The program FEMB users manual

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The Program FEMB

Users Manual

by

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pages + tables + illustrations

Abstract

This report contains a short description of the two-dimensional diffusion theory finite element program FEMB.

Input and output explanations are given together with two examples on the use.

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SHORT DESCRIPTION

FEMB is a finite element program for approximate solution of the diffusion-theory-equation

$$(1)\quad -\nabla(D_g(\underline{r})\nabla\phi_g(\underline{r})) + \Sigma_{r,g}(\underline{r})\phi_g(\underline{r}) + \sum_{g'\neq g}\Sigma_{s,g'\to g}(\underline{r})\phi_{g'}(\underline{r}) + \frac{1}{K_{eff}}\cdot\chi_g(\underline{r})\sum_{g'}(\nu\Sigma_f)_{g'}(\underline{r})\phi_{g'}(\underline{r}) = 0$$

within a domain Ω in the xy-plane with the boundary conditions

$$(2)\quad -D_g\frac{\partial\phi_g(\underline{r})}{\partial\underline{n}} = \sum_{g'}\gamma_{gg'}(\underline{r}) - \phi_{g'}(\underline{r})$$

or

$$(3)\quad \frac{\frac{\partial\phi_g(\underline{r})}{\partial\underline{n}}}{\phi_g(\underline{r})} = L_g(\underline{r})$$

Ω is divided in rectangular elements. Within each element the flux ($\phi_g(\underline{r})$) is approximated by a polynomial of order m.

For more details about the method and the approximation used see ref. 2-4.

The equations are solved for one group at a time using the ordinary power iteration technique. The equation for one group is solved by a pointvise successive overrelaxation technique. There is only one inner iteration for each outer.

The iterations are accelerated by extrapolation for removal of the dominating error-mode.

The iterations are stopped when the local error is less than a given input parameter (eps).

An approximate upper limit for the local error ($\varepsilon_{1,max}$) is calculated in this way:

$$\varepsilon_{1,max} \leq \frac{\max\left|\phi_i^k - \phi_i^{k-1}\right|}{\max\phi_i^k}\cdot \text{extpl}$$

where k gives the outer iteration number, i runs over all flux points in all groups and extpl is the maximal of the last three extra polation factors used for extrapolation.

APPLICATION

On the whole the program adheres to the input/output conventions of the Risø program TWODIM. It is therefore easy to use for users accustomed to this program.

The program gives very reliable results within reasonable calculation times, but it is not a fast program and should therefore mostly be used where high precision is needed.

The typical precision of a calculation with the program can be seen in ref. 1 and ref. 2.

INPUT SPECIFICATION

As mentioned before there is only little difference between FEMB and TWODIM in the input, therefore the same name for input variables with the same meaning is used.

First comes a complete list of the input parameters in the order in which they appear.

FF:
Problem nb:
day, month, year: } administration input

CMX: number of coarse mesh in the x-direction.

CMY: number of coarse mesh in the y-direction.

NCP: number of compositions=number of ordinary materials + number of boundary conditions.

NB: number of boundary conditions.

NDB: number of diagonal boundary conditions; condition (3)

NG: number of groups.

NRR: number of reaction-rates, for each reaction-rate the program calculates for each element

$$\sum_{g'} \left(RR_{g',\text{element}} \cdot \int_{\text{element}} \phi_{g'}(\underline{r})\,dr \right)$$

KDS: if KDS=1 then the reaction-integrals from the last calculation are printed in condensed form as specified by meshx and meshy.

if KDS=2 then the reaction-integrals from all calculations are printed in the same condensed form, as specified by meshx and meshy.

if KDS=0 meshx and meshy are not read.

NREC: the calculations are repeated NREC times, between each calculation the mesh is divided as specified by FACX and FACY.

M: gives the order of the interpolation polynomial, for practical reasons M should be less than or equal to 6.

MX: the maximal number of fine mesh in the x-direction.

MY: the maximal number of fine mesh in the y-direction.

XC: array (0: CMX), containing the coordinates of the coarse mesh division in the x-direction.

YC: as XC.

FMX: array (1: CMX), gives the number of fine mesh into which each coarse mesh is divided before the first calculation.

FMY: as FMX.

FACX: array (1: CMX) containing the number of fine mesh into which each mesh is divided before the next recalculation.

FACY: as FACX.

CMP: array (0: CMX + 1, 0: CMY + 1) containing lay-out of composition numbers. The numbers are read as if they form part of the first quadrant in the xy-plane. Each logical record corresponds to one mesh in the y-direction, the first and the last are boundary conditions.

Diffusion data for the NCP compositions:

K: composition number.

For $K \leq NB$ and $K \geq NDB$:

EXTPL: array (1:NG) current/flux ratios for the NG groups at the boundary characterized by the composition number K.

For $NDB < K \leq NB$

GAMMA: array (1:NG, 1:NG) corresponding to boundary condition (2); non-negative diagonal elements, non-positive of diagonal elements and $\sum_{g'} \gamma_{gg'} \geq 0$ for all g.

For NB < K ≤ NCP:

Data for the ordinary material, characterized by the composition number K.

D: array (1:NG) diffusion coefficient for the groups.

SS: the modified scattering matrix

$$SS(g,g) = \Sigma_{r,g} = \Sigma_{abs,g} + \sum_{g \neq g'} \Sigma_{s,g' \leftarrow g}$$

$$SS(g,g') = \Sigma_{s,g \leftarrow g'}$$

FS: array (1:NG) normalised fission spectrum.

NFS: array (1:NG), $\nu\Sigma_{fiss}$.

RR: array (1:NRR, 1:NG) reaction rate cross section, each reaction rate is one logical record, if NRR=0 RR is not read.

MESHX: array (0:MX) the first and the last number in the array must always be 1. All the numbers correspond to a fine mesh interface, if the number is 0 the two adjacent mesh are condensed in the output from the reaction integral.

if KDS=2 MESHX is $(0: \sum_{i=1}^{CMX} FMX(i))$ and the numbers corresponds to the mesh after the first subdivision as specified by FMX

MESHY: as MESHX.

The last cards contain four control variables for each calculation, if -1 is given for the first calculation then default values are used, if -1 is given in the following cards then unchanged values are used for the corresponding variable.

MAXANTALITERATIONER: the maximal number of iterations, default is 50.

EPS: The iterations are stopped when the local error ($\xi_{1,max}$, calculated as described on page 1) is less than eps, default is 0.0001.

EPSMY: Extrapolation is performed when the relative change in the extrapolation factor for two consecutive iterations is less than EPSMY, default is 0.1.

OMEGA: overrelaxation factor, default is 1.2.

The input is now concluded with the administration input cards FF and -1 or a new problem.

Quick reference input specification

Each line in the following corresponds to one logical record and must start on a new card.

Repeated equally structured data is shown as [data] · N where N gives the number of repeats.

