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A FORTRAN CODE CVTRAN TO PROVIDE CROSS-SECTION FILE FOR TWODANT BY USING MACROSCOPIC FILE WRITTEN BY SRAC

March 1999

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A Fortran Code CVTRAN to Provide Cross-section File for TWODANT by Using Macroscopic File Written by SRAC

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A code CVTRAN provides the macroscopic cross-sections in the format of XSLIB file which is one of Standard interface files for a two-dimensional Sn transport code TWODANT by reading a macroscopic cross section file in the PDS format which is prepared by SRAC execution.

While a two-dimensional Sn transport code TWOTRAN published by LANL is installed as a module in the SRAC code system, several functions such as alpha search, concentration search, zone thickness search and various edits are suppressed. Since the TWODANT code was released from LANL, its short running time, stable convergence and plenty of edits have attracted many users. The code CVTRAN makes the TWODANT available to the SRAC user by providing the macroscopic cross-sections on a card-image file XSLIB. The CVTRAN also provides material dependent fission spectra into a card-image format file CVLIB, together with group velocities, group boundary energies and material names. The user can feed them into the TWODANT input, if necessary, by cut-and-paste command.

Keywords: CVTRAN, Fortran Code, Interface File, XSLIB File, TWODANT Code, Macroscopic Cross-section, PDS File, SRAC Code System

* Radiation Application Development Association (RADA)

JAERI－Data/Code 99－011

CVTRAN:SRACで書いた巨視的断面積ファイルを用いてTWODANT用断面積ファイルを準備するFortranコード

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CVTRANコードは2次元Sn輸送コードTWODANT用にその標準入出力ファイルの一つXSLIBの形式で巨視的断面積を準備する。入力ファイルはSRACで作成しPDS形式で納められた断面積ファイルである。

SRACコードシステムにはすでにLANLで作成された2次元Sn輸送コードTWOTRANが収容されているが、オリジナル版にあったαサーチ、密度サーチ、厚みサーチやいろいろの出力編集機能が削除されている。TWODANTが発表されて以来、その短い計算時間、安定した収束、豊富な出力編集機能は利用者にとって魅力的である。このCVTRANコードは巨視的断面積をカードイメージファイルXSLIBに用意することで、SRACの利用者はTWODANTを容易に利用できる。CVTRANコードはさらに、CVLIBと名づけた別のカードイメージファイルに、物質依存の核分裂スペクトル、群別の中性子速度、エネルギ群境界や物質名を書き込む。これらはTWODANTの入力に、cut-and-paste操作で、利用できる。

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Contents

目　　次

1. General

A code CVTRAN provides the macroscopic cross-sections in the format of XSLIB file which is one of Standard interface files for a two-dimensional Sn transport code TWODANT[1] by reading a macroscopic cross section file in the PDS format which is prepared by SRAC[2,3] execution.

While a two-dimensional Sn transport code TWOTRAN[4] published by LANL is installed as a module in the SRAC code system, several functions such as alpha search, concentration search, zone thickness search and various edits are suppressed. Since the TWODANT code was released from LANL, its short running time, stable convergence and plenty of edits have attracted many users.

The TWODANT can accept zone-dependent fission spectra while the TWOTRAN accept only one spectrum. The SRAC provides the fission spectrum of the material corresponding to the last fissionable zone number into an ISOTXS file. The CVTRAN writes fission spectrum of every material into a CVLIB file in card-image format, together with group velocities, group boundary energies and material names. The user can feed them into the TWODANT input, if necessary, by cut-and-paste procedure.

2. How to Use

The process is briefly described by the following steps.

(1) Prepare the macroscopic cross-sections by mixing or cell calculations with the SRAC code system. Note that the whole energy group cross-sections are composed in the fine group structure if IC10=0 (in Block 3 of SRAC), or in the coarse group structure if IC10=1.

If the anisotropic scattering calculation is intended by TWODANT, a dummy input of the ANISN (or TWOTRAN) module has to be fed in the SRAC execution with specifying the order of ISCT>0 so that the anisotropic scattering components are written into the macroscopic PDS file MACRO (or MACROWRK).

