSET(P,P23,3.5491E+03,-3.8467E+02,0.0000E+00)
GSET(P,P24,3.0924E+03,-3.8346E+02,0.0000E+00)
GSET(P,P25,2.6375E+03,-3.7182E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

```
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-2.6970E+01,0.0000E+00)
GSET(P,P47,2.7000E+04,-2.4335E+02,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7520E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V2,P3,P4,P5,P6,P7)
GSET(V,V3,P36,P35,P34,P33,P32)
GSET(V,V9,P13,P14,P15,P16,P17)
GSET(V,V13,P26,P25,P24,P23,P22)
GSET(V,V14,P22,P21,P19)
GSET(V,V15,P17,P18,P19)
GSET(V,V10,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V12,P7,P8,P9,P10,P11,P12,P13)
   * Set lines/arcs
GSET(L,C1,P3,P36,2,1.0,CRV,V1)
GSET(L,C2,P3,P7,5,1.0,CRV,V2)
GSET(L,C3,P36,P32,5,1.0,CRV,V3)
GSET(L,L13,P38,P49,30,1.0)
GSET(L,L14,P49,P48,10,1.0)
GSET(L,L15,P48,P41,30,1.0)
GSET(L,L16,P41,P47,30,-1.5)
GSET(L,L17,P47,P46,2,1.0)
GSET(L,L18,P46,P40,30,1.5)
GSET(L,L19,P40,P45,30,1.0)
GSET(L,L20,P45,P44,10,1.0)
GSET(L,L21,P44,P39,30,1.0)
GSET(L,L22,P39,P43,30,-1.5)
GSET(L,L23,P43,P42,2,1.0)
GSET(L,L24,P42,P38,30,1.5)
GSET(L,L25,P43,P3,25,-1.6)
GSET(L,L26,P42,P36,25,-1.6)
GSET(L,L27,P44,P7,30,-1.5)
GSET(L,L28,P49,P32,30,-1.5)
GSET(L,L29,P48,P26,30,-1.5)
GSET(L,L30,P47,P22,20,-1.4)
GSET(L,L31,P46,P17,20,-1.4)
GSET(L,L32,P45,P13,30,-1.5)
GSET(L,C27,P13,P17,10,1.0,CRV,V9)
GSET(L,C29,P26,P22,10,1.0,CRV,V13)
GSET(L,C30,P22,P19,1,1.0,CRV,V14)
GSET(L,C31,P17,P19,1,1.0,CRV,V15)
GSET(L,C32,P32,P26,10,1.0,CRV,V10)
GSET(L,C33,P7,P13,10,1.0,CRV,V12)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P17,P46,-,P40,-)
GSET(F,F6,P17,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P17,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,31,1,TRANS)
GSET(M,F3,-J+I,1,63,1,TRANS)
```

```
GSET(M,F4,-J+I,31,63,1,TRANS)
GSET(M,F5,-J+I,41,63,1,TRANS)
GSET(M,F6,-J+I,51,33,1,TRANS)
GSET(M,F7,+J+I,41,1,1,TRANS)
GSET(M,F8,+I+J,31,1,1,TRANS)
GSET(M,F9,-J+I,26,33,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,70,1,62,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
*************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
IVARBK  =      -1 ;ISOLBK =       1
*************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
ISOLX   =       0 ;ISOLY  =       0 ;ISOLZ  =       0
*************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
*************************************************************
 Group 10.Inter-Phase Transfer Processes
*************************************************************
 Group 11.Initialise Var/Porosity Fields
FIINIT(KE  ) =  5.292E-03 ;FIINIT(EP  ) =  2.506E-01
FIINIT(NPOR) =  1.000E+00 ;FIINIT(EPOR) =  1.000E+00
FIINIT(VPOR) =  1.000E+00 ;FIINIT(BLOK) =  1.000E+00
FIINIT(UCRT) =  0.000E+00

CONPOR(LHR10   ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
*************************************************************
 Group 12. Convection and diffusion adjustments
*************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,70,1,62,1,1,1,1)
```

```
COVAL (KESOURCE,KE   , GRND4     , GRND4     )
COVAL (KESOURCE,EP   , GRND4     , GRND4     )

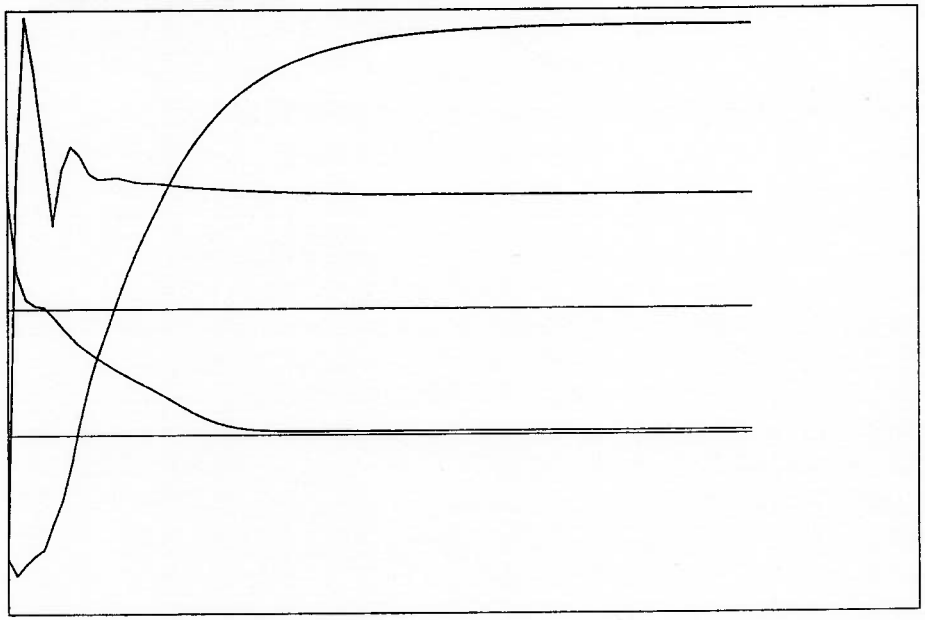
INLET (BFCE1    ,WEST   ,#1,#1,#1,#4,#1,#1,#1,#1)
VALUE (BFCE1    ,P1   , GRND1     )
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

PATCH (S1       ,EAST   ,#5,#5,#1,#4,#1,#1,#1,#1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

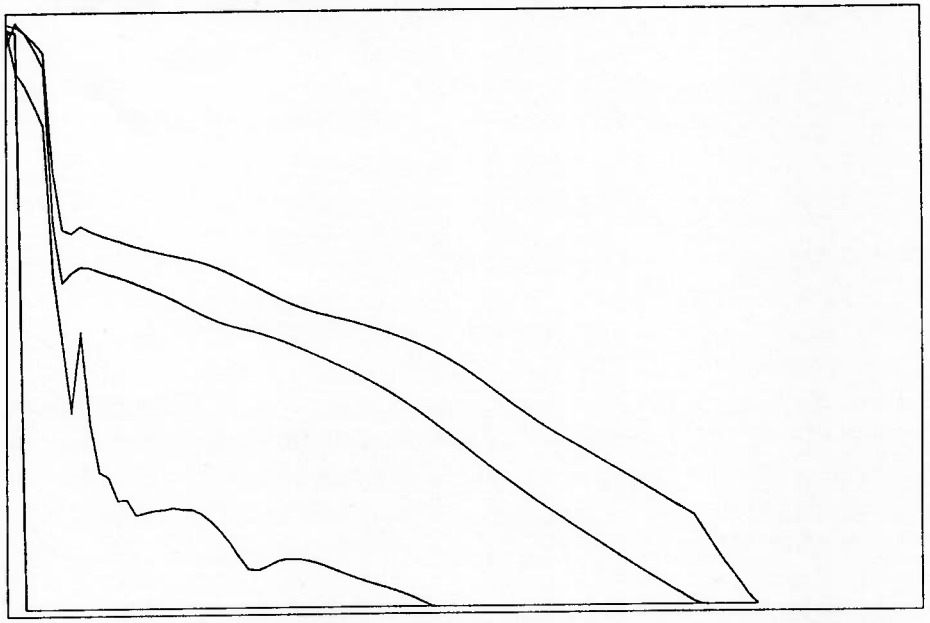
BFCA    = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP  =    3000
LITHYD  =       3
SELREF  =    T
RESFAC  = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E-01)
RELAX(U1   ,FALSDT, 1.000E-02)
RELAX(V1   ,FALSDT, 1.000E-02)
RELAX(KE   ,FALSDT, 1.000E-04)
RELAX(EP   ,FALSDT, 1.000E-04)
KELIN   =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK    =    T
************************************************************
 Group 20. Preliminary Printout
ECHO    =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON   =      20 ;IYMON   =      31 ;IZMON   =       1
TSTSWP  =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
NOWIPE  =    T
************************************************************
MENSAV(S,RELX,DEF,1.4286E-02,1,1.0000E-01)
```

```
 MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
 MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 20, 31, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| -3.00E+06 | 3.00E+06 | 1.19E+06 | -5.50E+00 |
| 4.00E+03 | 6.00E+03 | 4.60E+03 | 0.00E+00 |
| 0.00E+00 | 6.00E+02 | 5.92E+02 | 1.22E-03 |
| 5.00E-03 | 6.00E-03 | 5.29E-03 | 0.00E+00 |
| 2.00E-01 | 3.00E-01 | 2.51E-01 | 0.00E+00 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+03 | 2.50E-02 | 1.51E-02 |
| U1 | 1.00E+04 | 1.00E+00 | 9.65E-03 |
| V1 | 1.00E+05 | 9.88E-01 | -2.33E-01 |
| KE | 1.00E+05 | 0.00E+00 | 0.00E+00 |
| EP | 1.00E+05 | 0.00E+00 | 0.00E+00 |



| NX | NY | NZ | | | | | |
|---|---|---|---|---|---|---|---|
| 70 | 62 | 1 | ISWEEP | 627 | Time now | 0:35 | |
| | | | IZSTEP | OFF | (h:m) est | 2:48 | |

# ANEXO F

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 15 GRAUS PARA A PRIMEIRA CONFIGURAÇÃO (LHR15.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=VGAMOUSE
IRUNN    =        1 ;LIBREF =        0
**************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 15 GRAUS                    )
**************************************************************
 Group 2. Transience
STEADY   =     T
**************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,70,62,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
**************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.7818E+03,2.7887E+02,0.0000E+00)
GSET(P,P15,3.1990E+03,9.7210E+01,0.0000E+00)
GSET(P,P16,3.6134E+03,-9.4680E+01,0.0000E+00)
GSET(P,P17,4.0253E+03,-2.9624E+02,0.0000E+00)
GSET(P,P18,4.2301E+03,-4.0093E+02,0.0000E+00)
GSET(P,P19,4.4342E+03,-5.0852E+02,0.0000E+00)
GSET(P,P21,4.1988E+03,-5.1781E+02,0.0000E+00)
GSET(P,P22,3.9690E+03,-5.0604E+02,0.0000E+00)
GSET(P,P23,3.5116E+03,-4.7468E+02,0.0000E+00)
GSET(P,P24,3.0567E+03,-4.3365E+02,0.0000E+00)
GSET(P,P25,2.6046E+03,-3.8239E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

```
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-6.0000E+03,0.0000E+00)
GSET(P,P47,2.7000E+04,-6.5000E+03,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7520E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V3,P3,P4,P5,P6,P7)
GSET(V,V4,P36,P35,P34,P33,P32)
GSET(V,V5,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V6,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V10,P26,P25,P24,P23,P22)
GSET(V,V12,P19,P21,P22)
GSET(V,V13,P13,P14,P15,P16,P17,P18)
GSET(V,V14,P19,P18)
   * Set lines/arcs
GSET(L,C1,P3,P36,2,1.0,CRV,V1)
GSET(L,C3,P3,P7,5,1.0,CRV,V3)
GSET(L,C4,P36,P32,5,1.0,CRV,V4)
GSET(L,C5,P7,P13,10,1.0,CRV,V5)
GSET(L,C6,P32,P26,10,1.0,CRV,V6)
GSET(L,C9,P26,P22,10,1.0,CRV,V10)
GSET(L,C11,P19,P22,1,1.0,CRV,V12)
GSET(L,L12,P38,P49,30,-1.6)
GSET(L,L13,P49,P48,10,1.0)
GSET(L,L14,P48,P41,30,1.4)
GSET(L,L15,P41,P47,30,-1.5)
GSET(L,L16,P47,P46,2,1.0)
GSET(L,L17,P46,P40,30,1.5)
GSET(L,L18,P40,P45,30,-1.4)
GSET(L,L19,P45,P44,10,1.0)
GSET(L,L20,P44,P39,30,1.6)
GSET(L,L21,P39,P43,30,-1.5)
GSET(L,L22,P43,P42,2,1.0)
GSET(L,L23,P42,P38,30,1.5)
GSET(L,L24,P42,P36,25,-1.6)
GSET(L,L25,P43,P3,25,-1.6)
GSET(L,L26,P44,P7,30,-1.5)
GSET(L,L27,P45,P13,30,-1.5)
GSET(L,L28,P46,P18,20,-1.5)
GSET(L,L29,P47,P22,20,-1.5)
GSET(L,L30,P48,P26,30,-1.5)
GSET(L,L31,P49,P32,30,-1.5)
GSET(L,C30,P13,P18,10,1.0,CRV,V13)
GSET(L,C31,P19,P18,1,1.0,CRV,V14)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P18,P46,-,P40,-)
GSET(F,F6,P18,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P18,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,31,1,TRANS)
GSET(M,F3,-J+I,1,63,1,TRANS)
```