FF
problem
day, month, year
} administration-input

cmx, cmy, ncp, nb, ndb, ng, nrr, kds, nrec, m
mx, my
xc(0), xc(1), ..., xc(cmx)
fmx(1), fmx(2), ..., fmx(cmx)
facx(1), facx(2), ..., facx(cmx)
yc(0), yc(1), ..., yc(cmy)
fmy(1), fmy(2), ..., fmy(cmy)
facy(1), facy(2),...., facy(cmy)
cmp(0, cmy+1), cmp(1, cmy+1),...., cmp(cmx+1, cmy+1)
cmp(0, cmy), cmp(1, cmy), ..., cmp(cmx+1, cmy)
.
.
.
cmp(0,0), cmp(1,0), ..., cmp(cmx+1, 0)

[k
extpl(1), extpl(2), ..., extpl(ng)] · ndb; 1≤k≤ndb

[k
gamma(1,1), gamma(1,2),..., gamma(ng,ng)] · (nb-ndb); ndb< k≤nb

[k
d(1), d(2), ..., d(ng)
ss(1,1), ss(1,2), ..., ss(1,ng), ..., ss(ng, ng)
fs(1), fs(2), ..., fs(ng)
nfs(1), nfs(2), ..., nfs(ng)
rr(1,1), rr(1,2), ..., rr(1,ng)
rr(2,1), rr(2,2), ..., rr(2,ng)
.
.
.
rr(nrr,1), rr(nrr,2), ..., rr(nrr, ng)] nb<k≤ncp · (ncp-nb)

$$\left.\begin{array}{l} \text{meshx(0), meshx(1), ..., meshx(mx)} \\ \text{meshy(0), meshy(1), ..., meshy(my)} \end{array}\right\} \text{ if kds = 1}$$

$$\left.\begin{array}{l} \text{meshx(0), meshx(1), ..., meshx}\left(\sum_{i=1}^{CMX} \text{FMX(i)}\right) \\ \text{meshy(0), meshy(1), ..., meshy}\left(\sum_{i=1}^{CMX} \text{FMY(i)}\right) \end{array}\right\} \text{ if kds = 2}$$

if kds = 0 no reading of meshx and meshy

$$\left[\text{maxantaliterationer, eps, epsmy, omega}\right] \cdot \text{(nrec+1);-1} \Rightarrow \text{default}$$

$$\left.\begin{array}{l} \text{FF} \\ \text{-1 (or a new problem)} \end{array}\right\} \text{ administration input}$$

OUTPUT DESCRIPTION

Each logical page starts with the usual ADM. heading and can consist of several physical pages.

Page 1 is a listing of input in the order in which it is read, one logical record is read at a time and immediately written.

Page 2 starts with a listing of the parameters used for the following iteration (maxantaliterationer, eps, epsmy, omega). Then comes a listing of some control variables of minor interest for the ordinary user, they are:

OANTAL: number of compositions = NCP.

RTYPER: number of boundaries = NB.

GANTAL: number of groups.

EANTAL: number of elements = number of meshes with ordinary materials.

RANTAL: number of external boundaries.

ANTALUBK: number of unknowns per group.

MAXHUD: the amount of space used for the equations.

ANTALBLK: the number of blocks used for the equations on secondary storage. maxhud/900 gives the minimum number of blocks, if antalblk is much greater, contact the person responsible for the program.
The maximum allowed number of blocks is 600/ng, if more space is needed contact responsible engineer.

After these control variables comes the progress report for the iteration.

IT.NR: the number of this iteration

RESIDUE: $\frac{\max\left|\phi_i^k-\phi_i^{k-1}\right|}{\max \phi_i^k}$; k gives iteration number, i runs over all flux-points in all groups

RATIO: $\frac{\sum_i \left|\phi_i^{k-1}-\phi_i^k\right|/\max\phi_i^k}{\sum_i \left|\phi_i^{k-1}-\phi_i^{k-2}\right|} \cdot \text{sign}\,(\phi_j^k-\phi_j^{k-1}) \cdot \text{sign}\,(\phi_j^{k-1}-\phi_j^{k-2})$;

$$\left|\phi_j^{k-1}-\phi_j^{k-2}\right| = \max\left|\phi_i^{k-1}-\phi_i^{k-2}\right|$$

LAMBDA: $1/k_{eff}$

KEFF: k_{eff}

DELTAKEFF: $(k_{eff}^k - k_{eff}^{k-1})$

TOTALKILDE: $\sum_e \sum_g \left(\int_e \phi_g (\nu\Sigma_f)_g \, d\omega \right)$

e runs over all elements

g runs over all groups

Every time an extrapolation is performed MY and eksfac is written

MY: =RATIO

EKSFAC: 1/(1-MY)

Page 3 The result of the calculation, k_{eff} and fluxdistribution normalised so that $\phi_{max} = 9999$

Page 4 average flux for each group with the normalisation mentioned above, and a description of where the maximum occurs.

Page 5 if NRR $\neq$ 0 page 5 contains a map for each reaction-rate, the normalisation is done so that the average is 1000 for each reaction integral.

Page 6 if NREC $>$ 0 the following 4 pages contain the same as page 2-5.

EXAMPLE

As a simple example we take the reactor shown in fig. 1.

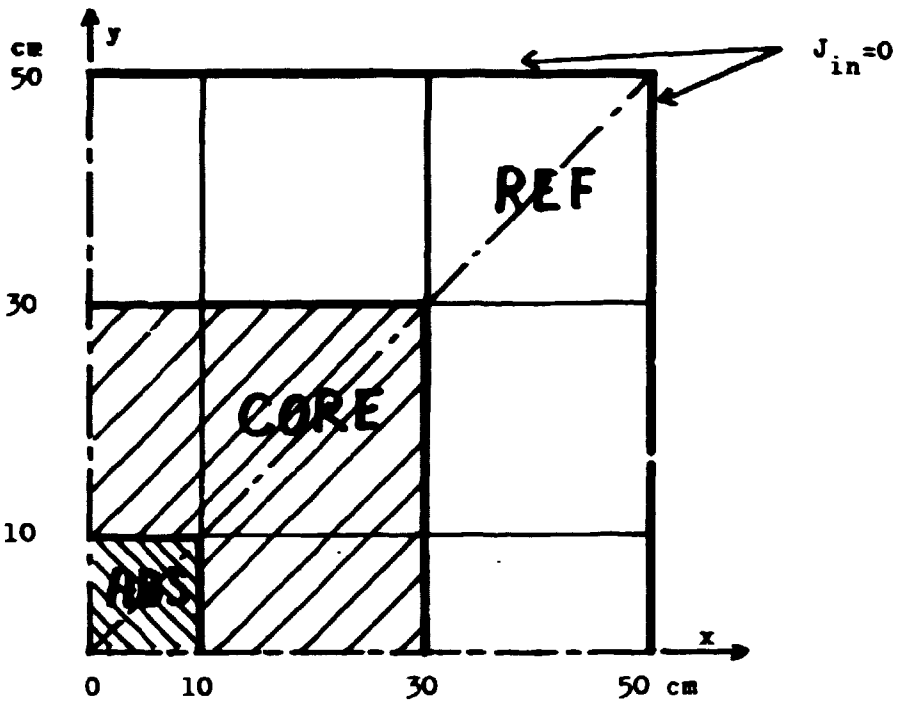


Fig. 1. Geometry specification.

For this reactor we perform a two-group calculation with the following coefficients.

Region	D_1	D_2	$\Sigma_{1\to2}$	Σ_{a1}	Σ_{a2}	$\nu\Sigma_{f2}$
3, CORE	1.5	0.4	0.02	0.01	0.085	0.135
4, ABS	1.5	0.4	0.02	0.01	0.13	0.135
5, REF	2.0	0.3	0.04	0	0.01	0

$\chi_1 = 1.0$, $\chi_2 = 0$, $\nu\Sigma_{f1} = 0$, $\Sigma_{2\to1} = 0$ all region

A list of the complete run is shown as appendix A.

The output from this calculation is shown as appendix B.