(2) Run the CVTRAN with specifying the materials used in the TWODANT run. The MACRO (or MACROWRK) is an input file and the XSLIB file that keeps cross-sections in card-image is output.

The material names (NAMES), material dependent fission spectra (CHI), velocities (VEL) and energy group boundaries (EBOUND) are always written into a separate card-image file CVLIB, so that they may be used for TWODANT input.

(3) Run TWODANT by feeding the XSLIB file with fixed naming as "xslib".
As the SRAC provides the macroscopic cross-sections of materials, the input for 'Mixing' can be minimized: in principle, the short forms of TWODANT

matls=isos

assign=matls

are sufficient as BLOCK-IV input.

3. Input Requirements of CVTRAN

3.1 Input Requirements

Input data are read in the free format by the REAG routine of the SRAC system which accepts a series of data prepared by alphanumeric characters in any form, length, occurrence on any column on the fixed logical record. However, character type data have to be always on the beginning columns on a card-image record.

Block 1 (A16,3I)

HCOM	Constant string of 16 characters to be written in header of each material
MTP	Number of materials
ISCT	Scattering order (0,1,....,5)
ICF	Index of energy group structure (0 for coarse, 2 for fine)

Block 2 MTP MTP times of (A8)

MTNAME	Material ID name, enter a member name in the MACRO (MACROWRK) file on a separate card. The higher scattering components and N2N components are automatically read in. Eight characters of material are composed by tags expressed by mmmmebfp or caseebxp, where mmmm with seventh character f denotes material name, case and x do case name of the cell calculation and the region number, respectively. The tag b denotes burnup step indicator. The energy range

indicator e must be common in every MTNAME. As the anisotropic and N2N components are searched automatically by this program, a character in the p position is meaningless in this input.

3.2 JCL Statement for MSP Operating System

A Sample JCL for Compile_Linkage_GO is shown below.

```
=================================================================
  T(03) C(08) W(00) I(04) E(03) SRP NOTIFY(J2218)                 00010000
//*****************************************                       00020000
//*  CVTRAN        LOAD MODULE PRODUCTION FOR GS8400               00030000
//*****************************************                       00040000
//FT1 EXEC FORTEX,RGN=6000K,SO='J2218.CVTRANT',Q='.FORT77',        00050000
//  A='ELM(*)',OPT=E                                               00060000
//SYSPRINT DD DUMMY                                                00070000
//*****************************************                       00080000
//FT7 EXEC FORTEX,RGN=6000K,SO='J2218.PDSLB',Q='.FORT77',          00090000
//  A='ELM(*)',OPT=E,DISP=MOD                                      00100000
//SYSPRINT DD DUMMY                                                00110000
//******* LINKAGE ***************************                       00120000
//  EXEC LKEDEX,A='AMODE(31),SIZE=(1000K,50K)',                    00130000
//        PRVLIB='J0001.PDSF',GRLIB=PNL                            00140000
//*SYSLMOD DD DSN=J2218.CVTRANT.LOAD,DISP=(NEW,CATLG,DELETE),      00150000
//*          UNIT=TSSWK,SPACE=(TRK,(100,5,5),RLSE)                 00160000
//  EXEC GOEX,RGN=30M                                              00170000
//STEPLIB DD DSN=&&LM,DISP=(OLD,DELETE)                            00180000
//         DD DSN=J0001.PDSF.LOAD,DISP=SHR                         00190000
//FT06F001 DD SYSOUT=*,DCB=(RECFM=FBA,LRECL=137,BLKSIZE=19043)     00200000
//FT99F001 DD SYSOUT=*,DCB=(RECFM=FBA,LRECL=137,BLKSIZE=19043)     00210000
//FT11F001 DD DSN=J2218.NCVLIB.DATA,UNIT=D1000,DISP=OLD            00230000
//MACROWRK DD DSN=J2218.MACRO.PDS,UNIT=D1000,DISP=SHR              00240000
//*SSIN DD DSN=J2218.SRACINPT.DATA(CVTRANT),UNIT=D1000,DISP=SHR    00250000
//SYSIN DD *                                                       00260000
SRAC TO TWODANT          5  0  2                                  00270000
FEMTF012                                                          00280000
```

```
UMETF022                                                          00290000
MOXMF032                                                          00300000
NATUF042                                                          00310000
DEPUF052                                                          00320000
/*                                                                00330000
//                                                                00340000
=====================================================================
```