```
GSET(M,F4,-J+I,31,63,1,TRANS)
GSET(M,F5,-J+I,41,63,1,TRANS)
GSET(M,F6,-J+I,51,33,1,TRANS)
GSET(M,F7,+J+I,41,1,1,TRANS)
GSET(M,F8,+I+J,31,1,1,TRANS)
GSET(M,F9,-J+I,26,33,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,70,1,62,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
*************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
IVARBK  =      -1 ;ISOLBK =       1
*************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
ISOLX   =       0 ;ISOLY  =       0 ;ISOLZ  =       0
*************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
*************************************************************
 Group 10.Inter-Phase Transfer Processes
*************************************************************
 Group 11.Initialise Var/Porosity Fields
FIINIT(KE  ) =  5.292E-03 ;FIINIT(EP  ) =  2.506E-01
FIINIT(NPOR) =  1.000E+00 ;FIINIT(EPOR) =  1.000E+00
FIINIT(VPOR) =  1.000E+00 ;FIINIT(BLOK) =  1.000E+00
FIINIT(UCRT) =  0.000E+00

CONPOR(LHR15   ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
*************************************************************
 Group 12. Convection and diffusion adjustments
*************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,70,1,62,1,1,1,1)
```

```
COVAL (KESOURCE,KE   , GRND4     , GRND4     )
COVAL (KESOURCE,EP   , GRND4     , GRND4     )

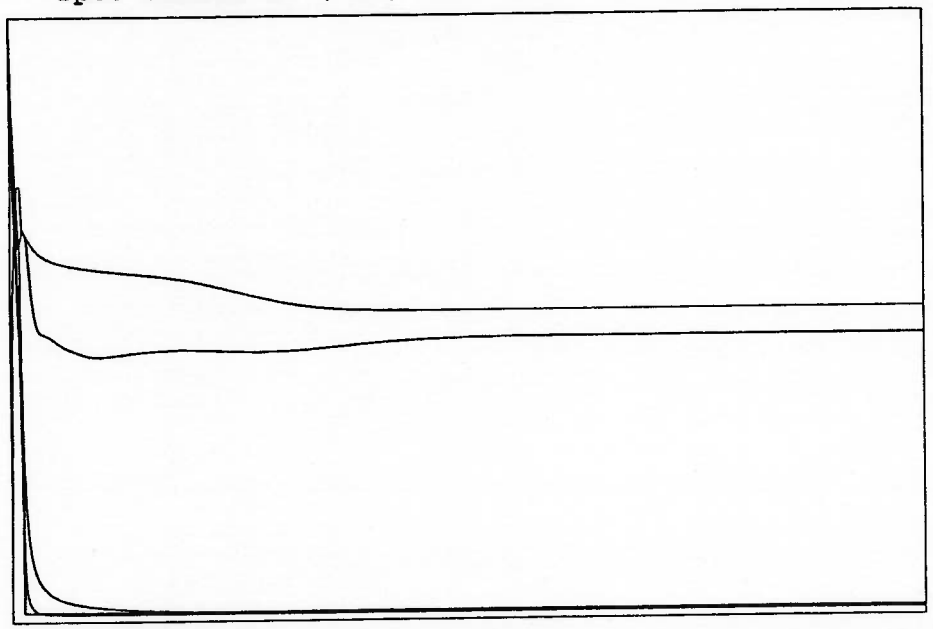
INLET (BFCE1    ,WEST   ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1    ,P1   , GRND1     )
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

PATCH (S1       ,EAST   ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

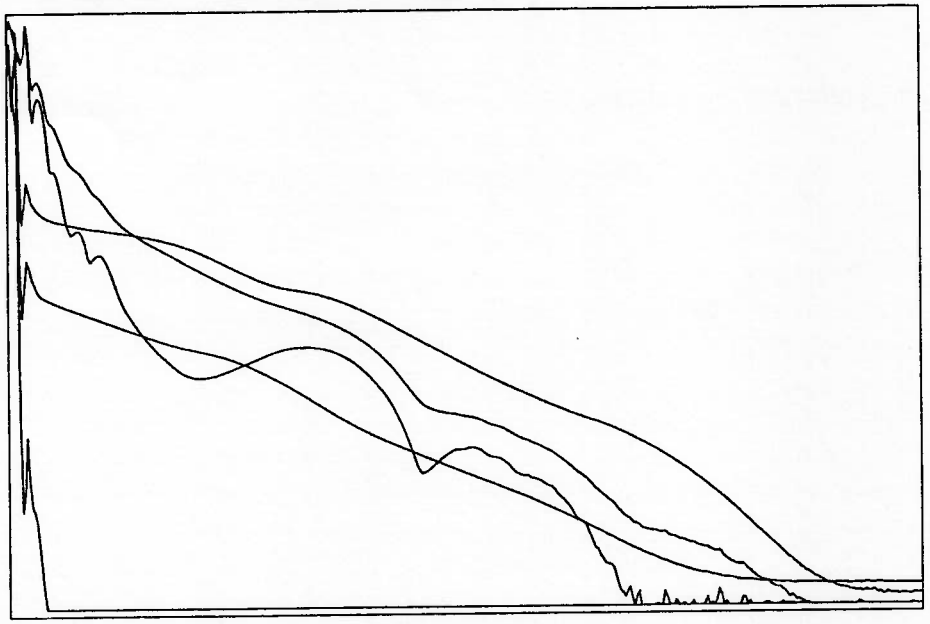
BFCA     = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP   =    3000
LITHYD   =       3
SELREF   =    T
RESFAC   = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E-01)
RELAX(U1   ,FALSDT, 1.000E-02)
RELAX(V1   ,FALSDT, 1.000E-02)
RELAX(KE   ,FALSDT, 1.000E-04)
RELAX(EP   ,FALSDT, 1.000E-04)
KELIN    =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK     =    T
************************************************************
 Group 20. Preliminary Printout
ECHO     =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON    =      21 ;IYMON   =      31 ;IZMON   =       1
TSTSWP   =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
NOWIPE   =    T
************************************************************
MENSAV(S,RELX,DEF,1.4286E-02,1,1.0000E-01)
```

```
 MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
 MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 21, 31, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| 0.00E+00 | 4.00E+08 | 1.65E+06 | 8.61E+01 |
| 4.00E+03 | 5.00E+03 | 4.51E+03 | 0.00E+00 |
| -1.00E+02 | 2.00E+02 | 4.06E+01 | -2.21E-04 |
| 0.00E+00 | 5.00E-03 | 3.80E-07 | 0.00E+00 |
| 0.00E+00 | 2.00E-01 | 1.77E-07 | 0.00E+00 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+03 | 4.34E-03 | -1.06E-04 |
| U1 | 1.00E+05 | 1.51E+00 | 5.81E-03 |
| V1 | 1.00E+05 | 1.26E+00 | -1.09E-02 |
| KE | 1.00E+05 | 9.77E-01 | -7.72E-03 |
| EP | 1.00E+05 | 9.65E-01 | -1.26E-02 |

| NX | NY | NZ | | | | | |
|---|---|---|---|---|---|---|---|
| 70 | 62 | 1 | ISWEEP | 5000 | Time now | 7:49 | |
| | | | IZSTEP | OFF | (h:m) est | 7:49 | |

# ANEXO G

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 20 GRAUS PARA A PRIMEIRA CONFIGURAÇÃO (LHR20.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=VGAMOUSE
IRUNN    =        1 ;LIBREF =        0
**************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 20 GRAUS                    )
**************************************************************
 Group 2. Transience
STEADY   =     T
**************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,70,62,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
**************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.8050E+03,2.5326E+02,0.0000E+00)
GSET(P,P15,3.2048E+03,3.5930E+01,0.0000E+00)
GSET(P,P16,3.6009E+03,-1.9136E+02,0.0000E+00)
GSET(P,P17,3.9937E+03,-4.2805E+02,0.0000E+00)
GSET(P,P18,4.1897E+03,-5.5020E+02,0.0000E+00)
GSET(P,P19,4.3826E+03,-6.7517E+02,0.0000E+00)
GSET(P,P21,4.1472E+03,-6.6390E+02,0.0000E+00)
GSET(P,P22,3.9194E+03,-6.3215E+02,0.0000E+00)
GSET(P,P23,3.4664E+03,-5.6104E+02,0.0000E+00)
GSET(P,P24,3.0168E+03,-4.8053E+02,0.0000E+00)
GSET(P,P25,2.5709E+03,-3.9006E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

```
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-9.0000E+03,0.0000E+00)
GSET(P,P47,2.7000E+04,-9.5000E+03,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7520E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V2,P3,P4,P5,P6,P7)
GSET(V,V3,P36,P35,P34,P33,P32)
GSET(V,V5,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V6,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V7,P13,P14,P15,P16,P17,P18)
GSET(V,V8,P18,P19)
GSET(V,V9,P19,P21,P22)
GSET(V,V10,P26,P25,P24,P23,P22)
   * Set lines/arcs
GSET(L,C1,P3,P36,2,1.0,CRV,V1)
GSET(L,C2,P3,P7,5,1.0,CRV,V2)
GSET(L,C3,P36,P32,5,1.0,CRV,V3)
GSET(L,C5,P7,P13,10,1.0,CRV,V5)
GSET(L,C6,P32,P26,10,1.0,CRV,V6)
GSET(L,C7,P13,P18,10,1.0,CRV,V7)
GSET(L,C8,P18,P19,1,1.0,CRV,V8)
GSET(L,C9,P19,P22,1,1.0,CRV,V9)
GSET(L,C10,P26,P22,10,1.0,CRV,V10)
GSET(L,L10,P38,P49,30,-1.6)
GSET(L,L11,P49,P48,10,1.0)
GSET(L,L12,P48,P41,30,1.4)
GSET(L,L13,P41,P47,30,-1.5)
GSET(L,L14,P47,P46,2,1.0)
GSET(L,L15,P46,P40,30,1.5)
GSET(L,L16,P40,P45,30,-1.4)
GSET(L,L17,P45,P44,10,1.0)
GSET(L,L18,P44,P39,30,1.6)
GSET(L,L19,P39,P43,30,-1.5)
GSET(L,L20,P43,P42,2,1.0)
GSET(L,L21,P42,P38,30,1.5)
GSET(L,L22,P42,P36,25,-1.6)
GSET(L,L23,P43,P3,25,-1.6)
GSET(L,L24,P44,P7,30,-1.5)
GSET(L,L25,P45,P13,30,-1.5)
GSET(L,L26,P46,P18,20,-1.5)
GSET(L,L27,P47,P22,20,-1.5)
GSET(L,L28,P48,P26,30,-1.5)
GSET(L,L29,P49,P32,30,-1.5)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P18,P46,-,P40,-)
GSET(F,F6,P18,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P18,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,31,1,TRANS)
GSET(M,F3,-J+I,1,63,1,TRANS)
```

```
GSET(M,F4,-J+I,31,63,1,TRANS)
GSET(M,F5,-J+I,41,63,1,TRANS)
GSET(M,F6,-J+I,51,33,1,TRANS)
GSET(M,F7,+J+I,41,1,1,TRANS)
GSET(M,F8,+I+J,31,1,1,TRANS)
GSET(M,F9,-J+I,26,33,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,70,1,62,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
*************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
IVARBK  =      -1 ;ISOLBK =       1
*************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
ISOLX   =       0 ;ISOLY  =       0 ;ISOLZ  =       0
*************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
*************************************************************
 Group 10.Inter-Phase Transfer Processes
*************************************************************
 Group 11.Initialise Var/Porosity Fields
FIINIT(KE  ) =  5.292E-03 ;FIINIT(EP  ) =  2.506E-01
FIINIT(NPOR) =  1.000E+00 ;FIINIT(EPOR) =  1.000E+00
FIINIT(VPOR) =  1.000E+00 ;FIINIT(BLOK) =  1.000E+00
FIINIT(UCRT) =  0.000E+00

CONPOR(LHR20   ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
*************************************************************
 Group 12. Convection and diffusion adjustments
*************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,70,1,62,1,1,1,1)
```

```
COVAL (KESOURCE,KE   , GRND4     , GRND4     )
COVAL (KESOURCE,EP   , GRND4     , GRND4     )

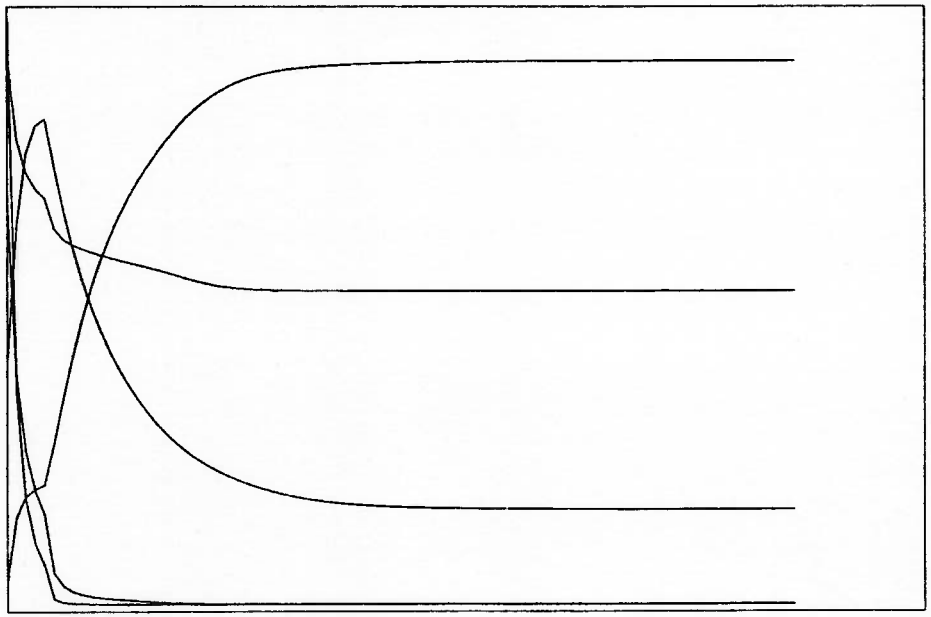
INLET (BFCE1    ,WEST  ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1    ,P1   , GRND1     )
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

PATCH (S1       ,EAST  ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

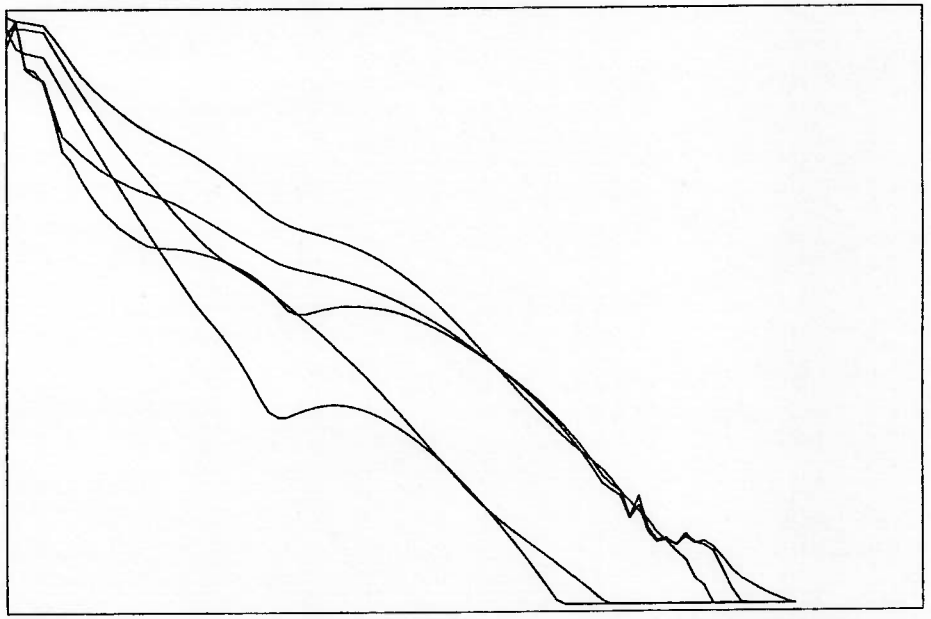
BFCA    = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP  =    3000
LITHYD  =       3
SELREF  =    T
RESFAC  = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1  ,LINRLX, 1.000E-01)
RELAX(U1  ,FALSDT, 1.000E-02)
RELAX(V1  ,FALSDT, 1.000E-02)
RELAX(KE  ,FALSDT, 1.000E-04)
RELAX(EP  ,FALSDT, 1.000E-04)
KELIN   =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK    =    T
************************************************************
 Group 20. Preliminary Printout
ECHO    =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON   =      21 ;IYMON  =      31 ;IZMON  =       1
TSTSWP  =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
NOWIPE  =    T
************************************************************
MENSAV(S,RELX,DEF,1.4286E-02,1,1.0000E-01)
```

```
 MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
 MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 21, 31, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| 1.00E+06 | 4.00E+06 | 1.48E+06 | 4.00E+00 |
| 4.00E+03 | 5.00E+03 | 4.53E+03 | 0.00E+00 |
| -1.00E+02 | 9.00E+02 | 8.21E+02 | 6.10E-05 |
| 0.00E+00 | 3.00E-03 | 3.99E-07 | 0.00E+00 |
| 0.00E+00 | 5.00E-02 | 1.87E-07 | 0.00E+00 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+03 | 1.53E-02 | -5.19E-04 |
| U1 | 1.00E+04 | 9.61E-01 | 1.84E-03 |
| V1 | 1.00E+04 | 9.85E-01 | 2.08E-02 |
| KE | 1.00E+05 | 9.29E-01 | -1.26E-01 |
| EP | 1.00E+05 | 9.66E-01 | 2.80E-02 |



| NX | NY | NZ | | ISWEEP | 653 | Time now | 1:00 |
|---|---|---|---|---|---|---|---|
| 70 | 62 | 1 | | IZSTEP | OFF | (h:m) est | 4:37 |

# ANEXO H

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 25 GRAUS PARA A PRIMEIRA CONFIGURAÇÃO (LHR25.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=VGAMOUSE
IRUNN    =        1 ;LIBREF =        0
*************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 25 GRAUS                    )
*************************************************************
 Group 2. Transience
STEADY   =     T
*************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,70,62,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
*************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9711E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.8259E+03,2.2571E+02,0.0000E+00)
GSET(P,P15,3.2052E+03,-2.5640E+01,0.0000E+00)
GSET(P,P16,3.5806E+03,-2.8659E+02,0.0000E+00)
GSET(P,P17,3.9507E+03,-5.5661E+02,0.0000E+00)
GSET(P,P18,4.1343E+03,-6.9529E+02,0.0000E+00)
GSET(P,P19,4.3166E+03,-8.3668E+02,0.0000E+00)
GSET(P,P21,4.0831E+03,-8.0495E+02,0.0000E+00)
GSET(P,P22,3.8589E+03,-7.5345E+02,0.0000E+00)
GSET(P,P23,3.4138E+03,-6.4313E+02,0.0000E+00)
GSET(P,P24,2.9230E+03,-5.2374E+02,0.0000E+00)
GSET(P,P25,2.5366E+03,-3.9475E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