REFERENCES

1. I. Misfeldt, Solution of the Multigroup Neutron Diffusion Equation by the Finite Element Method.

2. I. Misfeldt, Master thesis.

3. The application of the Finite Element Method to the multigroup neutron diffusion equation, Nuclear Science and Engineering 47. By L.A. Semanza et al.

4. The Finite Element Method in Engineering Science. By O.C. Zienkewicz.

APPENDIX A

A complete card deck for a calculation on the example shown page 8.

Output from this job is shown as appendix B.

```
?JOB PT/MISET;CLASS=1;CHARGE=...51R02;USER=RTHISFELDT/WORK
?PROCESSTIME=300; IOTIME=300; PRINTLIMIT=5000;
?BEGIN COMPILE PROB ALGOL
?ALGOL FILE TAPE=IFMP
?DATA
$SET MERGE
?DATA INPDATA
FI                                  } administration input
1
17.3.1976
3.3.5.2.2.2.1.1.1.2.                } control variables
6.6.
0.10.30.50
1.1.1.
2.2.2.                              } mesh specification
0.10.30.50.
1.1.1.
2.2.2.
1.2.2.2.2.
1.5.5.5.2.                          } composition
1.3.3.5.2.                          } numbers
1.4.3.5.2.
1.1.1.1.1.
1
0.0.                                } boundary
2.                                  } conditions
0.467.0.467.
3
1.5.0.4.
0.03.0.0.02.0.065                                          } INPUT
1.0.0.
0.0.135.
1.1.
4.
1.5.0.4.                            } ordinary
 0.03.0.0.02.0.13.                  } materials
1.0.0.
0.0.135.
1.1.
5.
2.0.0.3.
 0.04.0.0.04.0.01.
1.0.
0.0.
0.0.
1.0.1.0.1.0.1.                      } condensation specifications
1.0.1.0.1.0.1.
-1.-1.-1.-1.                        } control variables for the iterations
 15.-1.-1.1.2.
FI
-1.                                 } administration input
?END JOB
```

APPENDIX B

Output from a calculation on the example shown page 8.

COMPILED: 21/04-1977. 22.25
21/04-1977. 22.26
PROCESSOR = 0 SEC
ELAPSED = 0 SEC
INPUT/OUTPUT= 0 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 1 17/3.1976
FLUXBEREGNINGER ELEMENTMETODEN

CNX	CNY	NLP	NN	NDD	NG	NNN	KDS	NREC	M
3.	3.	5.	2.	2.	2.	1.	1.	1.	2.

MX	MY
6.	6.

XC

0. 1.000E+01 3.000E+01 5.000E+01

FMX

1. 1. 1.

FACX/

2. 2. 2.

YC

0. 1.000E+01 3.000E+01 5.000E+01

FMY

1. 1. 1.

FACY

2. 2. 2.

COMPOSITIONS NUMBERS

1.	2.	2.	2.	2.
1.	1.	1.	1.	1.
1.	1.	1.	1.	1.
1.	1.	1.	1.	1.

1
EXTPL: 0. 0.

```
2
EXTPL: 4.67000E-01 4.67000E-01


3
    D: 1.50000E+00 4.00000E-01
   SS: 3.00000E-02 0.           2.00000E-02 8.50000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          1.35000E-01
 RR  1 1.00000E+00 1.00000E+00


4
    D: 1.50000E+00 4.00000E-01
   SS: 3.00000E-02 0.           2.00000E-02 1.30000E-01
   FS: 1.00000E+00 0.
  NFS: 0.          1.35000E-01
 RR  1 1.00000E+00 1.00000E+00


5
    D: 2.00000E+00 3.00000E-01
   SS: 4.00000E-02 0.           4.00000E-02 1.00000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          0.
 RR  1 0.          0.

  MESHX
   1.000E+00   0.        1.000E+00   0.        1.000E+00   0.        1.000E+00

  MESHY
   1.000E+00   0.        1.000E+00   0.        1.000E+00   0.        1.000E+00


MAXIMALITERATIONEN        EPS             EPSMY           OMEGA
            50.        1.0000E-04      1.0000E-01      1.2000E+00
```

21/04-1977. 22.26
PROCESSOR = 4 SEC
ELAPSED = 21 SEC
INPUT/OUTPUT= 1 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 1 17/3.1976
FLUXBEREGNINGER ELEMENTMETODEN

MAXN	MAXANTALITERATIONER	EPS	EPSMY	OMEGA
2916.	50.	1.0000E-04	1.0000E-01	1.2000E+00

QANTAL	RTYPER	GANTAL	EANTAL	PANTAL	ANTALUBK	MAXHUD	ANTALBLK
5	2	2	9	12	49	625	1

IT. NR	RESIDUE	RATIO	LAMBDA	KEFF	DELTAKEFF	TOTALKILDE
1	7.0391E-01	-0.00000000	4.56387339	0.21911213	-7.8089E-01	2.6622E+01
2	9.0071E-01	-0.59341881	1.41347284	0.70747733	4.8837E-01	8.5958E+01
3	6.3546E-01	-0.60087888	1.27099998	0.78678206	7.9305E-02	9.5594E+01
4	3.4410E-01	-0.65628040	1.24784523	0.80138144	1.4599E-02	9.7368E+01
MY: -0.656280	EKSFAC : 0.603763					
5	6.5049E-02	0.20812452	1.23163916	0.81192612	1.0545E-02	9.8649E+01
6	6.0808E-02	0.60479805	1.20698252	0.82651241	1.6586E-02	1.0066E+02
7	4.4897E-02	0.76583404	1.18818730	0.84161815	1.3106E-02	1.0226E+02
8	3.8365E-02	0.77477469	1.18240903	0.84573102	4.1129E-03	1.0276E+02
9	3.3256E-02	0.84818818	1.17090095	0.85404320	8.3122E-03	1.0377E+02
10	2.8495E-02	0.81018541	1.16987375	0.85479309	7.4989E-04	1.0386E+02
11	2.3052E-02	0.85704474	1.16329243	0.85962908	4.8360E-03	1.0444E+02
12	2.0253E-02	0.80714359	1.16239254	0.86029456	6.6550E-04	1.0453E+02
13	1.5890E-02	0.85212703	1.15800164	0.86310943	2.8149E-03	1.0487E+02
14	1.3940E-02	0.81378231	1.15782383	0.86360926	5.7983E-04	1.0494E+02
15	1.0842E-02	0.64824208	1.15546132	0.86545520	1.7659E-03	1.0515E+02
16	9.5138E-03	0.62043426	1.15487357	0.86589565	4.4046E-04	1.0521E+02
17	7.4559E-03	0.84594760	1.15338089	0.86701627	1.1206E-03	1.0534E+02
18	6.4751E-03	0.82708436	1.15292799	0.86735606	3.4059E-04	1.0538E+02
19	5.1038E-03	0.84397360	1.15199595	0.86805861	7.0175E-04	1.0547E+02
20	4.3970E-03	0.83005035	1.15165025	0.86831918	2.6057E-04	1.0550E+02
21	3.8843E-03	0.84098925	1.15106760	0.86875071	4.3953E-04	1.0555E+02
MY: 0.840989	EKSFAC : 6.288883					
22	3.8045E-03	0.76560698	1.14947118	0.86996527	1.2066E-03	1.0570E+02
23	3.0052E-03	-0.90990436	1.14654962	0.87218205	2.2168E-03	1.0597E+02
24	2.2527E-03	-0.79709292	1.14882943	0.87045124	-1.7308E-03	1.0576E+02
25	1.5279E-03	-0.62795846	1.14836318	0.87080465	3.5341E-04	1.0580E+02
MY: -0.627958	EKSFAC : 0.614266					
26	3.9843E-04	-0.39971867	1.14889800	0.87039929	-4.0536E-04	1.0575E+02
27	2.8890E-04	0.57651048	1.14907872	0.87026240	-1.3689E-04	1.0574E+02
28	1.8438E-04	0.64111460	1.14911565	0.87023443	-2.7969E-05	1.0573E+02
29	1.6092E-04	0.80962135	1.14912448	0.87022774	-6.6931E-06	1.0573E+02
30	1.1537E-04	0.70858433	1.14914324	0.87021354	-1.4200E-05	1.0573E+02
31	9.8336E-05	0.82882590	1.14916052	0.87020045	-1.3088E-05	1.0573E+02
32	7.6159E-05	0.81161009	1.14916714	0.87019544	-5.0138E-06	1.0573E+02