3.3 Shell Script for UNIX Operating System

Shell Script for Compile and Link on VPP500

```
# Compile and Link : create a Load module
#!/bin/csh -f
#@$-C cvtranLM
#
# set Input file name and PDS directory name
set FORT = /dg02/ufs02/j3812/CVTRANT/src/cvtran
set PDSLIB = /dg02/ufs02/j3812/CVTRANT/src/pdslib
# set directory of OBJECT files and LOAD module
set BIN = $HOME/CVTRANT/bin
#
# Compile and Create object modules of J2218.CVTRANT.FORT77/*.f
cd $BIN
/usr/bin/rm $BIN/*
f77vpp -c -Ob  -Ps $FORT/*.f
f77vpp -c -Ob  -Ps $PDSLIB/*.f
#/usr/bin/rm $BIN/*.s
#
# Create a load module of J2218.CVTRANT.FORT77
f77vpp $BIN/*.o
/usr/bin/mv a.out $BIN/cvtrant.lm
#
# remove object files
#/usr/bin/rm $BIN/*.o
```

Shell Script for RUN on VPP500

```
# CVTRAN run
#!/bin/csh -f
################# SET NQS OPTIONS ###########################
#@$-q  vpps    # vpp queue class
#@$-lM  96mb   # memory size limit to XXX (MB)
#@$-lT  30:00  # CPU time limit to XX:XX (mm:ss)
#@$-C  CVTRAN  # code name to XXXXX
#@$-eo         # direct stderr output to the stdout destination
#@$-me         #
################# SET NQS OPTIONS ###########################
#
set CASE = cvtrango
# set Input file name and PDS directory name
set PDSIN = $HOME/CVTRANT/MACROPDS
# set Output directory name
set OUT = $HOME/CVTRANT/output
# set Load module of CVTRAN
set LM = $HOME/CVTRANT/bin/cvtrant.lm
#
cd $OUT
/usr/bin/rm *
#
#
# set I/O files
setenv fu06 $OUT/ft06f001
setenv fu99 $OUT/ft99f001
setenv fu10 $OUT/xslib
setenv fu11 $OUT/ncvlib.data
#
# run cvtrant
##timex -H $LM < cvtrant.inp
cat - << END_DATA | timex -H $LM >& $OUT/$CASE.out
$PDSIN   Old   File
SRAC TO TWODANT        5  0  1
```

```
FEMTF012
UMETF022
MOXMF032
NATUF042
DEPUF052
END_DATA
#
```

4. Structure of CVTRAN

User Routines

MAIN (main routine)

CVMASW (subroutine) SERCH (subroutine) XSLIB (subroutine)

The above routines are newly written for CVTRAN.

CLEA (subroutine to reset an array)

READ (subroutine) FILSRC (subroutine) PDSERR (subroutine)

The above three are routines for PDS file management on MSP OS working with an assembler routine PDSF. The routine READ also has the following entry names

WRITE, OVRWRT, RENAME, OPNPDS, CLSPDS, DELETE, INFOR, GETLEN, and SEARCH.

The three routines (READ, FILSRC, and PDSERR) are replaced for UNIX version by retrieving from /dg02/ufs02/j9347/SRAC98/SRAC/src as

read.f, copydt.f, filsrc.f, getlen.f, lnmemb.f, lnpath.f, opnpds.f, pdserr.f, pdslen.f, pdsrd.f and search.f

where no assembler routine is required on UNIX.

REAG (subroutine to read data in 'Free Format')

This routine includes the entry names; REAI and REAM.