```
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-1.2000E+04,0.0000E+00)
GSET(P,P47,2.7000E+04,-1.2500E+04,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7500E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V2,P3,P4,P5,P6,P7)
GSET(V,V3,P36,P35,P34,P33,P32)
GSET(V,V4,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V5,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V9,P13,P14,P15,P16,P17,P18)
GSET(V,V10,P26,P25,P24,P23,P22)
GSET(V,V11,P18,P19)
GSET(V,V12,P19,P21,P22)
   * Set lines/arcs
GSET(L,C1,P3,P36,2,1.0,CRV,V1)
GSET(L,C2,P3,P7,5,1.0,CRV,V2)
GSET(L,C3,P36,P32,5,1.0,CRV,V3)
GSET(L,C4,P7,P13,10,1.0,CRV,V4)
GSET(L,C5,P32,P26,10,1.0,CRV,V5)
GSET(L,C9,P13,P18,10,1.0,CRV,V9)
GSET(L,C10,P26,P22,10,1.0,CRV,V10)
GSET(L,C11,P18,P19,1,1.0,CRV,V11)
GSET(L,C12,P19,P22,1,1.0,CRV,V12)
GSET(L,L10,P38,P49,30,-1.6)
GSET(L,L11,P49,P48,10,1.0)
GSET(L,L12,P48,P41,30,1.4)
GSET(L,L13,P41,P47,30,-1.5)
GSET(L,L14,P47,P46,2,1.0)
GSET(L,L15,P46,P40,30,1.5)
GSET(L,L16,P40,P45,30,-1.4)
GSET(L,L17,P45,P44,10,1.0)
GSET(L,L18,P44,P39,30,1.6)
GSET(L,L19,P39,P43,30,-1.5)
GSET(L,L20,P43,P42,2,1.0)
GSET(L,L21,P42,P38,30,1.5)
GSET(L,L22,P42,P36,25,-1.6)
GSET(L,L23,P43,P3,25,-1.6)
GSET(L,L24,P44,P7,30,-1.5)
GSET(L,L25,P45,P13,30,-1.5)
GSET(L,L26,P46,P18,20,-1.5)
GSET(L,L27,P47,P22,20,-1.5)
GSET(L,L28,P48,P26,30,-1.5)
GSET(L,L29,P49,P32,30,-1.5)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P18,P46,-,P40,-)
GSET(F,F6,P18,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P18,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,31,1,TRANS)
GSET(M,F3,-J+I,1,63,1,TRANS)
```

```
GSET(M,F4,-J+I,31,63,1,TRANS)
GSET(M,F5,-J+I,41,63,1,TRANS)
GSET(M,F6,-J+I,51,33,1,TRANS)
GSET(M,F7,+J+I,41,1,1,TRANS)
GSET(M,F8,+I+J,31,1,1,TRANS)
GSET(M,F9,-J+I,26,33,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,70,1,62,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
IVARBK  =      -1 ;ISOLBK =       1
************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
ISOLX   =       0 ;ISOLY  =       0 ;ISOLZ  =       0
************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
FIINIT(KE  ) =  5.292E-03 ;FIINIT(EP  ) =  2.506E-01
FIINIT(NPOR) =  1.000E+00 ;FIINIT(EPOR) =  1.000E+00
FIINIT(VPOR) =  1.000E+00 ;FIINIT(BLOK) =  1.000E+00
FIINIT(UCRT) =  0.000E+00

CONPOR(LHR25   ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,70,1,62,1,1,1,1)
```

```
COVAL (KESOURCE,KE   , GRND4     , GRND4     )
COVAL (KESOURCE,EP   , GRND4     , GRND4     )

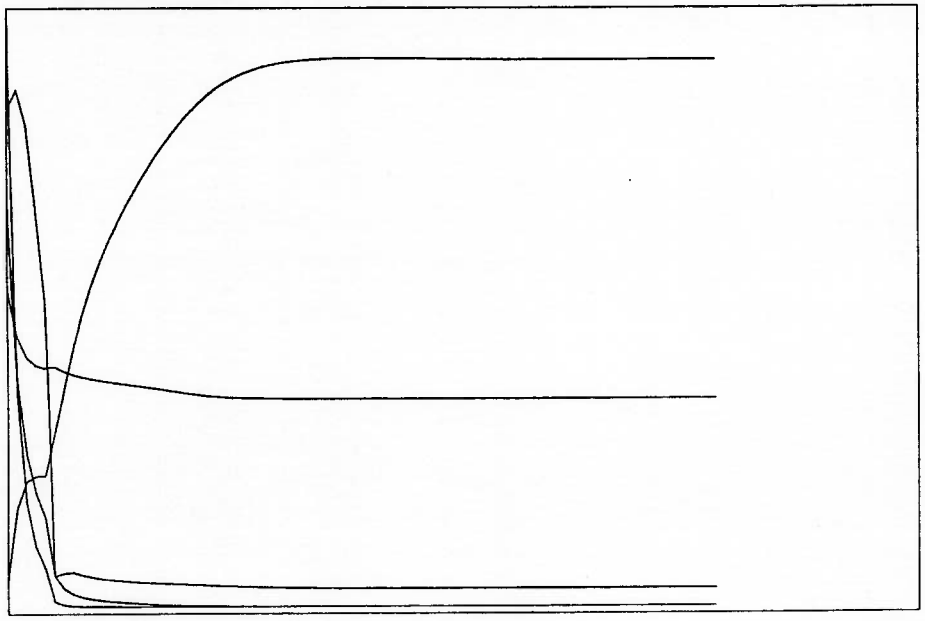
INLET (BFCE1    ,WEST   ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1    ,P1   , GRND1     )
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

PATCH (S1       ,EAST   ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

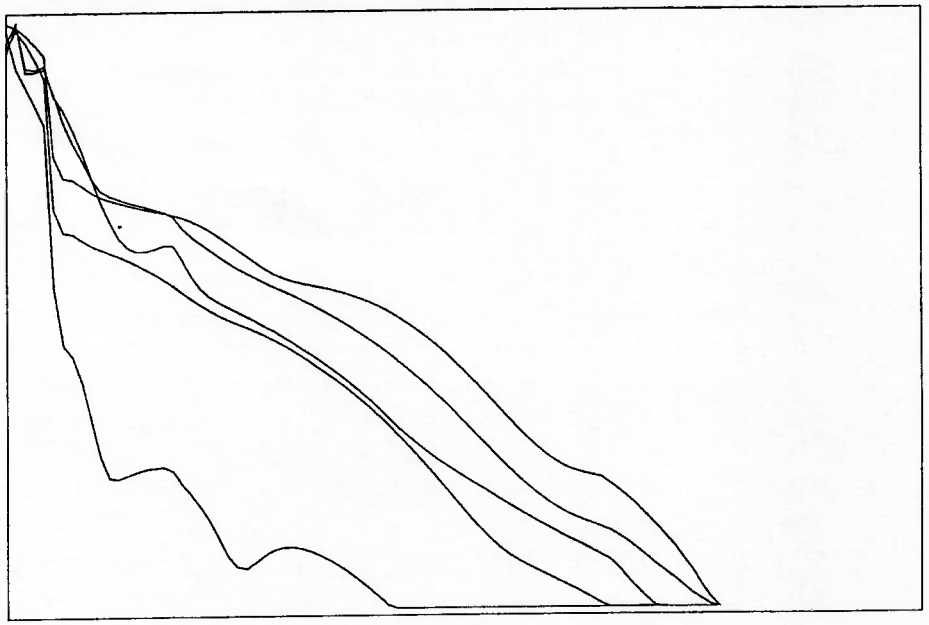
BFCA    = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP  =    3000
LITHYD  =       3
SELREF  =    T
RESFAC  = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E-01)
RELAX(U1   ,FALSDT, 1.000E-02)
RELAX(V1   ,FALSDT, 1.000E-02)
RELAX(KE   ,FALSDT, 1.000E-04)
RELAX(EP   ,FALSDT, 1.000E-04)
KELIN   =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK    =    T
************************************************************
 Group 20. Preliminary Printout
ECHO    =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON   =      20 ;IYMON  =      31 ;IZMON  =       1
TSTSWP  =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
NOWIPE  =    T
************************************************************
MENSAV(S,RELX,DEF,1.4286E-02,5.1440E+00,1.0000E-01)
```