	33	6.3541E-05	0.82420313	1.14918109	0.87018487	-1.0562E-05	1.0573E+02
MY:	0.824203		ERSTAC :	5.6A6383			
	34	1.1934E-04	-1.31517513	1.14920864	0.87016401	-2.0864E-05	1.0572E+02
	35	9.3564E-05	-0.64759470	1.14927801	0.87011149	-5.2516E-05	1.0572E+02
	36	5.1352E-05	-0.67054333	1.14922709	0.87015004	3.8549E-05	1.0572E+02
	37	4.7A37E-05	-0.70182664	1.14924036	0.87013999	-1.0048E-05	1.0572E+02
MY:	-0.701827		ERSTAC :	0.5A7604			
	38	6.A107E-06	0.33387A49	1.14922867	0.87014885	8.8558E-06	1.0572E+02
	39	3.A510E-06	-0.56958953	1.14922397	0.87015240	3.5542E-06	1.0572E+02
	40	3.5677E-06	0.49979640	1.14922481	0.87015177	-6.3374E-07	1.0572E+02

page 2 cont.

21/04-1977. 22.28
PROCESSOR = 28 SEC
ELAPSED = 126 SEC
INPUT/OUTPUT= 8 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 1 17/3.1976
FLUXBEREGNINGER ELEMENTMETODEN

ITERATIONEN ER AFSLUTTET
DER ER UDFØRT 40 ITERATIONER
EPSILON VAR 0.000100000000 DET MAKSIMALE ANTAL ITERATIONER 50
DEN TOTALE FISSIONSKILDE ER 2.7853E+05

KEFF 0.870151768O
FLUKSEN BLEV

FLUX I GRUPPE 1

5000.:	309.	307.	285.	246.	141.	41.	23.
4000.:	1344.	1329.	1278.	1022.	616.	245.	41.
3000.:	5980.	5906.	5650.	4728.	2572.	616.	141.
2000.:	9999.	9944.	9625.	8489.	4728.	1022.	246.
1000.:	9469.	9595.	9802.	9626.	5650.	1278.	285.
500.:	8926.	9134.	9595.	9945.	5906.	1329.	307.
0.:	8688.	8926.	9469.	9999.	5980.	1348.	309.
	0.	500.	1000.	2000.	3000.	4000.	5000.

FLUX I GRUPPE 2

5000.:	178.	169.	172.	122.	104.	83.	11.
4000.:	5337.	5268.	5032.	4117.	2626.	1166.	83.
3000.:	3805.	3754.	3745.	2958.	3050.	2626.	104.
2000.:	2178.	2164.	2304.	1672.	2958.	4117.	122.
1000.:	2157.	2153.	2029.	2304.	3745.	5032.	172.
500.:	1482.	1443.	2153.	2164.	3754.	5268.	169.
0.:	1494.	1482.	2157.	2178.	3805.	5337.	178.
	0.	500.	1000.	2000.	3000.	4000.	5000.

21/04-1977. 22.28
PROCESSOR = 28 SEC
ELAPSED = 128 SEC
INPUT/OUTPUT= 8 SEC

A.F.K. PROGRAM NO. 10 PROBLEM NO. 1 17/3.1976
FLUXBEREGNINGER ELEMENTMETODEN

I GRUPPE: 1 ER DEN MAKSIMALE MIDDELFLUX: 9215
FLUXEN FOREKOM I OMRAADET X FRA 0. TIL 10. OG Y FRA 0. TIL 10.
I GRUPPE: 2 ER DEN MAKSIMALE MIDDELFLUX: 4149
FLUXEN FOREKOM I OMRAADET X FRA 30. TIL 50. OG Y FRA 0. TIL 10.

MIDDELFLUX I GRUPPE 1

5000.			
	1912	1458	335
3000.			
	9181	7620	1458
1000.			
	9215	9181	1912
0.			

0. 1000. 3000. 5000.

MIDDELFLUX I GRUPPE 2

5000.			
	4149	3219	1211
3000.			
	2459	2278	3219
1000.			
	1683	2459	4149
0.			

0. 1000. 3000. 5000.

DEN INTEGREREDE FLUX FOR HELE REAKTOREN OG ALLE GRUPPER ER: 10489068

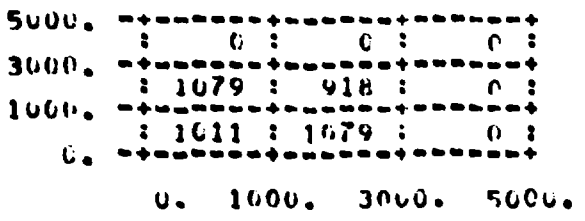
21/04-1977. 22.28
PROCESSOR = 28 SEC
ELAPSED = 130 SEC
INPUT/OUTPUT= 8 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 1 17/3.1976
FLUXBEREGNINGER ELEMENTMETODEN

REAKTIONSINTEGRALER:

REAKTIONSINTEGRALERNE ER NORMERET SAA GENNEMSNITTET FOR DEN DEL AF REAKTOREN HVOR REAKTIONSINTEGRALET OVERSTIGER P=10*MAX(REAKTIONSINTEGRAL) ER 1000.