The routine REAG is replaced for UNIX version by ream.f and ream0.f which are retrieved from /dg02/ufs02/j9347/SRAC98/SRAC/src.

FORTRAN Library Routines

FLOAT MAX MIN DATE TIME ERRTRA

Tree Structure

```
-----------------------------------------------------------------------------
MAIN  ---*REAM
        +-%->(OPNPDS )
        +--SERCH  ---%->(GETLEN )
        !          +--->(READ   )
        !          +-%->(SEARCH )
        +--CVMASW ----CLEA
                   +-%->(SEARCH )
                   +--->(READ   )
                   +--XSLIB

READ  ----FILSRC
        +-*PDSRD  (assembler)
        +-*PDSWRT (assembler)
        +-*PDSSRC (assembler)
        +-*PDSDEL (assembler)
        +-*PDSREN (assembler)
        +-*PDSOPN (assembler)
        +-*PDSCLS (assembler)
        +-*PDSMEM (assembler)
        +-*PDSLEN (assembler)
        +--PDSERR
-----------------------------------------------------------------------------
```

* Routines written by assembler language for MSP OS. On UNIX OS, they are replaced by Fortran77 statements.

Main Routine

Read input data

Set file; fine/coarse-group macroscopic cross section file

Call SERCH

Call CVMASW

Write output data

Subroutine SERCH (MTNAME, NM, IGM, NUS, NDS, ICODE, IB, B, LIMB, EB)

Read group structure from the member CONTe000

Find number of groups

Find maximum up-scatter and down-scatter

Subroutine CVMASW (MTNAME, MTP, B, IB, CRX, IGM, ISCT1, IHM, IHS)

```
┌── Material Loop
│   ┌── Group Loop
│   │     (1) Transfer 1D X-section
│   │     (2) Transfer scattering X-section
│   └── End Group Loop
│   ┌── Group Loop if ISCT>0
│   │     (3) Transfer scattering X-section
│   │     (4) Correct transport X-section
│   └── End Group Loop
│         (5) Call subroutine XSLIB ( NXSLIB, NOUT2, IDENT, ARRAY,
│                                     CRX, ISCT1, IHT, IHS, IHM, IGM, IHMIGM )
└── End Material Loop
```

Subroutine XSLIB

Write macroscopic cross-sections into XSLIB file

5. Output Files of CVTRAN

The CVTRAN permits two card-image output files; XSLIB and CVLIB.

5.1 Contents and Structure of XSLIB File

Begin Material loop ----------

Begin Scattering order loop ----------

(A header record)

SOLD(M)	A8	MAT ID
ISCT	I1	Scattering order as P=0/1

IGM	I2	Number of energy groups
IHT	I2	Position of total X-section (=8)
IHS	I2	Position of in-group scattering X-section
IHM	I3	Length of group vector
HCOM	A16	String given by Block 1
IHH	I2	Hour
IMM	I2	Minute
IDATE	A8	date
NUM	I5	Serial number of record

Begin Group loop ----------
IHT-7 : Fission Spectrum
IHT-6 : SIG(n,f)
IHT-5 : SIG(n, γ)
IHT-4 : SIG(n,2n)
IHT-3 : SIG-TR
IHT-2 : SIG(n,A)
IHT-1 : υ *SIG(n,f)
IHT : SIG-Total
IHT+1 : S(G+NUS → G) up-scattering
.....
IHS-1 : S(G+1 → G) up-scattering
HIS : in-group scattering
HIS+1 : S(G –1 → G) down-scattering
.....
IHM : S(G-NDS → G) down-scattering
(immediately followed by next group
End group loop ----------
End scattering loop ----------
End material loop ----------

The first 5 data; fission spectrum, fission, capture, N2N, and transport cross-sections in each group vector are not used in SOLVER modules, but in EDIT modules of TWODANT.

5.2 Contents and Structure of CVLIB File

The CVLIB file provides the input data related to BLOCK III (the Nuclear Data Details) for the user of TWODANT. They are written in card-image format required in TWODANT. The user utilizes the contents of CVLIB file by cut-and-paste process for the TWODANT input. As seen in the sample output, the material dependent fission spectra may be used as they are or a spectrum of the specified material can be used as CHIVEC vector.