```
 MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
 MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 20, 31, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| 0.00E+00 | 3.00E+07 | 9.24E+05 | 3.21E+01 |
| 4.00E+03 | 6.00E+03 | 4.70E+03 | 0.00E+00 |
| -1.00E+02 | 9.00E+02 | 8.25E+02 | -6.10E-05 |
| 0.00E+00 | 3.00E-03 | 4.15E-07 | 0.00E+00 |
| 0.00E+00 | 5.00E-02 | 2.02E-07 | -1.42E-14 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+03 | 6.01E-03 | -9.66E-04 |
| U1 | 1.00E+04 | 9.74E-01 | -8.81E-03 |
| V1 | 1.00E+05 | 9.76E-01 | -2.24E-01 |
| KE | 1.00E+05 | 8.68E-01 | -1.73E-01 |
| EP | 1.00E+05 | 9.80E-01 | -1.80E-02 |



| NX | NY | NZ | | | | | |
|---|---|---|---|---|---|---|---|
| 70 | 62 | 1 | ISWEEP | 591 | Time now | 2:01 | |
| | | | IZSTEP | OFF | (h:m) est | 10:18 | |

# ANEXO I

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 5 GRAUS PARA A SEGUNDA CONFIGURAÇÃO (LHR51.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=X11-TERM
IRUNN    =        1 ;LIBREF =        0                                  312
*************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 5 GRAUS (REF.1          )
*************************************************************
 Group 2. Transience
STEADY   =    T
*************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,100,84,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
*************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.7291E+03,3.2356E+02,0.0000E+00)
GSET(P,P15,3.1715E+03,2.1708E+02,0.0000E+00)
GSET(P,P16,3.6130E+03,1.0003E+02,0.0000E+00)
GSET(P,P17,4.0536E+03,-2.6970E+01,0.0000E+00)
GSET(P,P18,4.2735E+03,-9.4510E+01,0.0000E+00)
GSET(P,P19,4.4932E+03,-1.6504E+02,0.0000E+00)
GSET(P,P21,4.2630E+03,-2.1505E+02,0.0000E+00)
GSET(P,P22,4.0346E+03,-2.4335E+02,0.0000E+00)
GSET(P,P23,3.5787E+03,-2.9187E+02,0.0000E+00)
GSET(P,P24,3.1236E+03,-3.3044E+02,0.0000E+00)
GSET(P,P25,2.6694E+03,-3.5844E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
```

```
GSET(P,P46,2.7000E+04,-2.6970E+01,0.0000E+00)
GSET(P,P47,2.7000E+04,-2.4335E+02,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7500E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V4,P3,P4,P5,P6,P7)
GSET(V,V7,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V8,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V11,P3,P2,P1,P37)
GSET(V,V12,P37,P35,P33,P32)
GSET(V,V13,P13,P14,P15,P16,P17)
GSET(V,V14,P26,P25,P24,P23,P22)
GSET(V,V15,P17,P18,P19)
GSET(V,V16,P19,P21,P22)
   * Set lines/arcs
GSET(L,C4,P3,P7,10,1.0,CRV,V4)
GSET(L,C7,P7,P13,20,1.0,CRV,V7)
GSET(L,C8,P32,P26,20,1.0,CRV,V8)
GSET(L,L12,P38,P42,40,-1.5)
GSET(L,L13,P42,P43,4,1.0)
GSET(L,L14,P43,P39,40,1.5)
GSET(L,L15,P39,P44,40,-1.6)
GSET(L,L16,P44,P45,20,1.0)
GSET(L,L17,P45,P40,40,1.5)
GSET(L,L18,P40,P46,40,-1.5)
GSET(L,L19,P46,P47,4,1.0)
GSET(L,L20,P47,P41,40,1.5)
GSET(L,L21,P41,P48,40,1.0)
GSET(L,L22,P48,P49,20,1.0)
GSET(L,L23,P49,P38,40,1.6)
GSET(L,L24,P42,P37,30,-1.6)
GSET(L,L25,P43,P3,30,-1.6)
GSET(L,L26,P44,P7,40,-1.5)
GSET(L,L27,P45,P13,40,-1.5)
GSET(L,L28,P46,P17,25,-1.4)
GSET(L,L29,P47,P22,25,-1.4)
GSET(L,L30,P48,P26,40,-1.5)
GSET(L,L31,P49,P32,40,-1.5)
GSET(L,C29,P3,P37,4,1.0,CRV,V11)
GSET(L,C30,P37,P32,10,1.0,CRV,V12)
GSET(L,C31,P13,P17,15,1.2,CRV,V13)
GSET(L,C32,P26,P22,15,1.1,CRV,V14)
GSET(L,C33,P17,P19,2,1.2,CRV,V15)
GSET(L,C34,P19,P22,2,1.2,CRV,V16)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P37,P42,-)
GSET(F,F2,P42,-,P37,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P17,P46,-,P40,-)
GSET(F,F6,P17,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P37,P32.P26,P22,P19,P17,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,41,1,TRANS)
GSET(M,F3,-J+I,1,85,1,TRANS)
GSET(M,F4,-J+I,41,85,1,TRANS)
GSET(M,F5,-J+I,61,85,1,TRANS)
```

```
GSET(M,F6,-J+I,76,45,1,TRANS)
GSET(M,F7,+J+I,61,1,1,TRANS)
GSET(M,F8,+I+J,41,1,1,TRANS)
GSET(M,F9,-J+I,31,45,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,100,1,84,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
*************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
*************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
*************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT    = GRND3
PRT   (EP  ) =  1.314E+00
*************************************************************
 Group 10.Inter-Phase Transfer Processes
*************************************************************
 Group 11.Initialise Var/Porosity Fields
RESTRT(ALL)

CONPOR(LHR5     ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
*************************************************************
 Group 12. Convection and diffusion adjustments
*************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,100,1,84,1,1,1,1)
COVAL (KESOURCE,KE  , GRND4    , GRND4    )
COVAL (KESOURCE,EP  , GRND4    , GRND4    )

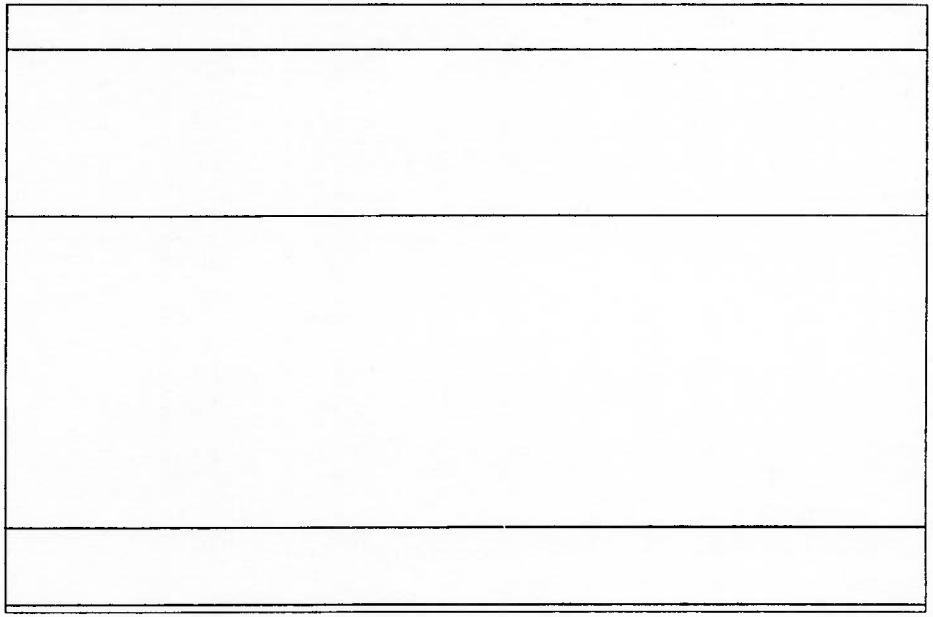
INLET (BFCE1   ,WEST  ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1   ,P1  , GRND1    )
VALUE (BFCE1   ,U1  , GRND1    )
VALUE (BFCE1   ,V1  , GRND1    )
```

```
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

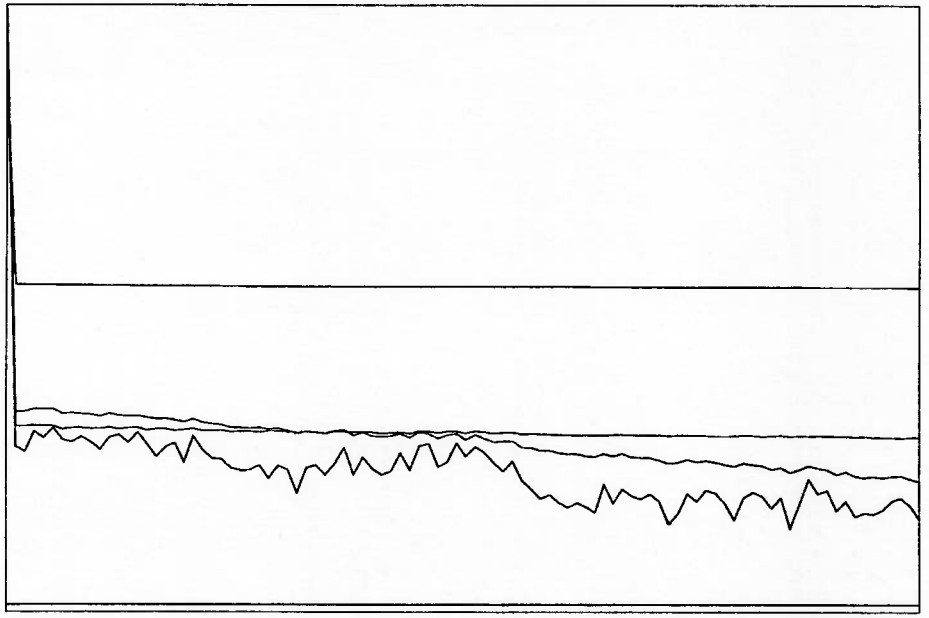
PATCH (S1       ,EAST   ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

BFCA     = 9.982E+02
**********************************************************
 Group 14. Downstream Pressure For PARAB
**********************************************************
 Group 15. Terminate Sweeps
LSWEEP  =    3000
LITHYD  =       3
SELREF  =    T
RESFAC  = 1.000E-02
**********************************************************
 Group 16. Terminate Iterations
**********************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E-02)
RELAX(U1   ,FALSDT, 1.000E-03)
RELAX(V1   ,FALSDT, 1.000E-03)
RELAX(KE   ,FALSDT, 1.000E-03)
RELAX(EP   ,FALSDT, 1.000E-03)
KELIN   =       0
**********************************************************
 Group 18. Limits
**********************************************************
 Group 19. EARTH Calls To GROUND Station
GENK    =    T
**********************************************************
 Group 20. Preliminary Printout
ECHO    =    T
**********************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
**********************************************************
 Group 22. Monitor Print-Out
IXMON   =      30 ;IYMON  =      42 ;IZMON  =       1
TSTSWP  =   12345
**********************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
**********************************************************
 Group 24. Dumps For Restarts
**********************************************************
MENSAV(S,RELX,DEF,1.0000E-02,1,1.0000E-01)
MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
TALK=T;RUN( 1, 1);VDU=X11-TERM
IRUNN   =       1 ;LIBREF =       0
**********************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 5 GRAUS (REF.1          )
```

Spot Values at ( 30, 42, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change | Variable | Max | % Error | Change |
|---|---|---|---|---|---|---|---|
| 1.00E+07 | 2.00E+07 | 1.13E+07 | 1.00E+00 | P1 | 1.00E+01 | 3.08E-02 | 3.77E-04 |
| 0.00E+00 | 1.00E+00 | 1.00E-10 | 0.00E+00 | U1 | 1.00E+01 | 3.44E+00 | -5.01E-06 |
| 1.00E+03 | 2.00E+03 | 1.94E+03 | 9.77E-04 | V1 | 1.00E+02 | 3.67E+00 | 1.40E-02 |
| 5.00E+02 | 6.00E+02 | 5.66E+02 | 1.10E-03 | KE | 1.00E+04 | 8.65E+00 | -3.68E-01 |
| 1.00E+02 | 2.00E+02 | 1.13E+02 | 3.43E-04 | EP | 1.00E+04 | 4.97E+00 | -1.38E+00 |



NX NY NZ ISWEEP 758 Time now 2:04

# ANEXO J

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 10 GRAUS PARA A SEGUNDA CONFIGURAÇÃO (LHR101.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=X11-TERM
IRUNN    =        1 ;LIBREF =        0                                  318
*************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 10 GRAUS (REF.1         )
*************************************************************
 Group 2. Transience
STEADY   =     T
*************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,100,84,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
*************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.7568E+03,3.0238E+02,0.0000E+00)
GSET(P,P15,3.1878E+03,1.5778E+02,0.0000E+00)
GSET(P,P16,3.6174E+03,2.7500E+00,0.0000E+00)
GSET(P,P17,4.0453E+03,-1.6243E+02,0.0000E+00)
GSET(P,P18,4.2585E+03,-2.4856E+02,0.0000E+00)
GSET(P,P19,4.4712E+03,-3.3794E+02,0.0000E+00)
GSET(P,P21,4.2375E+03,-3.6772E+02,0.0000E+00)
GSET(P,P22,4.0076E+03,-3.7603E+02,0.0000E+00)
GSET(P,P23,3.5491E+03,-3.8467E+02,0.0000E+00)
GSET(P,P24,3.0924E+03,-3.8346E+02,0.0000E+00)
GSET(P,P25,2.6375E+03,-3.7182E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