REAKTIONSINTEGRAL OVER ALLE GRUPPER. ELEMENTVIS.
REAKTIONSTVAERSNIT NR. 1



A.E.K. PROGRAM NR. 10   PROBLEM NR. 1   17/3.1976
FLUXBEREGNINGER   ELEMENTMETODEN

21/04-1977.   22.29
PROCESSOR   =   37 SEC
ELAPSED   =   216 SEC
INPUT/OUTPUT=   9 SEC

MAXIT	MAXANTALITERATIONER	EPS	EPSMY	OMEGA
2016.	75.	1.0000E-04	1.0000E-01	1.5000E+00

DANTAL	NTYPER	GANTAL	EANTAL	PANTAL	ANTALUBK	MAXHUD	ANTALBLK
5	2	2	36	24	169	2401	3

IT. NR	RESIDUE	RATIO	LAMBDA	KEFF	DELTAKEFF	TOTALKILDE
1	3.9773E-01	0.00000000	1.30133043	0.72393974	-1.4621E-01	2.5232E+05
2	1.9367E-01	-0.64396430	1.22665431	0.81522560	9.1286E-02	2.8414E+05
3	1.1781E-01	-0.70278459	1.23069651	0.81254801	-2.6776E-03	2.8321E+05
4	1.0326E-01	-0.79732117	1.19641453	0.83583071	2.3283E-02	2.9132E+05
MY: -0.797321	FESFAC : 0.556384					
5	5.0061E-02	0.30168920	1.19563758	0.83637385	5.4314E-04	2.9151E+05
6	3.1695E-02	-0.81121559	1.19457796	0.83711573	7.4188E-04	2.9177E+05
7	2.1252E-02	-0.75238613	1.18364269	0.84470668	7.5910E-03	2.9441E+05
8	1.5633E-02	-0.71535874	1.17925457	0.84799332	3.2866E-03	2.9556E+05
MY: -0.715359	FESFAC : 0.582968					
9	1.3329E-02	0.65613933	1.17651696	0.84996050	1.9732E-03	2.9625E+05
10	8.0042E-03	0.76072102	1.17379787	0.85193544	1.9689E-03	2.9693E+05
11	7.2867E-03	-0.82221338	1.17121171	0.85381660	1.8612E-03	2.9759E+05
12	[illegible]	0.83185366	1.16908695	0.85536691	1.5503E-03	2.9813E+05
13	5.6001E-03	0.80664242	1.16753472	0.85650558	1.1367E-03	2.9853E+05
14	4.9362E-03	0.86323731	1.16648654	0.85727521	7.6963E-04	2.9880E+05
15	4.2561E-03	0.87933385	1.16548033	0.85801534	7.4013E-04	2.9905E+05
16	3.7006E-03	0.88176674	1.16482475	0.85849624	4.8290E-04	2.9922E+05
17	3.1723E-03	0.87336948	1.16421331	0.85894912	4.5088E-04	2.9938E+05
MY: 0.873364	FESFAC : 7.846490					
18	2.2588E-03	0.65960791	1.16040082	0.86177120	2.8221E-03	3.0036E+05
19	1.6559E-03	-0.71603137	1.15914438	0.86270530	9.3410E-04	3.0069E+05
20	1.2117E-03	-0.90399851	1.15987509	0.86216101	-5.4349E-04	3.0050E+05
21	7.6669E-04	-0.71362256	1.16025475	0.86187969	-2.8212E-04	3.0040E+05
MY: -0.713923	FESFAC : 0.583457					
22	4.2830E-04	0.65583256	1.16042542	0.86175292	-1.2676E-04	3.0036E+05
23	3.9729E-04	0.90605871	1.16057982	0.86163828	-1.1465E-04	3.0032E+05
24	[illegible]	[illegible]	1.16073920	0.86151997	-1.1631E-04	3.0027E+05
25	2.3796E-04	0.81847651	1.16084682	0.86144010	-7.9869E-05	3.0025E+05
26	[illegible]	[illegible]	1.16092799	0.86137987	-6.0230E-05	3.0023E+05
27	1.7864E-04	0.81919866	1.16097791	0.86134283	-3.7042E-05	3.0021E+05
28	[illegible]	[illegible]	1.16101810	0.86131302	-2.9810E-05	3.0020E+05
29	[illegible]	[illegible]	1.16104190	0.86129536	-1.7663E-05	3.0020E+05
30	[illegible]	[illegible]	1.16106448	0.86127861	-1.6745E-05	3.0019E+05
31	[illegible]	[illegible]	1.16108017	0.86126697	-1.1645E-05	3.0019E+05

```
          32  5.6370E-05  0.86297660  1.16109064  0.86125920 -7.7660E-06  3.0018E+05
MY:  0.862977        FRSFAC :  7.298023
          33  4.9971E-05  0.53009140  1.16116711  0.86120246 -5.6717E-05  3.0016E+05
          34  3.7089E-05 -0.73125440  1.16118101  0.86119217 -1.0310E-05  3.0016E+05
          35  3.2021E-05 -0.86644860  1.16116655  0.86120290  1.0729E-05  3.0016E+05
          36  1.4191E-05 -0.62962657  1.16116301  0.86120552  2.6207E-06  3.0017E+05
MY: -0.629627        FRSFAC :  0.613638
          37  1.0158E-05  0.50530331  1.16116014  0.86120766  2.1327E-06  3.0017E+05
          38  7.2458E-06  0.72444582  1.16115737  0.86120970  2.0490E-06  3.0017E+05
          39  3.6702E-06  0.74054001  1.16115552  0.86121108  1.3764E-06  3.0017E+05
```

page 6 cont.

21/04-1977. 22.32
PROCESSOR = 107 SEC
ELAPSED = 387 SEC
INPUT/OUTPUT= 25 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 1 17/3.1976
FLUXBEREGNINGER ELEMENTMETODEN

ITERATIONEN ER AFSLUTTET
DER ER UDFØRT 39 ITERATIONER
EPSILON VAR 0.000100000000 DET MAKSIMALE ANTAL ITERATIONER 75
DEN TOTALE FISSIONSKILDE ER 2.5505E+05

KEFF 0.6012110814
FLUKSEN BLEV

FLUX I GRUPPE 1

5000.:	223.	222.	219.	215.	209.	191.	167.	136.	102.	70.	44.	24.	10.
4500.:	564.	562.	555.	545.	524.	485.	423.	344.	255.	172.	105.	56.	24.
4000.:	1221.	1216.	1203.	1181.	1146.	1055.	918.	745.	536.	342.	201.	105.	44.
3500.:	2536.	2527.	2501.	2456.	2393.	2205.	1932.	1549.	1079.	642.	342.	172.	70.
3000.:	5262.	5246.	5195.	5108.	4968.	4614.	4057.	3313.	2144.	1079.	536.	255.	102.
2500.:	6213.	8191.	8123.	8005.	7633.	7303.	6458.	5352.	3313.	1549.	745.	344.	136.
2000.:	9516.	9699.	9644.	9345.	9191.	8669.	7753.	6458.	4057.	1932.	918.	423.	167.
1500.:	9994.	9967.	9986.	9963.	9894.	9539.	8669.	7303.	4614.	2205.	1055.	485.	191.
1000.:	9568.	9590.	9657.	9768.	9898.	9899.	9191.	7633.	4984.	2393.	1149.	529.	209.
750.:	9223.	9257.	9361.	9539.	9768.	9963.	9345.	8005.	5108.	2456.	1181.	545.	215.
500.:	8958.	9002.	9133.	9361.	9657.	9989.	9444.	8123.	5195.	2501.	1203.	555.	219.
250.:	8804.	8853.	9002.	9257.	9590.	9997.	9499.	8191.	5246.	2527.	1216.	562.	222.
0.:	8754.	8804.	8956.	9223.	9568.	9999.	9516.	8214.	5263.	2536.	1221.	564.	223.
	0.	250.	500.	750.	1000.	1500.	2000.	2500.	3000.	3500.	4000.	4500.	5000.