(1) Velocity vector
(2) Fission spectrum by material
(3) Material names
(4) Boundary energies of group structure

6. Sample I/O of CVTRAN

6.1 Sample Input

As seen in the sample JCL, a set of input data for the case (5 materials, isotropic scattering, fine group structure) is as follows.

```
=================================================================
SRAC TO TWODANT          5  0  1                          00270000
FEMTF012                                                  00280000
UMETF022                                                  00290000
MOXMF032                                                  00300000
NATUF042                                                  00310000
DEPUF052                                                  00320000
/*                                                        00330000
=================================================================
```

6.2 Contents of XSLIB File for Sample Run of CVTRAN

```
=====================================================================
FEMTF012:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/98)   0
 0.00000E+00 0.00000E+00 8.21129E-04 0.00000E+00 1.55900E-01 8.21129E-04      1
 0.00000E+00 1.55900E-01 1.19036E-01 0.00000E+00 0.00000E+00 0.00000E+00      2
 0.00000E+00 0.00000E+00 0.00000E+00 4.31870E-04 0.00000E+00 1.30686E-01      3
 4.31870E-04 0.00000E+00 1.30686E-01 1.26396E-01 3.48686E-02 0.00000E+00      4
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 6.89589E-04 0.00000E+00      5
 1.67925E-01 6.89589E-04 0.00000E+00 1.67925E-01 1.61719E-01 3.82094E-03      6
 1.06288E-03 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 2.06620E-03      7
 0.00000E+00 5.32220E-01 2.06620E-03 0.00000E+00 5.32220E-01 5.21868E-01      8
 5.51403E-03 3.67821E-05 1.14530E-04 0.00000E+00 0.00000E+00 0.00000E+00      9
 5.72785E-03 0.00000E+00 8.19056E-01 5.72785E-03 0.00000E+00 8.19056E-01     10
 8.05271E-01 8.28566E-03 1.74189E-06 0.00000E+00 0.00000E+00 0.00000E+00     11
 0.00000E+00 1.93803E-02 0.00000E+00 8.83907E-01 1.93803E-02 0.00000E+00     12
 8.83907E-01 8.64526E-01 8.05683E-03 0.00000E+00 2.37271E-09 0.00000E+00     13
UMETF022:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/98)   0
 6.73377E-01 0.00000E+00 1.05350E-03 0.00000E+00 1.79336E-01 1.67698E-02      1
 4.37957E-02 1.79336E-01 9.31266E-02 0.00000E+00 0.00000E+00 0.00000E+00      2
 0.00000E+00 3.16423E-01 0.00000E+00 4.58991E-03 0.00000E+00 2.82577E-01      3
 4.97244E-03 9.50099E-04 2.82577E-01 2.71201E-01 6.60562E-02 0.00000E+00      4
 0.00000E+00 0.00000E+00 9.96858E-03 0.00000E+00 1.46398E-02 0.00000E+00      5
 4.41581E-01 1.52041E-02 1.36718E-03 4.41581E-01 4.22253E-01 6.38038E-03      6
 3.88719E-03 0.00000E+00 0.00000E+00 2.31092E-04 0.00000E+00 2.22144E-02      7
 0.00000E+00 4.23396E-01 2.38371E-02 3.92723E-03 4.23396E-01 3.96901E-01      8
 4.12393E-03 2.27859E-05 1.03183E-05 0.00000E+00 0.00000E+00 0.00000E+00      9