```
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-3.7000E+03,0.0000E+00)
GSET(P,P47,2.7000E+04,-4.0000E+03,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7520E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V2,P3,P4,P5,P6,P7)
GSET(V,V3,P36,P35,P34,P33,P32)
GSET(V,V9,P13,P14,P15,P16,P17)
GSET(V,V13,P26,P25,P24,P23,P22)
GSET(V,V14,P22,P21,P19)
GSET(V,V15,P17,P18,P19)
GSET(V,V10,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V12,P7,P8,P9,P10,P11,P12,P13)
   * Set lines/arcs
GSET(L,C1,P3,P36,4,1.0,CRV,V1)
GSET(L,C2,P3,P7,10,1.0,CRV,V2)
GSET(L,C3,P36,P32,10,1.0,CRV,V3)
GSET(L,L13,P38,P49,40,-1.6)
GSET(L,L14,P49,P48,20,1.0)
GSET(L,L15,P48,P41,40,1.6)
GSET(L,L16,P41,P47,40,-1.5)
GSET(L,L17,P47,P46,4,1.0)
GSET(L,L18,P46,P40,40,1.5)
GSET(L,L19,P40,P45,40,-1.6)
GSET(L,L20,P45,P44,20,1.0)
GSET(L,L21,P44,P39,40,1.6)
GSET(L,L22,P39,P43,40,-1.5)
GSET(L,L23,P43,P42,4,1.0)
GSET(L,L24,P42,P38,40,1.5)
GSET(L,L25,P43,P3,30,-1.6)
GSET(L,L26,P42,P36,30,-1.6)
GSET(L,L27,P44,P7,40,-1.5)
GSET(L,L28,P49,P32,40,-1.5)
GSET(L,L29,P48,P26,40,-1.5)
GSET(L,L30,P47,P22,25,-1.4)
GSET(L,L31,P46,P17,25,-1.4)
GSET(L,L32,P45,P13,40,-1.5)
GSET(L,C27,P13,P17,15,1.0,CRV,V9)
GSET(L,C29,P26,P22,15,1.0,CRV,V13)
GSET(L,C30,P22,P19,2,1.0,CRV,V14)
GSET(L,C31,P17,P19,2,1.0,CRV,V15)
GSET(L,C32,P32,P26,20,1.0,CRV,V10)
GSET(L,C33,P7,P13,20,1.0,CRV,V12)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P17,P46,-,P40,-)
GSET(F,F6,P17,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P17,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,41,1,TRANS)
GSET(M,F3,-J+I,1,85,1,TRANS)
```

```
GSET(M,F4,-J+I,41,85,1,TRANS)
GSET(M,F5,-J+I,61,85,1,TRANS)
GSET(M,F6,-J+I,76,45,1,TRANS)
GSET(M,F7,+J+I,61,1,1,TRANS)
GSET(M,F8,+I+J,41,1,1,TRANS)
GSET(M,F9,-J+I,31,45,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,100,1,84,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
RESTRT(ALL)

CONPOR(LHR10    ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,100,1,84,1,1,1,1)
COVAL (KESOURCE,KE  , GRND4    , GRND4    )
COVAL (KESOURCE,EP  , GRND4    , GRND4    )

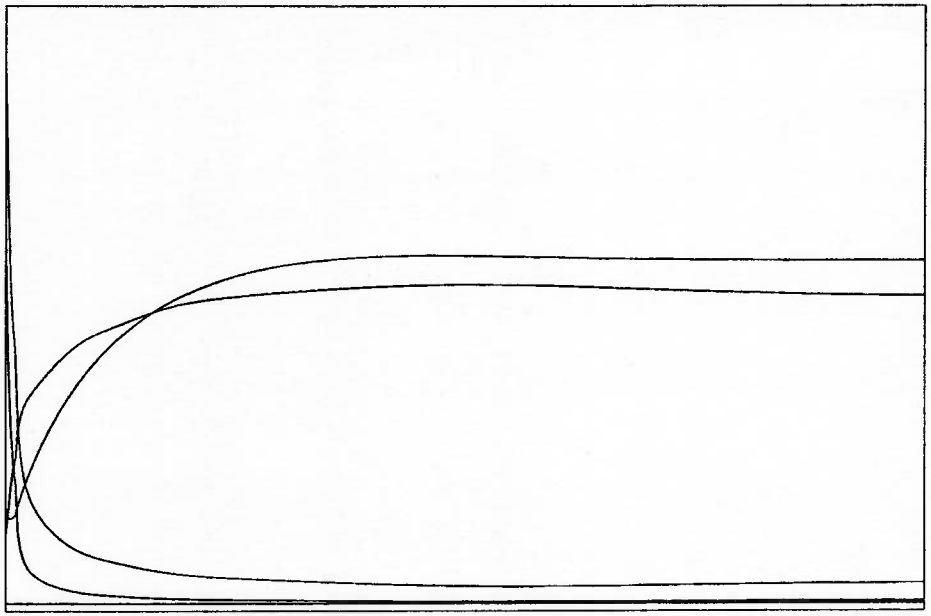
INLET (BFCE1   ,WEST  ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1   ,P1  , GRND1    )
```

```
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

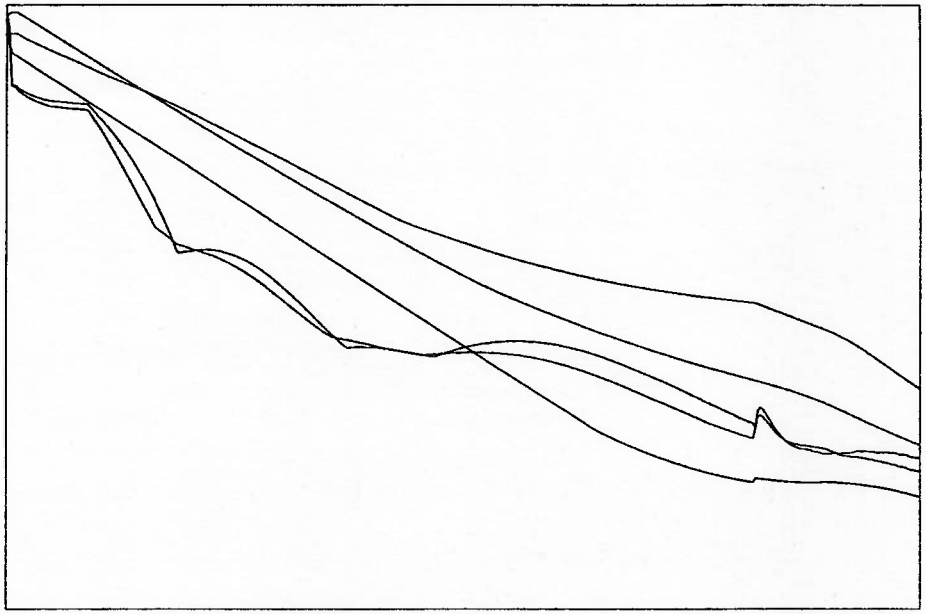
PATCH (S1       ,EAST  ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

BFCA    = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP  =    3000
LITHYD  =       3
SELREF  =    T
RESFAC  = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1  ,LINRLX, 1.000E-03)
RELAX(U1  ,FALSDT, 1.000E-03)
RELAX(V1  ,FALSDT, 1.000E-03)
RELAX(KE  ,LINRLX, 1.000E-03)
RELAX(EP  ,LINRLX, 1.000E-03)
KELIN   =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK    =    T
************************************************************
 Group 20. Preliminary Printout
ECHO    =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON   =      30 ;IYMON  =      42 ;IZMON  =       1
TSTSWP  =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
************************************************************
MENSAV(S,RELX,DEF,1.0000E-02,1,1.0000E-01)
MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 30, 42, 1)



% Error - Cut off 1.000E+00 %

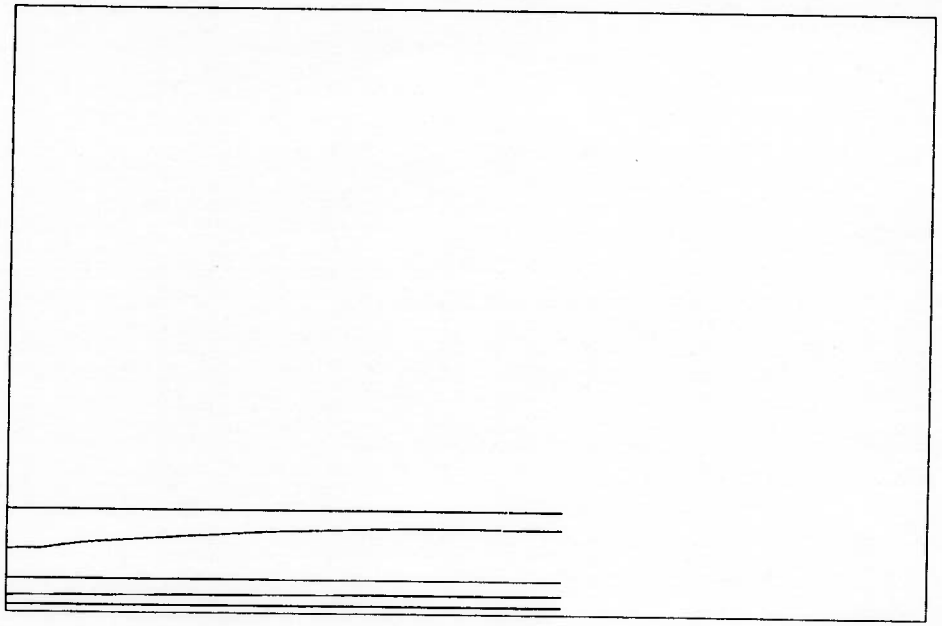


| Min | Max | Spot Value | Change | Variable | Max | % Error | Change |
|---|---|---|---|---|---|---|---|
| 0.00E+00 | 2.00E+07 | 1.16E+07 | -7.10E+01 | P1 | 1.00E+03 | 4.83E+00 | -5.37E-02 |
| 0.00E+00 | 1.00E+00 | 5.27E-08 | 0.00E+00 | U1 | 1.00E+04 | 1.22E+01 | -1.94E-01 |
| 0.00E+00 | 2.00E+03 | 1.04E+03 | -4.44E-02 | V1 | 1.00E+05 | 6.94E+01 | -2.27E+00 |
| 0.00E+00 | 3.00E+03 | 1.02E+02 | 2.49E-02 | KE | 1.00E+05 | 1.31E+01 | -1.88E-01 |
| 0.00E+00 | 2.00E+03 | 9.09E+00 | 3.35E-03 | EP | 1.00E+05 | 1.81E+01 | -1.81E-01 |

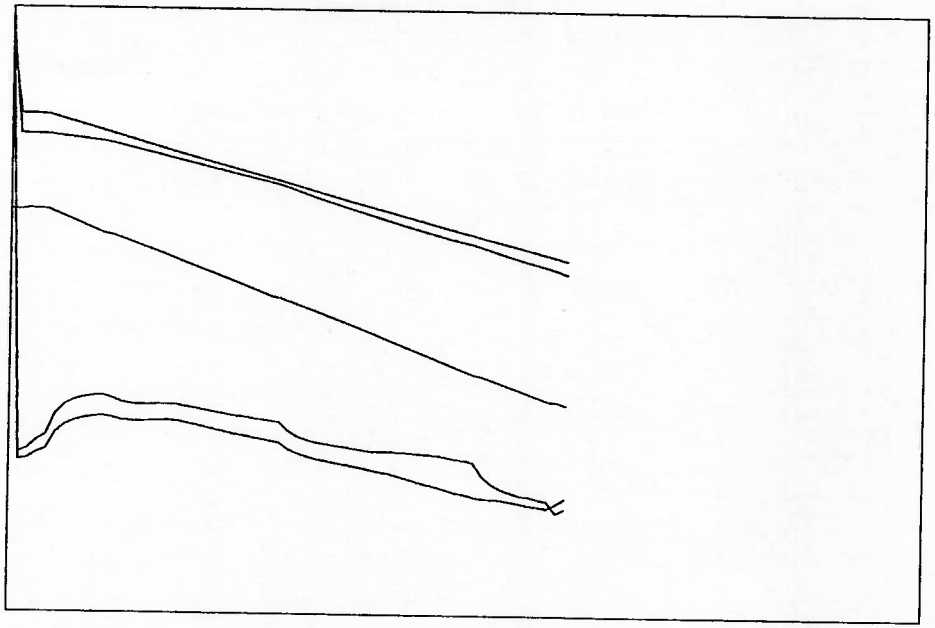


| NX | NY | NZ | | ISWEEP | 3000 | Time | now | 9:15 |
|---|---|---|---|---|---|---|---|---|
| 100 | 84 | 1 | | IZSTEP | OFF | (h:m) | est | 9:15 |