FLUX I GRUPPE 2

5000.:	272.	271.	266.	263.	256.	234.	205.	170.	132.	95.	61.	32.	4.
4500.:	2293.	2284.	2256.	2214.	2152.	1975.	1730.	1432.	1111.	797.	514.	267.	32.
4000.:	4306.	4292.	4244.	4163.	4044.	3719.	3266.	2700.	2115.	1549.	986.	514.	61.
3500.:	6028.	6007.	5942.	5833.	5679.	5232.	4598.	3856.	3103.	2339.	1549.	797.	95.
3000.:	3669.	3656.	3619.	3557.	3470.	3208.	2668.	2423.	2761.	3104.	2115.	1111.	132.
2500.:	2049.	2044.	2126.	1998.	1957.	1824.	1687.	1430.	2423.	3656.	2700.	1432.	170.
2000.:	2297.	2293.	2280.	2255.	2224.	2111.	1979.	1888.	2088.	4598.	3267.	1730.	205.
1500.:	2293.	2293.	2293.	2293.	2284.	2210.	2111.	1824.	3208.	5232.	3719.	1975.	234.
1000.:	1866.	1852.	1874.	1931.	2094.	2264.	2229.	1957.	3470.	5679.	4049.	2152.	256.
750.:	1519.	1526.	1559.	1634.	1931.	2293.	2255.	1998.	3557.	5833.	4163.	2214.	263.
500.:	1420.	1430.	1467.	1559.	1874.	2293.	2280.	2027.	3619.	5942.	4244.	2256.	266.
250.:	1374.	1389.	1430.	1527.	1852.	2293.	2293.	2044.	3656.	6007.	4293.	2284.	271.
0.:	1366.	1379.	1420.	1519.	1866.	2293.	2298.	2049.	3669.	6029.	4309.	2293.	272.
	0.	250.	500.	750.	1000.	1500.	2000.	2500.	3000.	3500.	4000.	4500.	5000.

21/04-1977.   22.32
PROCESSOR   =   107 SEC
ELAPSED   =   387 SEC
INPUT/OUTPUT =   26 SEC

A.L.F. PROGRAM NO. 10   PROBLEM NO. 1   17/3.1976
FLUXBEREGNINGER   ELEMENTMETODEN

I GRUPPE: 1   ER DEN MAKSIMALE MIDDELFLUX: 9646

FLUXEN FOREKOM I OMRAADET X FRA 10. TIL 20. OG Y FRA 0. TIL 5.

I GRUPPE: 2   ER DEN MAKSIMALE MIDDELFLUX: 5323

FLUXEN FOREKOM I OMRAADET X FRA 30. TIL 40. OG Y FRA 0. TIL 5.

MIDDELFLUX I GRUPPE   1

5000.–4000.	614	595	528	378	187	63
4000.–3000.	2759	2662	2399	1607	696	187
3000.–2000.	7911	7737	7031	5696	1607	378
2000.–1000.	9666	9622	9366	7031	2399	528
1000.–500.	9261	9556	9622	7737	2662	595
500.–0.	6666	9262	9646	7911	2759	614
	0.–500.	500.–1000.	1000.–2000.	2000.–3000.	3000.–4000.	4000.–5000.

MIDDELFLUX I GRUPPE   2

5000.–4000.	2281	2211	1964	1030	809	271
4000.–3000.	5323	5169	4616	3444	2295	809
3000.–2000.	2352	2298	2099	1144	3444	1030
2000.–1000.	2219	2228	2195	2699	4616	1964
1000.–500.	1567	1765	2228	2298	5169	2211
500.–0.	1399	1568	2219	2352	5323	2281

0. 500. 1000. 2000. 3000. 4000. 5000.
DEN INTEGRERTE FLUX FOR HELE REAKTOREN OG ALLE GRUPPER ER: 15177199

page 8 cont.

21/04-1977. 22.32
PROCESSOR = 108 SEC
ELAPSED = 388 SEC
INPUT/OUTPUT= 26 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 1 17/3.1976
FLUXREGULERINGER ELEMENTMETODEN

REAKTIONSINTEGRALER:

REAKTIONSINTEGRALERNE ER NORMALISERET SAA GENNEMSNITTET FOR DEN DEL AF REAKTOREN
HVOR REAKTIONSINTEGRALET OVERSTIGER 0-10*MAX(REAKTIONSINTEGRAL) ER 1000.

REAKTIONSINTEGRAL OVER ALLE GRUPPER, ELEMENTVIS.
REAKTIONSTVAERSNIT NR. 1

5000.	0	0	0
3000.	1067	698	0
1000.	1059	1067	0
0.			

0. 1000. 3000. 5000.

TIME USED FOR THIS PROBLEM
PROCESSOR = 108 SEC
ELAPSED = 309 SEC
INPUT/OUTPUT = 26 SEC

APPENDIX C

Example II

A complete card deck for a calculation with boundary condition (2), gamma matrix.

Output corresponding to this run is shown in appendix D.

```
?JOB RT/MISFT;CLASS=1;CHARGE=2518C2;USER=RTMISFELDT/WORK
?PROCESSTIME=300; IOTIME=300; PRINTLIMIT=5000;
?BEGIN COMPILE FEMB ALGOL
?ALGOL FILE TAPE=FEMB
?DATA
$SET MLNGL
?DATA INPDATA
FF
2
22.3.1977.
2.2.4.2.1.2.1.0.0.1.
8.8.
0.7.8.
7.1.
2.2.
0.7.8.
7.1.
2.2.
1.2.2.2.
1.3.3.2.
1.4.3.2.
1.1.1.1.
1.
0.0.
2.
0.2.0.-0.1.0.05.
3.
2.0.3.
0.03.0.0.03.0.01.
1.0.
0.0.
0.0.
4.
1.0.4.
0.02.0.0.01.0.01.
1.0.
0.0.05.
0.0.02.
 75.-1.-1.1.5.
FF
-1.
?END JOB
```

APPENDIX D

Output for example II corresponding to the card deck shown in appendix C.


```
A.E.K. PROGRAM NO. 10       PROBLEM NO. 2  22/3.1977
FLUXBEREGNINGER   ELEMENTMETODEN

  CMX   CMY   NCP   NR   NLL   NG   NPR   KDS  NREC    M
   2.    2.    4.   2.    1.   2.    1.    0.    0.   1.

   NX     NY
   7.     6.


  XC

   0.          7.000E+00   6.000E+00

  FMX

         7.          1.

  FACX
         2.          2.


  YC

   0.          7.000E+00   6.000E+00

  FMY

         7.          1.

  FACY

         2.          2.


  COMPOSITIONS NUMBERS

   1.   2.   2.   2.
   1.   3.   3.   2.
   1.   4.   4.   2.
   1.   1.   1.   1.

1
EXTRAS 0.             0.
```

```
2
GAMMA: 2.00000E-01 0.          -1.00000E-01 5.00000E-02


3
    D: 2.00000E+00 3.00000E-01
   SS: 3.00000E-02 0.          3.00000E-02 1.00000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          0.
 RR  : 0.          0.


4
    D: 1.00000E+00 4.00000E-01
   SS: 2.00000E-02 0.          1.00000E-02 1.00000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          5.00000E-02
 RR  : 0.          2.00000E-02


MAXIMALITERATIONEN      EPS             EPSHY           OMEGA
               77.  1.0000E-06      1.0000E-01      1.5000E+00
```

page 1 cont.