Spot Values at ( 30, 42, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| 1.00E+07 | 2.00E+07 | 1.16E+07 | 1.70E+01 |
| 0.00E+00 | 1.00E+00 | 5.27E-08 | 0.00E+00 |
| 1.00E+03 | 2.00E+03 | 1.04E+03 | -7.32E-04 |
| 1.00E+02 | 2.00E+02 | 1.02E+02 | -2.44E-04 |
| 9.00E+00 | 1.00E+01 | 9.13E+00 | -3.34E-05 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+01 | 2.22E+00 | -2.69E-02 |
| U1 | 1.00E+01 | 5.83E+00 | -7.14E-02 |
| V1 | 1.00E+02 | 2.00E+01 | -6.25E-01 |
| KE | 1.00E+04 | 6.90E+00 | 6.14E-01 |
| EP | 1.00E+04 | 6.22E+00 | 4.83E-01 |



| NX | NY | NZ | | | | |
|---|---|---|---|---|---|---|
| 100 | 84 | 1 | ISWEEP | 456 | Time now | 1:24 |
| | | | IZSTEP | OFF | (h:m) est | 1:24 |

# ANEXO K

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 15 GRAUS PARA A SEGUNDA CONFIGURAÇÃO (LHR151.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=X11-TERM
IRUNN    =        1 ;LIBREF =        0                                    325
*************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 15 GRAUS (REF.1         )
*************************************************************
 Group 2. Transience
STEADY   =     T
*************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,100,84,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
*************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.7818E+03,2.7887E+02,0.0000E+00)
GSET(P,P15,3.1990E+03,9.7210E+01,0.0000E+00)
GSET(P,P16,3.6134E+03,-9.4680E+01,0.0000E+00)
GSET(P,P17,4.0253E+03,-2.9624E+02,0.0000E+00)
GSET(P,P18,4.2301E+03,-4.0093E+02,0.0000E+00)
GSET(P,P19,4.4342E+03,-5.0852E+02,0.0000E+00)
GSET(P,P21,4.1988E+03,-5.1781E+02,0.0000E+00)
GSET(P,P22,3.9690E+03,-5.0604E+02,0.0000E+00)
GSET(P,P23,3.5116E+03,-4.7468E+02,0.0000E+00)
GSET(P,P24,3.0567E+03,-4.3365E+02,0.0000E+00)
GSET(P,P25,2.6046E+03,-3.8239E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

```
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-6.0000E+03,0.0000E+00)
GSET(P,P47,2.7000E+04,-6.5000E+03,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7520E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V3,P3,P4,P5,P6,P7)
GSET(V,V4,P36,P35,P34,P33,P32)
GSET(V,V5,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V6,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V10,P26,P25,P24,P23,P22)
GSET(V,V12,P19,P21,P22)
GSET(V,V13,P13,P14,P15,P16,P17,P18)
GSET(V,V14,P19,P18)
   * Set lines/arcs
GSET(L,C1,P3,P36,4,1.0,CRV,V1)
GSET(L,C3,P3,P7,10,1.0,CRV,V3)
GSET(L,C4,P36,P32,10,1.0,CRV,V4)
GSET(L,C5,P7,P13,20,1.0,CRV,V5)
GSET(L,C6,P32,P26,20,1.0,CRV,V6)
GSET(L,C9,P26,P22,15,1.0,CRV,V10)
GSET(L,C11,P19,P22,2,1.0,CRV,V12)
GSET(L,L12,P38,P49,40,-1.6)
GSET(L,L13,P49,P48,20,1.0)
GSET(L,L14,P48,P41,40,1.4)
GSET(L,L15,P41,P47,40,-1.5)
GSET(L,L16,P47,P46,4,1.0)
GSET(L,L17,P46,P40,40,1.5)
GSET(L,L18,P40,P45,40,-1.4)
GSET(L,L19,P45,P44,20,1.0)
GSET(L,L20,P44,P39,40,1.6)
GSET(L,L21,P39,P43,40,-1.5)
GSET(L,L22,P43,P42,4,1.0)
GSET(L,L23,P42,P38,40,1.5)
GSET(L,L24,P42,P36,30,-1.6)
GSET(L,L25,P43,P3,30,-1.6)
GSET(L,L26,P44,P7,40,-1.5)
GSET(L,L27,P45,P13,40,-1.5)
GSET(L,L28,P46,P18,25,-1.5)
GSET(L,L29,P47,P22,25,-1.5)
GSET(L,L30,P48,P26,40,-1.5)
GSET(L,L31,P49,P32,40,-1.5)
GSET(L,C30,P13,P18,15,1.0,CRV,V13)
GSET(L,C31,P19,P18,2,1.0,CRV,V14)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P18,P46,-,P40,-)
GSET(F,F6,P18,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P18,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,41,1,TRANS)
GSET(M,F3,-J+I,1,85,1,TRANS)
```

```
GSET(M,F4,-J+I,41,85,1,TRANS)
GSET(M,F5,-J+I,61,85,1,TRANS)
GSET(M,F6,-J+I,76,45,1,TRANS)
GSET(M,F7,+J+I,61,1,1,TRANS)
GSET(M,F8,+I+J,41,1,1,TRANS)
GSET(M,F9,-J+I,31,45,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,100,1,84,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
RESTRT(ALL)

CONPOR(LHR15   ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,100,1,84,1,1,1,1)
COVAL (KESOURCE,KE  , GRND4    , GRND4    )
COVAL (KESOURCE,EP  , GRND4    , GRND4    )

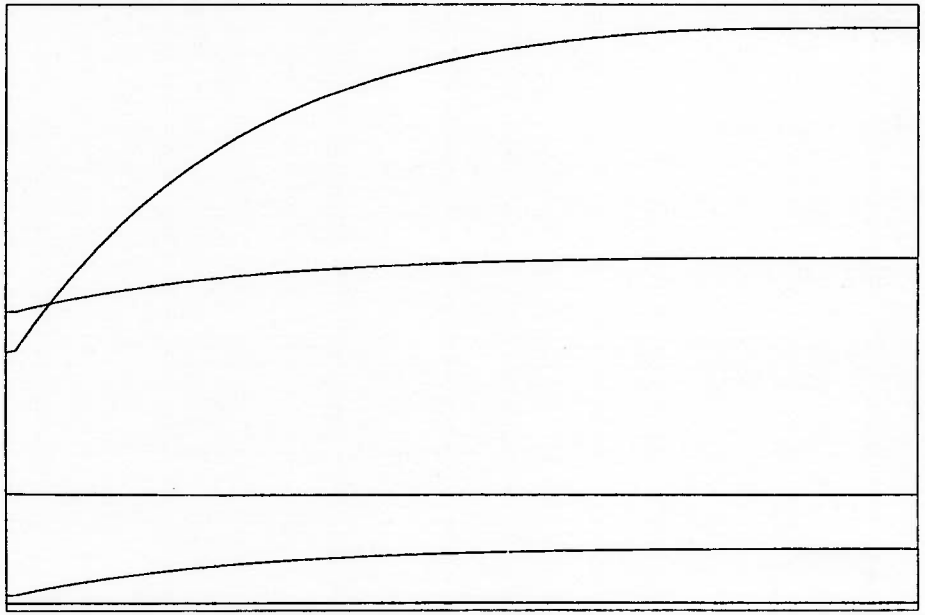
INLET (BFCE1   ,WEST  ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1   ,P1  , GRND1    )
```

```
 VALUE (BFCE1    ,U1   , GRND1     )
 VALUE (BFCE1    ,V1   , GRND1     )
 VALUE (BFCE1    ,UCRT, 5.144E+00)

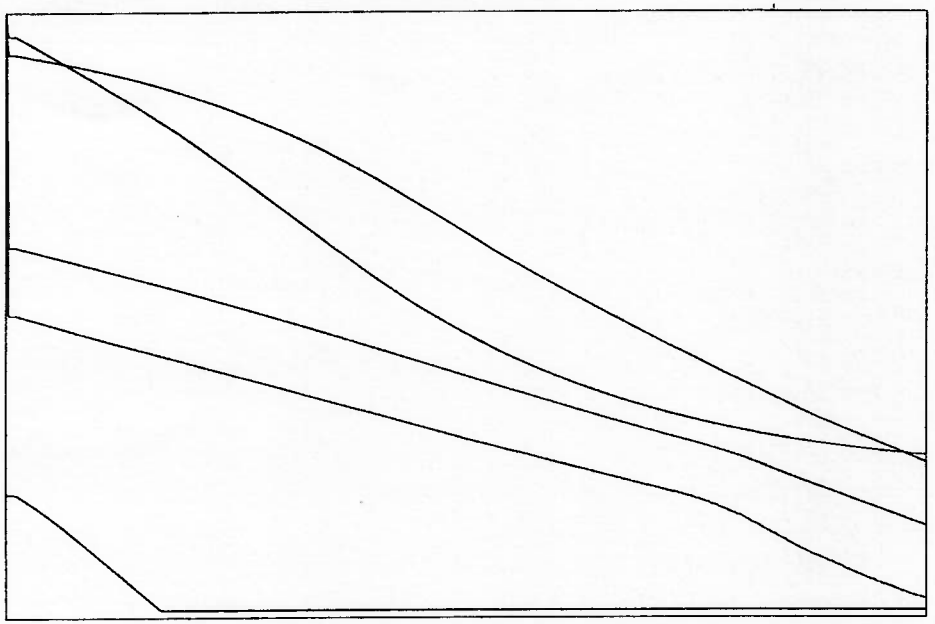
 PATCH (S1       ,EAST  ,#5,#5,#1,#4,#1,#1,1,1)
 COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
 COVAL (S1       ,KE   , 0.000E+00, SAME     )
 COVAL (S1       ,EP   , 0.000E+00, SAME     )

 BFCA     = 9.982E+02
 ************************************************************
  Group 14. Downstream Pressure For PARAB
 ************************************************************
  Group 15. Terminate Sweeps
 LSWEEP   =     3000
 LITHYD   =        3
 SELREF   =     T
 RESFAC   = 1.000E-02
 ************************************************************
  Group 16. Terminate Iterations
 ************************************************************
  Group 17. Relaxation
 RELAX(P1   ,LINRLX, 1.000E-02)
 RELAX(U1   ,FALSDT, 1.000E-03)
 RELAX(V1   ,FALSDT, 1.000E-03)
 RELAX(KE   ,FALSDT, 1.000E-03)
 RELAX(EP   ,FALSDT, 1.000E-03)
 KELIN    =        0
 ************************************************************
  Group 18. Limits
 ************************************************************
  Group 19. EARTH Calls To GROUND Station
 GENK     =     T
 ************************************************************
  Group 20. Preliminary Printout
 ECHO     =     T
 ************************************************************
  Group 21. Print-out of Variables
 OUTPUT(NPOR,N,N,N,Y,N,N)
 OUTPUT(EPOR,N,N,N,Y,N,N)
 OUTPUT(VPOR,N,N,N,Y,N,N)
 ************************************************************
  Group 22. Monitor Print-Out
 IXMON    =       30 ;IYMON  =       42 ;IZMON  =        1
 TSTSWP   =    12345
 ************************************************************
  Group 23.Field Print-Out & Plot Control
   No PATCHes used for this Group
 ************************************************************
  Group 24. Dumps For Restarts
 ************************************************************
 MENSAV(S,RELX,DEF,1.0000E-02,1,1.0000E-01)
 MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
 MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 30, 42, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change | Variable | Max | % Error | Change |
|---|---|---|---|---|---|---|---|
| 1.00E+07 | 2.00E+07 | 1.18E+07 | 5.00E+00 | P1 | 1.00E+01 | 3.27E-02 | -9.96E-05 |
| 0.00E+00 | 1.00E+00 | 1.00E-10 | 0.00E+00 | U1 | 1.00E+01 | 3.14E+00 | -3.84E-03 |
| 3.00E+03 | 4.00E+03 | 3.09E+03 | 0.00E+00 | V1 | 1.00E+02 | 5.28E+00 | -6.13E-02 |
| 1.00E+03 | 3.00E+03 | 2.16E+03 | 2.44E-04 | KE | 1.00E+04 | 4.39E+00 | -7.48E-02 |
| 7.00E+02 | 9.00E+02 | 8.94E+02 | 1.83E-04 | EP | 1.00E+04 | 1.23E+00 | -9.31E-03 |



| NX | NY | NZ | | ISWEEP | 3000 | Time now | 9:00 |
|---|---|---|---|---|---|---|---|
| 100 | 84 | 1 | | ISTEP | OFF | (h:m) set | 9:00 |

# ANEXO L

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 20 GRAUS PARA A SEGUNDA CONFIGURAÇÃO (LHR201.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=X11-TERM
IRUNN    =        1 ;LIBREF =        0
*************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 20 GRAUS (REF.1         )
*************************************************************
 Group 2. Transience
STEADY  =     T
*************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,100,84,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
*************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9710E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.8050E+03,2.5326E+02,0.0000E+00)
GSET(P,P15,3.2048E+03,3.5930E+01,0.0000E+00)
GSET(P,P16,3.6009E+03,-1.9136E+02,0.0000E+00)
GSET(P,P17,3.9937E+03,-4.2805E+02,0.0000E+00)
GSET(P,P18,4.1897E+03,-5.5020E+02,0.0000E+00)
GSET(P,P19,4.3826E+03,-6.7517E+02,0.0000E+00)
GSET(P,P21,4.1472E+03,-6.6390E+02,0.0000E+00)
GSET(P,P22,3.9194E+03,-6.3215E+02,0.0000E+00)
GSET(P,P23,3.4664E+03,-5.6104E+02,0.0000E+00)
GSET(P,P24,3.0168E+03,-4.8053E+02,0.0000E+00)
GSET(P,P25,2.5709E+03,-3.9006E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