21/04-1977. 22.32
PROCESSOR = 3 SEC
ELAPSED = 5 SEC
INPUT/OUTPUT= 1 SEC

A.F.K. PROGRAM NO. 10 PROBLEM NO. 2 22/3.1977
FLUXBEREGNINGER [illegible]

[illegible]	MAXANTALITERATIONER	EPS	EPSMY	OMEGA
1024.	75.	1.0000E-06	1.0000E-01	1.5000E+00

ORDTAL	PTYPE	GANTAL	EANTAL	RANTAL	ANTALUBK	MAXHUD	ANTALBLK
4	2	[illegible]	64	32	61	625	1

ITE. NR	RESIDUE	RATIO	LAMBDA	KEFF	DELTAKEFF	TOTALKILDE
1	3.0676E-01	-1.00000000	0.94064054	1.06310536	6.3105E-02	2.6046E+00
2	1.2400E-01	-0.50492239	0.90137609	1.10941402	4.6309E-02	2.7181E+00
3	6.0027E-02	-0.61836428	0.88307342	1.13240868	2.2994E-02	2.7744E+00
4	8.9036E-02	0.76483700	0.87392512	1.14426260	1.1654E-02	2.8034E+00
5	6.7761E-02	0.70780323	0.86993523	1.14951007	5.2401E-03	2.8163E+00
6	4.9906E-02	0.83253144	0.86939467	1.15022560	7.1473E-04	2.8181E+00
7	3.9618E-02	0.86502852	0.87106150	1.14802456	-2.2010E-03	2.8127E+00
8	2.9452E-02	0.86329842	0.87474226	1.14319309	-4.8307E-03	2.8008E+00
MY: 0.873264	ELSFAC : 7.315205					
9	9.7267E-02	-1.51094120	0.91291970	1.09530059	-4.7607E-02	2.6637E+00
10	5.7210E-02	-0.60468396	0.92595279	1.07996266	-1.5418E-02	2.6459E+00
11	4.7430E-02	-0.85105773	0.93600448	1.06518453	-1.4704E-02	2.6097E+00
12	3.3200E-02	-0.82500126	0.95114590	1.05136331	-1.3621E-02	2.5758E+00
13	2.2419E-02	-0.90344091	0.96264234	1.03880742	-1.2556E-02	2.5451E+00
MY: -0.903441	ELSFAC : 6.525364					
14	2.0367E-02	0.80982063	0.96815972	1.03288742	-5.9200E-03	2.5306E+00
15	1.4325E-02	0.92104467	0.97815719	1.02233057	-1.0557E-02	2.5047E+00
16	1.1406E-02	0.99384900	0.98716402	1.01300258	-9.3277E-03	2.4619E+00
17	9.7905E-03	0.96797275	0.99538176	1.00465985	-8.3430E-03	2.4614E+00
18	8.8227E-03	0.94511159	1.00288930	0.99711902	-7.5408E-03	2.4429E+00
19	7.9066E-03	0.90837526	1.00977567	0.99031897	-6.8001E-03	2.4263E+00
MY: 0.906375	ELSFAC : 10.914063					
20	1.1051E-02	-0.60152307	1.08303467	0.92333148	-6.6987E-02	2.2622E+00
21	5.2131E-03	-0.34627292	1.08289954	0.92344670	1.1522E-04	2.2624E+00
22	3.2265E-03	0.77383773	1.08291999	0.92342926	-1.7441E-05	2.2624E+00
23	1.7460E-03	0.75945867	1.08308251	0.92329070	-1.3856E-04	2.2621E+00
24	1.3634E-03	0.80786345	1.08324018	0.92315630	-1.3439E-04	2.2617E+00
25	1.0106E-03	0.85511739	1.08337443	0.92304190	-1.1440E-04	2.2615E+00
26	8.2152E-04	0.84676223	1.08344283	0.92298364	-5.8267E-05	2.2613E+00
27	6.3321E-04	0.80615758	1.08345595	0.92297245	-1.1181E-05	2.2613E+00
28	5.1200E-04	0.84524251	1.08341529	0.92300710	3.4642E-05	2.2614E+00
29	4.1375E-04	0.97157596	1.08335395	0.92305936	5.2262E-05	2.2615E+00
30	3.8545E-04	1.01460850	1.08325104	0.92314705	8.7688E-05	2.2617E+00
31	3.9500E-04	1.04477429	1.08310385	0.92327250	1.2546E-04	2.2620E+00
32	2.6432E-04	1.01170441	1.08299291	0.92342677	1.5426E-04	2.2624E+00

33	2.3692E-04	0.99023807	1.06271865	0.92360098	1.7421E-04	2.2628E+00
34	2.2846E-04	0.97820458	1.06249824	0.92378903	1.8806E-04	2.2633E+00
35	2.2414E-04	0.96924162	1.06226814	0.92398544	1.9640E-04	2.2638E+00
36	2.1962E-04	0.96066417	1.06203329	0.92418598	2.0054E-04	2.2643E+00
37	2.1490E-04	0.95429626	1.06179781	0.92438715	2.0117E-04	2.2647E+00
38	2.1003E-04	0.94943462	1.06156472	0.92458637	1.9922E-04	2.2652E+00
39	2.0604E-04	0.94535339	1.06133640	0.92478159	1.9522E-04	2.2657E+00
40	2.0104E-04	0.94180678	1.06111468	0.92497125	1.8966E-04	2.2662E+00
MY: 0.941807	FKSFAC : 17.184131					
41	4.6647E-04	0.75150320	1.07745331	0.92811446	3.1432E-03	2.2739E+00
42	3.0984E-04	-0.65696127	1.07738122	0.92817656	6.2104E-05	2.2740E+00
43	2.0953E-04	0.86782146	1.07732074	0.92822867	5.2109E-05	2.2742E+00
44	1.3720E-04	0.96614711	1.07727245	0.92827028	4.1605E-05	2.2743E+00
45	1.0274E-04	0.80189753	1.07723954	0.92829864	2.8359E-05	2.2743E+00
46	8.8779E-05	0.85512709	1.07722098	0.92831463	1.5995E-05	2.2744E+00
47	7.7477E-05	0.87606044	1.07721488	0.92831989	5.2622E-06	2.2744E+00
48	6.4420E-05	0.92606723	1.07721899	0.92831635	-3.5436E-06	2.2744E+00
49	5.5108E-05	0.92143062	1.07723138	0.92830567	-1.0678E-05	2.2743E+00
50	4.6570E-05	0.98974077	1.07724923	0.92829029	-1.5382E-05	2.2743E+00
51	4.1744E-05	1.02184114	1.07727230	0.92827041	-1.9860E-05	2.2743E+00
52	3.6907E-05	1.00029816	1.07729986	0.92824666	-2.3749E-05	2.2742E+00
53	3.5951E-05	0.96368765	1.07733062	0.92822016	-2.6503E-05	2.2741E+00
54	3.5093E-05	0.97283342	1.07736348	0.92819185	-2.8311E-05	2.2741E+00
55	3.3919E-05	0.96464538	1.07739759	0.92816246	-2.9387E-05	2.2740E+00
56	3.2721E-05	0.95841353	1.07743225	0.92813261	-2.9855E-05	2.2739E+00
57	3.1804E-05	0.95254384	1.07746690	0.92810276	-2.9847E-05	2.2739E+00
58	3.1032E-05	0.94785676	1.07750110	0.92807330	-2.9458E-05	2.2738E+00
59	3.0447E-05	0.94395331	1.07753452	0.92804452	-2.8784E-05	2.2737E+00
60	2.9538E-05	0.94058043	1.07756695	0.92801663	-2.7891E-05	2.2736E+00
MY: 0.940580	FKSFAC : 16.829472					
61	6.7509E-05	0.74114431	1.07809162	0.92756495	-4.5168E-04	2.2725E+00
62	4.4020E-05	-0.51583084	1.07810165	0.92755632	-8.6258E-06	2.2725E+00
63	2.7669E-05	0.86703866	1.07811012	0.92754903	-7.2925E-06	2.2725E+00
64	1.9312E-05	0.88623485	1.07811695	0.92754316	-5.8735E-06	2.2725E+00
65	1.4342E-05	0.86252362	1.07812165	0.92753911	-4.0455E-06	2.2725E+00
66	1.2389E-05	0.95353022	1.07812436	0.92753678	-2.3279E-06	2.2725E+00
67	1.0895E-05	0.97618579	1.07812533	0.92753595	-3.3619E-07	2.2725E+00
68	9.3615E-06	0.92256270	1.07812487	0.92753634	3.9296E-07	2.2725E+00
69	7.6686E-06	0.91884529	1.07812326	0.92753773	1.3887E-06	2.2725E+00
70	6.5238E-06	0.96799824	1.07812098	0.92753977	2.0443E-06	2.2725E+00
71	5.7928E-06	1.02404059	1.07811777	0.92754245	2.6757E-06	2.2725E+00

page 2 cont.