```
GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-9.0000E+03,0.0000E+00)
GSET(P,P47,2.7000E+04,-9.5000E+03,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7520E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V2,P3,P4,P5,P6,P7)
GSET(V,V3,P36,P35,P34,P33,P32)
GSET(V,V5,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V6,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V7,P13,P14,P15,P16,P17,P18)
GSET(V,V8,P18,P19)
GSET(V,V9,P19,P21,P22)
GSET(V,V10,P26,P25,P24,P23,P22)
   * Set lines/arcs
GSET(L,C1,P3,P36,4,1.0,CRV,V1)
GSET(L,C2,P3,P7,10,1.0,CRV,V2)
GSET(L,C3,P36,P32,10,1.0,CRV,V3)
GSET(L,C5,P7,P13,20,1.0,CRV,V5)
GSET(L,C6,P32,P26,20,1.0,CRV,V6)
GSET(L,C7,P13,P18,15,1.0,CRV,V7)
GSET(L,C8,P18,P19,2,1.0,CRV,V8)
GSET(L,C9,P19,P22,2,1.0,CRV,V9)
GSET(L,C10,P26,P22,15,1.0,CRV,V10)
GSET(L,L10,P38,P49,40,-1.6)
GSET(L,L11,P49,P48,20,1.0)
GSET(L,L12,P48,P41,40,1.4)
GSET(L,L13,P41,P47,40,-1.5)
GSET(L,L14,P47,P46,4,1.0)
GSET(L,L15,P46,P40,40,1.5)
GSET(L,L16,P40,P45,40,-1.4)
GSET(L,L17,P45,P44,20,1.0)
GSET(L,L18,P44,P39,40,1.6)
GSET(L,L19,P39,P43,40,-1.5)
GSET(L,L20,P43,P42,4,1.0)
GSET(L,L21,P42,P38,40,1.5)
GSET(L,L22,P42,P36,30,-1.6)
GSET(L,L23,P43,P3,30,-1.6)
GSET(L,L24,P44,P7,40,-1.5)
GSET(L,L25,P45,P13,40,-1.5)
GSET(L,L26,P46,P18,25,-1.5)
GSET(L,L27,P47,P22,25,-1.5)
GSET(L,L28,P48,P26,40,-1.5)
GSET(L,L29,P49,P32,40,-1.5)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P18,P46,-,P40,-)
GSET(F,F6,P18,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P18,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,41,1,TRANS)
GSET(M,F3,-J+I,1,85,1,TRANS)
```

```
GSET(M,F4,-J+I,41,85,1,TRANS)
GSET(M,F5,-J+I,61,85,1,TRANS)
GSET(M,F6,-J+I,76,45,1,TRANS)
GSET(M,F7,+J+I,61,1,1,TRANS)
GSET(M,F8,+I+J,41,1,1,TRANS)
GSET(M,F9,-J+I,31,45,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,100,1,84,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
SOLUTN(P1  ,Y,Y,Y,N,N,N)
************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
RESTRT(ALL)

CONPOR(LHR20    ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,100,1,84,1,1,1,1)
COVAL (KESOURCE,KE  , GRND4    , GRND4    )
COVAL (KESOURCE,EP  , GRND4    , GRND4    )

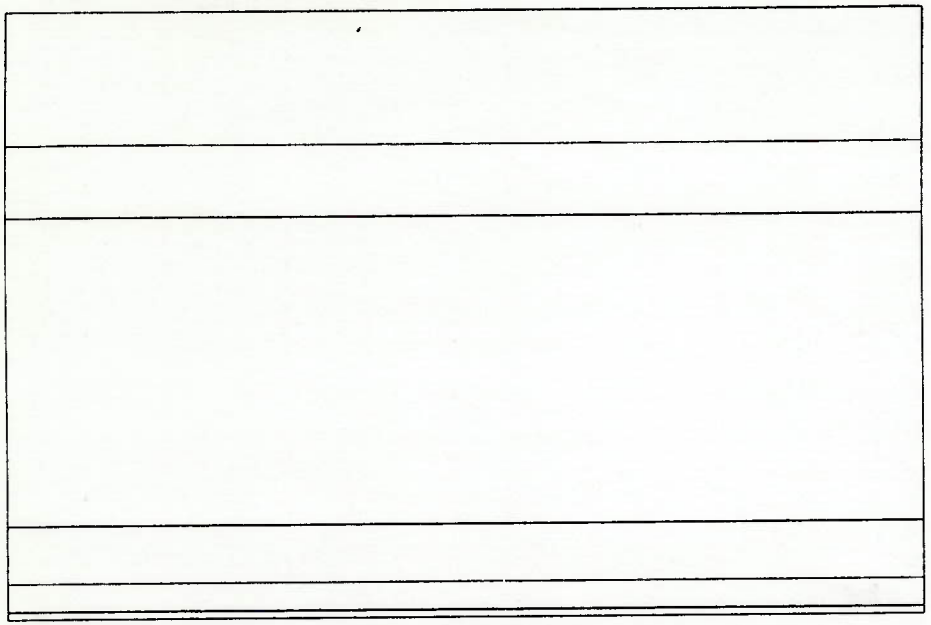
INLET (BFCE1   ,WEST  ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1   ,P1  , GRND1    )
VALUE (BFCE1   ,U1  , GRND1    )
VALUE (BFCE1   ,V1  , GRND1    )
```

```
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

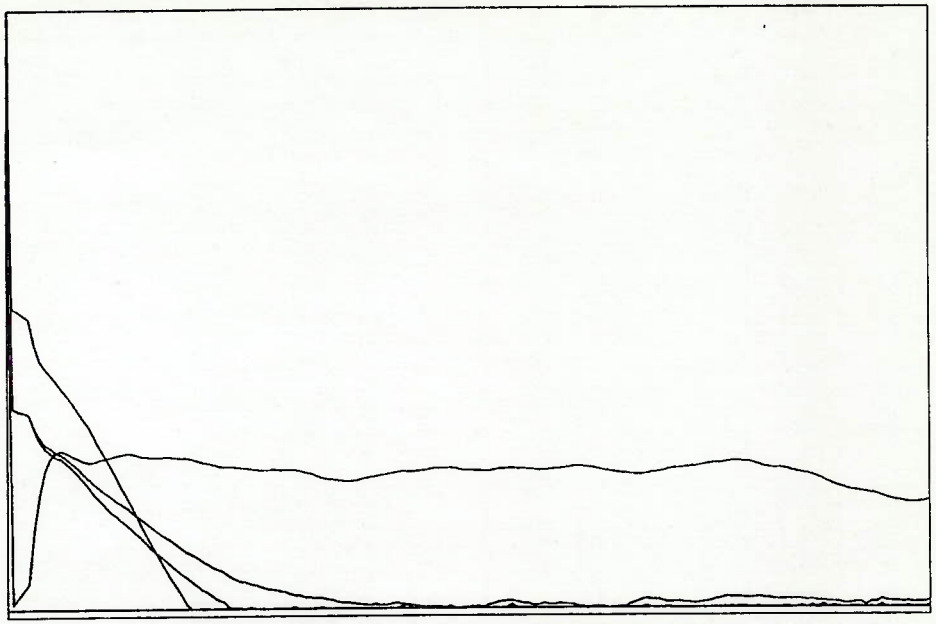
PATCH (S1       ,EAST  ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

BFCA     = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP   =    3000
LITHYD   =       3
SELREF   =    T
RESFAC   = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E-02)
RELAX(U1   ,FALSDT, 1.000E-03)
RELAX(V1   ,FALSDT, 1.000E-02)
RELAX(KE   ,FALSDT, 1.000E-03)
RELAX(EP   ,FALSDT, 1.000E-03)
KELIN    =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK     =    T
************************************************************
 Group 20. Preliminary Printout
ECHO     =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON    =      30 ;IYMON  =      42 ;IZMON  =       1
TSTSWP   =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
************************************************************
MENSAV(S,RELX,DEF,1.0000E-02,1,1.0000E-01)
MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 30, 42, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| 1.00E+07 | 2.00E+07 | 1.05E+07 | -2.80E+01 |
| 0.00E+00 | 1.00E+00 | 1.00E-10 | 0.00E+00 |
| 4.00E+03 | 5.00E+03 | 4.14E+03 | 1.95E-03 |
| 5.00E+03 | 6.00E+03 | 5.67E+03 | 7.32E-03 |
| 3.00E+03 | 4.00E+03 | 3.79E+03 | -5.98E-02 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+01 | 1.95E-02 | 7.51E-04 |
| U1 | 1.00E+01 | 1.51E+00 | 8.57E-03 |
| V1 | 1.00E+02 | 9.35E-01 | -4.81E-02 |
| KE | 1.00E+04 | 1.12E+00 | 2.73E-02 |
| EP | 1.00E+04 | 1.03E+00 | 4.53E-02 |



| NX | NY | NZ | | ISWEEP | 1343 | Time now | 5:13 |
|---|---|---|---|---|---|---|---|
| 100 | 84 | 1 | | IZSTEP | OFF | (h:m) est | 5:13 |

# ANEXO M

## ARQUIVO DE DADOS DO PROBLEMA DO FÓLIO COM FLAP A 25 GRAUS PARA A SEGUNDA CONFIGURAÇÃO (LHR251.Q1) E EVOLUÇÃO DOS RESÍDUOS DAS VARIÁVEIS NAS ÚLTIMAS ITERAÇÕES

```
TALK=T;RUN( 1, 1);VDU=X11-TERM
IRUNN    =        1 ;LIBREF =        0                                  337
************************************************************
 Group 1. Run Title
TEXT(FOLIO COM FLAP A 25 GRAUS (REF.1         )
************************************************************
 Group 2. Transience
STEADY   =     T
************************************************************
 Groups 3, 4, 5  Grid Information
   * Overall number of cells, RSET(M,NX,NY,NZ,tolerance)
RSET(M,100,84,1)
   * Overall domain extent, RSET(D,name,XULAST,YVLAST,ZWLAST)
RSET(D,CHAM,1.000E+00,1.000E+00,1.000E+00)
************************************************************
 Group 6. Body-Fitted coordinates
BFC=T
   * Set points
GSET(P,P1,0.0000E+00,0.0000E+00,0.0000E+00)
GSET(P,P2,5.6200E+01,1.4210E+02,0.0000E+00)
GSET(P,P3,1.1250E+02,1.9610E+02,0.0000E+00)
GSET(P,P4,2.2500E+02,2.6660E+02,0.0000E+00)
GSET(P,P5,3.3750E+02,3.1500E+02,0.0000E+00)
GSET(P,P6,4.5000E+02,3.5120E+02,0.0000E+00)
GSET(P,P7,6.7500E+02,4.0090E+02,0.0000E+00)
GSET(P,P8,9.0000E+02,4.3030E+02,0.0000E+00)
GSET(P,P9,1.1250E+03,4.4560E+02,0.0000E+00)
GSET(P,P10,1.3500E+03,4.5020E+02,0.0000E+00)
GSET(P,P11,1.8000E+03,4.3520E+02,0.0000E+00)
GSET(P,P12,2.2500E+03,3.9711E+02,0.0000E+00)
GSET(P,P13,2.5000E+03,3.7930E+02,0.0000E+00)
GSET(P,P14,2.8259E+03,2.2571E+02,0.0000E+00)
GSET(P,P15,3.2052E+03,-2.5640E+01,0.0000E+00)
GSET(P,P16,3.5806E+03,-2.8659E+02,0.0000E+00)
GSET(P,P17,3.9507E+03,-5.5661E+02,0.0000E+00)
GSET(P,P18,4.1343E+03,-6.9529E+02,0.0000E+00)
GSET(P,P19,4.3166E+03,-8.3668E+02,0.0000E+00)
GSET(P,P21,4.0831E+03,-8.0495E+02,0.0000E+00)
GSET(P,P22,3.8589E+03,-7.5345E+02,0.0000E+00)
GSET(P,P23,3.4138E+03,-6.4313E+02,0.0000E+00)
GSET(P,P24,2.9230E+03,-5.2374E+02,0.0000E+00)
GSET(P,P25,2.5366E+03,-3.9475E+02,0.0000E+00)
GSET(P,P26,2.5000E+03,-3.7930E+02,0.0000E+00)
GSET(P,P27,2.2500E+03,-3.9710E+02,0.0000E+00)
GSET(P,P28,1.8000E+03,-4.3520E+02,0.0000E+00)
GSET(P,P29,1.3500E+03,-4.5020E+02,0.0000E+00)
GSET(P,P30,1.1250E+03,-4.4560E+02,0.0000E+00)
GSET(P,P31,9.0000E+02,-4.3030E+02,0.0000E+00)
GSET(P,P32,6.7500E+02,-4.0090E+02,0.0000E+00)
GSET(P,P33,4.5000E+02,-3.5120E+02,0.0000E+00)
GSET(P,P34,3.3750E+02,-3.1500E+02,0.0000E+00)
GSET(P,P35,2.2500E+02,-2.6660E+02,0.0000E+00)
GSET(P,P36,1.1250E+02,-1.9610E+02,0.0000E+00)
GSET(P,P37,5.6200E+01,-1.4210E+02,0.0000E+00)
GSET(P,P38,-2.2500E+04,-2.2500E+04,0.0000E+00)
GSET(P,P39,-2.2500E+04,2.2500E+04,0.0000E+00)
GSET(P,P40,2.7000E+04,2.2500E+04,0.0000E+00)
GSET(P,P41,2.7000E+04,-2.2500E+04,0.0000E+00)
GSET(P,P42,-2.2500E+04,-1.9610E+02,0.0000E+00)
GSET(P,P43,-2.2500E+04,1.9610E+02,0.0000E+00)
```

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GSET(P,P44,6.7500E+02,2.2500E+04,0.0000E+00)
GSET(P,P45,2.5000E+03,2.2500E+04,0.0000E+00)
GSET(P,P46,2.7000E+04,-1.2000E+04,0.0000E+00)
GSET(P,P47,2.7000E+04,-1.2500E+04,0.0000E+00)
GSET(P,P48,2.5000E+03,-2.2500E+04,0.0000E+00)
GSET(P,P49,6.7500E+02,-2.2500E+04,0.0000E+00)
   * Set curved lines
GSET(V,V1,P3,P2,P1,P37,P36)
GSET(V,V2,P3,P4,P5,P6,P7)
GSET(V,V3,P36,P35,P34,P33,P32)
GSET(V,V4,P7,P8,P9,P10,P11,P12,P13)
GSET(V,V5,P32,P31,P30,P29,P28,P27,P26)
GSET(V,V9,P13,P14,P15,P16,P17,P18)
GSET(V,V10,P26,P25,P24,P23,P22)
GSET(V,V11,P18,P19)
GSET(V,V12,P19,P21,P22)
   * Set lines/arcs
GSET(L,C1,P3,P36,4,1.0,CRV,V1)
GSET(L,C2,P3,P7,10,1.0,CRV,V2)
GSET(L,C3,P36,P32,10,1.0,CRV,V3)
GSET(L,C4,P7,P13,20,1.0,CRV,V4)
GSET(L,C5,P32,P26,20,1.0,CRV,V5)
GSET(L,C9,P13,P18,15,1.0,CRV,V9)
GSET(L,C10,P26,P22,15,1.0,CRV,V10)
GSET(L,C11,P18,P19,2,1.0,CRV,V11)
GSET(L,C12,P19,P22,2,1.0,CRV,V12)
GSET(L,L10,P38,P49,40,-1.6)
GSET(L,L11,P49,P48,20,1.0)
GSET(L,L12,P48,P41,40,1.4)
GSET(L,L13,P41,P47,40,-1.5)
GSET(L,L14,P47,P46,4,1.0)
GSET(L,L15,P46,P40,40,1.5)
GSET(L,L16,P40,P45,40,-1.4)
GSET(L,L17,P45,P44,20,1.0)
GSET(L,L18,P44,P39,40,1.6)
GSET(L,L19,P39,P43,40,-1.5)
GSET(L,L20,P43,P42,4,1.0)
GSET(L,L21,P42,P38,40,1.5)
GSET(L,L22,P42,P36,30,-1.6)
GSET(L,L23,P43,P3,30,-1.6)
GSET(L,L24,P44,P7,40,-1.5)
GSET(L,L25,P45,P13,40,-1.5)
GSET(L,L26,P46,P18,25,-1.5)
GSET(L,L27,P47,P22,25,-1.5)
GSET(L,L28,P48,P26,40,-1.5)
GSET(L,L29,P49,P32,40,-1.5)
   * Set frames
GSET(F,F1,P38,-,P49,-,P32,P36,P42,-)
GSET(F,F2,P42,-,P36,-,P3,-,P43,-)
GSET(F,F3,P39,-,P43,P3,P7,-,P44,-)
GSET(F,F4,P44,-,P7,-,P13,-,P45,-)
GSET(F,F5,P45,-,P13,P18,P46,-,P40,-)
GSET(F,F6,P18,P19,P22,-,P47,-,P46,-)
GSET(F,F7,P48,-,P26,P22,P47,-,P41,-)
GSET(F,F8,P49,-,P48,-,P26,-,P32,-)
GSET(F,F9,P3,-,P36,P32.P26,P22,P19,P18,P13.P7)
   * Match a grid mesh
GSET(M,F1,+I+J,1,1,1,TRANS)
GSET(M,F2,+I+J,1,41,1,TRANS)
GSET(M,F3,-J+I,1,85,1,TRANS)
```

```
GSET(M,F4,-J+I,41,85,1,TRANS)
GSET(M,F5,-J+I,61,85,1,TRANS)
GSET(M,F6,-J+I,76,45,1,TRANS)
GSET(M,F7,+J+I,61,1,1,TRANS)
GSET(M,F8,+I+J,41,1,1,TRANS)
GSET(M,F9,-J+I,31,45,1,TRANS)
   * Copy/Transfer/Block grid planes
GSET(C,K2,F,K1,1,100,1,84,+,0,0,1,INC,1)
   **********
NONORT  =    T
   * X-cyclic boundaries switched
************************************************************
 Group 7. Variables: STOREd,SOLVEd,NAMEd
ONEPHS  =    T
   * Non-default variable names
NAME(42) =NPOR ; NAME(43) =EPOR
NAME(44) =VPOR ; NAME(45) =WCRT
NAME(46) =ENUT ; NAME(47) =VCRT
NAME(48) =BLOK ; NAME(49) =DEN1
NAME(50) =UCRT
   * Solved variables list
SOLVE(P1  ,U1  ,V1  ,KE  ,EP  )
   * Stored variables list
STORE(UCRT,DEN1,BLOK,VCRT,ENUT,WCRT,VPOR,EPOR)
STORE(NPOR)
   * Additional solver options
SOLUTN(P1  ,Y,Y,Y,N,N,N)
************************************************************
 Group 8. Terms & Devices
TERMS (KE  ,N,Y,Y,Y,Y,N)
TERMS (EP  ,N,Y,Y,Y,Y,N)
NEWENT  =    T
************************************************************
 Group 9. Properties
RHO1    = 1.000E+00
EL1     = GRND4
ENUL    = 1.006E-06 ;ENUT   = GRND3
PRT   (EP  ) =  1.314E+00
************************************************************
 Group 10.Inter-Phase Transfer Processes
************************************************************
 Group 11.Initialise Var/Porosity Fields
RESTRT(ALL)

CONPOR(LHR25   ,  0.00,VOLUME,-#2,-#4,-#2,-#3,-#1,-#1)

RSTGRD  =    F

INIADD  =    F
************************************************************
 Group 12. Convection and diffusion adjustments
************************************************************
 Group 13. Boundary & Special Sources

PATCH (KESOURCE,PHASEM,1,100,1,84,1,1,1,1)
COVAL (KESOURCE,KE  , GRND4    , GRND4    )
COVAL (KESOURCE,EP  , GRND4    , GRND4    )

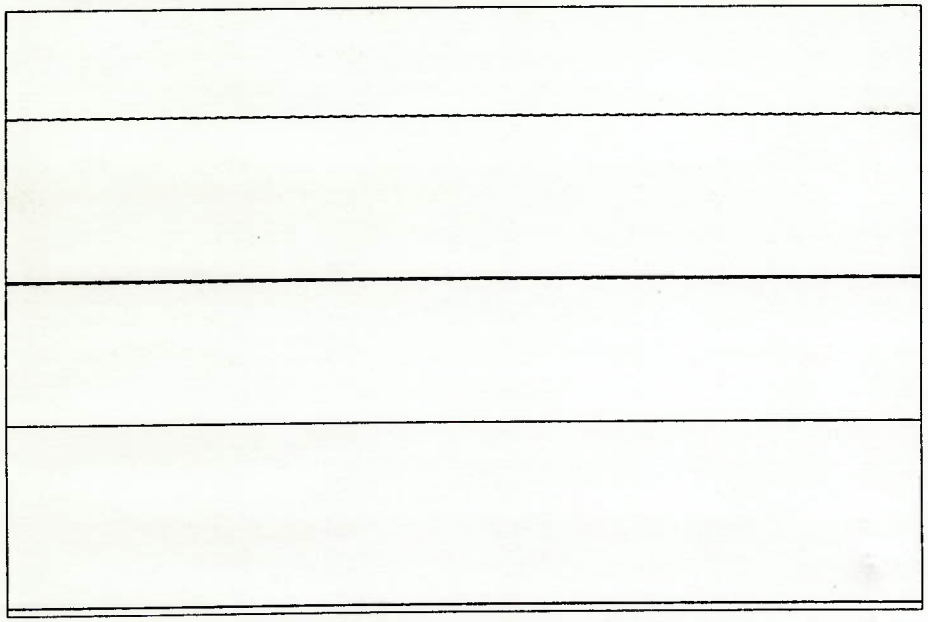
INLET (BFCE1   ,WEST  ,#1,#1,#1,#4,#1,#1,1,1)
VALUE (BFCE1   ,P1  , GRND1    )
```

```
VALUE (BFCE1    ,U1   , GRND1     )
VALUE (BFCE1    ,V1   , GRND1     )
VALUE (BFCE1    ,KE   , 5.292E-03)
VALUE (BFCE1    ,EP   , 2.506E-01)
VALUE (BFCE1    ,UCRT, 5.144E+00)

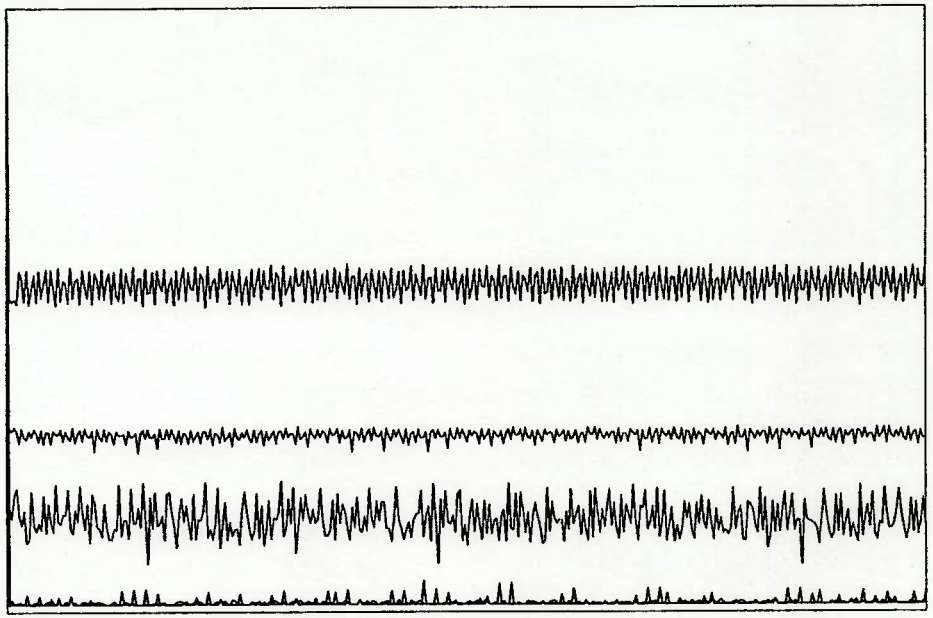
PATCH (S1       ,EAST  ,#5,#5,#1,#4,#1,#1,1,1)
COVAL (S1       ,P1   , 1.000E+00, 0.000E+00)
COVAL (S1       ,KE   , 0.000E+00, SAME     )
COVAL (S1       ,EP   , 0.000E+00, SAME     )

BFCA     = 9.982E+02
************************************************************
 Group 14. Downstream Pressure For PARAB
************************************************************
 Group 15. Terminate Sweeps
LSWEEP   =    3000
LITHYD   =       3
SELREF   =    T
RESFAC   = 1.000E-02
************************************************************
 Group 16. Terminate Iterations
************************************************************
 Group 17. Relaxation
RELAX(P1   ,LINRLX, 1.000E-02)
RELAX(U1   ,FALSDT, 1.000E-02)
RELAX(V1   ,FALSDT, 1.000E-02)
RELAX(KE   ,FALSDT, 1.000E-03)
RELAX(EP   ,FALSDT, 9.000E-02)
KELIN    =       0
************************************************************
 Group 18. Limits
************************************************************
 Group 19. EARTH Calls To GROUND Station
GENK     =    T
************************************************************
 Group 20. Preliminary Printout
ECHO     =    T
************************************************************
 Group 21. Print-out of Variables
OUTPUT(NPOR,N,N,N,Y,N,N)
OUTPUT(EPOR,N,N,N,Y,N,N)
OUTPUT(VPOR,N,N,N,Y,N,N)
************************************************************
 Group 22. Monitor Print-Out
IXMON    =      30 ;IYMON  =      42 ;IZMON  =       1
TSTSWP   =   12345
************************************************************
 Group 23.Field Print-Out & Plot Control
  No PATCHes used for this Group
************************************************************
 Group 24. Dumps For Restarts
************************************************************
MENSAV(S,RELX,DEF,1.0000E-02,5.1440E+00,1.0000E-01)
MENSAV(S,PHSPROP,DEF,200,0,9.9820E+02,1.0060E-06)
MENSAV(S,FLPRP,DEF,K-E,CONSTANT,AIR-CONSTANT)
STOP
```

Spot Values at ( 30, 42, 1)



% Error - Cut off 1.000E+00 %



| Min | Max | Spot Value | Change |
|---|---|---|---|
| 9.00E+06 | 1.00E+07 | 9.31E+06 | 1.69E+02 |
| 0.00E+00 | 1.00E+00 | 1.00E-10 | 0.00E+00 |
| 4.00E+03 | 5.00E+03 | 4.55E+03 | 1.63E-01 |
| 7.00E+03 | 8.00E+03 | 7.55E+03 | 7.98E-01 |
| 5.00E+03 | 6.00E+03 | 5.83E+03 | 9.24E-01 |

| Variable | Max | % Error | Change |
|---|---|---|---|
| P1 | 1.00E+01 | 1.05E+00 | 1.77E-01 |
| U1 | 1.00E+01 | 1.00E+00 | -4.80E-03 |
| V1 | 1.00E+02 | 2.13E+01 | 4.24E+00 |
| KE | 1.00E+04 | 2.01E+01 | 6.47E-01 |
| EP | 1.00E+04 | 4.29E+00 | -2.52E+00 |



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