21/04-1977. 22.36
PROCESSOR = 96 SEC
ELAPSED = 195 SEC
INPUT/OUTPUT= 13 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 2 22/3.1977
FLUXBEREGNINGER [illegible]

ITERATIONEN ER AFSLUTTET
DER ER UDFØRT 71 ITERATIONER
EPSILON VAR 0.0001000000 OG MAKSIMALE ANTAL ITERATIONER 75
DEN TOTALE FISSIONSKILDE ER 2.2196E+04

KEFF 0.9275424503
FLUKSEN BLEV

FLUX I GRUPPE 1

8000.:	5234.	5197.	5085.	4899.	4646.	4314.	3942.	3572.	3224.
7000.:	5837.	5796.	5672.	5466.	5177.	4809.	4373.	3917.	3572.
6000.:	7061.	7012.	6864.	6611.	6259.	5789.	5188.	4373.	3942.
5000.:	8026.	7979.	[illegible]	7511.	7094.	6531.	5789.	4809.	4314.
4000.:	[illegible]	[illegible]	8519.	8136.	7724.	7094.	6259.	5177.	4641.
3000.:	9322.	9255.	9031.	8703.	8196.	7511.	6515.	5466.	4899.
2000.:	9703.	9632.	9417.	9031.	8519.	7700.	6864.	5672.	5086.
1000.:	9926.	9853.	9632.	9255.	8703.	7970.	7012.	5796.	5197.
0.:	9999.	9926.	9703.	9322.	8770.	8027.	7062.	5837.	5235.
	0.	1000.	2000.	3000.	4000.	5000.	6000.	7000.	8000.

FLUX I GRUPPE 2

8000.:	9525.	[illegible]	9495.	9345.	9148.	8913.	8672.	8417.	8145.
7000.:	9395.	9371.	9301.	9192.	9052.	8896.	8741.	8600.	8417.
6000.:	9214.	9196.	9145.	[illegible]	8963.	8861.	8776.	8741.	8672.
5000.:	9127.	9113.	9075.	[illegible]	8944.	8887.	8861.	8896.	8918.
4000.:	9097.	[illegible]	9057.	9015.	8973.	8948.	8963.	9052.	9149.
3000.:	9097.	9089.	9067.	9039.	9015.	9015.	9062.	9192.	9346.
2000.:	9111.	9104.	9087.	9063.	9057.	9073.	9143.	9301.	9495.
1000.:	9123.	9116.	9104.	9089.	9086.	9113.	9196.	9371.	9558.
0.:	9125.	9123.	9111.	9097.	9097.	9127.	9215.	9395.	9620.
	0.	1000.	2000.	3000.	4000.	5000.	6000.	7000.	8000.

21/04-1977. 22.36
PROCESSOR = 96 SEC
ELAPSED = 195 SEC
INPUT/OUTPUT= 13 SEC

A.E.K. PROGRAM NO. 10 PROBLEM NO. 2 22/3.1977
FLUXBEREGNINGER LIFBEATMETODEN

I GRUPPE: 1 ER DEN MAKSIMALE MIDDELFLUX: 9926

FLUXEN FOREKOM I OMRAADET X FRA 0. TIL 1. OG Y FRA 0. TIL 1.

I GRUPPE: 2 ER DEN MAKSIMALE MIDDELFLUX: 9494

FLUXEN FOREKOM I OMRAADET X FRA 7. TIL 8. OG Y FRA 0. TIL 1.

MIDDELFLUX I GRUPPE 1

	0.–1000.	1000.–2000.	2000.–3000.	3000.–4000.	4000.–5000.	5000.–6000.	6000.–7000.	7000.–8000.
8000.–7000.	5516	5438	5281	5046	4735	4360	3951	3572
7000.–6000.	6427	6336	6154	5879	5508	5040	4463	3951
6000.–5000.	7518	7412	7197	6869	6418	5824	5040	4360
5000.–4000.	8369	8249	8007	7632	7112	6418	5508	4735
4000.–3000.	9014	8863	8617	[illegible]	7632	6869	5879	5046
3000.–2000.	9478	9339	9055	8617	8007	7197	6154	5281
2000.–1000.	9778	9633	9339	8863	8249	7412	6336	5438
1000.–0.	9926	9778	9478	9014	8369	7518	6427	5516

0. 1000. 2000. 3000. 4000. 5000. 6000. 7000. 8000.

MIDDELFLUX I GRUPPE 2

8000.–7000.	9494	9439	9333	9184	9003	8807	8608	8395
7000.–6000.	9294	9253	9175	9067	8943	8818	8715	8608
6000.–5000.	9163	9131	9073	8997	8915	8847	8818	8807
5000.–4000.	9106	9082	9040	8988	8939	8915	8943	9003
4000.–	[illegible]	9075	9045	9011	8988	8997	9067	9184

3000.								
	9100	9067	9065	9045	9040	9073	9175	9333
2000.								
	9114	9103	9087	9075	9082	9132	9253	9439
1000.								
	9123	9114	9100	9092	9106	9163	9294	9494
0.								

0. 1000. 2000. 3000. 4000. 5000. 6000. 7000. 8000.

DEN TOTALE EFFEKT FLUX FOR HELE REAKTOREN OG ALLE GRUPPER ER: 1022746

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21/04-1977. 22.36
PROCESSOR = 97 SEC
ELAPSED = 196 SEC
INPUT/OUTPUT= 13 SEC

A.E.K. PROGRAM NR. 10 PROBLEM NR. 2 22/3.1977
FLUXKALCULATIONER (EIGENVALUE)

REAKTIONSINTEGRALER:

REAKTIONSINTEGRALERNE ER NORMERET SAA GENNEMSNITTET FOR DEN DEL AF REAKTOREN
HVOR REAKTIONSINTEGRALET OVERSTIGER 0=10*MAX(REAKTIONSINTEGRAL) ER 1000

REAKTIONSINTEGRAL OVER ALLE GRUPPER. ELEMENTVIS.
REAKTIONSTVAERKSOTT NR. 1

8000.	0	0	0	0	0	0	0	0	0
7000.	1026	1021	1013	1001	987	973	962	0	
6000.	1011	1006	1002	993	984	977	973	0	
5000.	1005	1002	996	992	987	984	987	0	
4000.	1004	1002	998	995	992	993	1001	0	
3000.	1005	1003	1001	998	996	1002	1013	0	
2000.	1006	1005	1003	1002	1000	1004	1021	0	
1000.	1007	1006	1005	1004	1005	1011	1026	0	
0.									

0. 1000. 2000. 3000. 4000. 5000. 6000. 7000. 8000.

TIME USED FOR THIS PROBLEM
PROCESSOR = 97 SEC
ELAPSED = 197 SEC
INPUT/OUTPUT = 13 SEC