 4.40433E-02 0.00000E+00 4.73738E-01 5.16280E-02 1.83151E-02 4.73738E-01     10
 4.20165E-01 2.65832E-03 2.66454E-07 0.00000E+00 0.00000E+00 0.00000E+00     11
 0.00000E+00 4.30171E-02 0.00000E+00 4.59260E-01 5.22086E-02 2.23446E-02     12
 4.59260E-01 4.07051E-01 1.94445E-03 0.00000E+00 2.05029E-10 0.00000E+00     13
MOXMF032:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/98)   0
 6.85826E-01 0.00000E+00 7.50041E-04 0.00000E+00 1.27247E-01 7.34275E-03      1
 1.93073E-02 1.27247E-01 9.07715E-02 0.00000E+00 0.00000E+00 0.00000E+00      2
 0.00000E+00 3.04462E-01 0.00000E+00 1.47847E-03 0.00000E+00 2.28640E-01      3
 5.04520E-03 9.57666E-03 2.28640E-01 2.14904E-01 2.81610E-02 0.00000E+00      4
 0.00000E+00 0.00000E+00 9.49208E-03 0.00000E+00 4.80617E-03 0.00000E+00      5
 3.14908E-01 9.96646E-03 1.34193E-02 3.14908E-01 2.96945E-01 8.67470E-03      6
```

```
 1.06435E-03 0.00000E+00 0.00000E+00 2.20010E-04 0.00000E+00 1.46382E-02      7
 0.00000E+00 4.20771E-01 2.81160E-02 3.46441E-02 4.20771E-01 3.86406E-01      8
 7.99417E-03 1.56310E-05 2.15949E-05 0.00000E+00 0.00000E+00 0.00000E+00      9
 6.16664E-02 0.00000E+00 4.49193E-01 1.28273E-01 1.73320E-01 4.49193E-01     10
 3.16719E-01 6.24875E-03 2.21468E-06 1.18234E-07 0.00000E+00 0.00000E+00     11
 0.00000E+00 1.22162E-01 0.00000E+00 4.84606E-01 2.02833E-01 2.10612E-01     12
 4.84606E-01 2.81773E-01 4.20162E-03 0.00000E+00 3.79037E-10 2.54031E-08     13
NATUF042:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/98)   0
 6.73373E-01 0.00000E+00 1.08216E-03 0.00000E+00 2.05532E-01 1.93057E-02      1
 5.07825E-02 2.05532E-01 1.06095E-01 0.00000E+00 0.00000E+00 0.00000E+00      2
 0.00000E+00 3.16427E-01 0.00000E+00 5.30176E-03 0.00000E+00 3.23791E-01      3
 5.74447E-03 1.09961E-03 3.23791E-01 3.10799E-01 7.62217E-02 0.00000E+00      4
 0.00000E+00 0.00000E+00 9.96866E-03 0.00000E+00 1.67996E-02 0.00000E+00      5
 4.88993E-01 1.74522E-02 1.58098E-03 4.88993E-01 4.66762E-01 7.22219E-03      6
 4.49454E-03 0.00000E+00 0.00000E+00 2.31093E-04 0.00000E+00 2.54511E-02      7
 0.00000E+00 4.69159E-01 2.73274E-02 4.54088E-03 4.69159E-01 4.39088E-01      8
 4.77882E-03 2.60200E-05 1.04491E-05 0.00000E+00 0.00000E+00 0.00000E+00      9
 4.88545E-02 0.00000E+00 5.20387E-01 5.76251E-02 2.11787E-02 5.20387E-01     10
 4.60707E-01 2.74436E-03 2.86458E-07 0.00000E+00 0.00000E+00 0.00000E+00     11
 0.00000E+00 4.73573E-02 0.00000E+00 5.04438E-01 5.79846E-02 2.58351E-02     12
 5.04438E-01 4.46453E-01 2.05465E-03 0.00000E+00 2.10136E-10 0.00000E+00     13
DEPUF052:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/98)   0
 6.72362E-01 0.00000E+00 1.07877E-03 0.00000E+00 2.04896E-01 1.91285E-02      1
 5.03043E-02 2.04896E-01 1.05814E-01 0.00000E+00 0.00000E+00 0.00000E+00      2
 0.00000E+00 3.17418E-01 0.00000E+00 5.26288E-03 0.00000E+00 3.22644E-01      3
 5.52547E-03 6.54548E-04 3.22644E-01 3.09905E-01 7.60480E-02 0.00000E+00      4
 0.00000E+00 0.00000E+00 9.98932E-03 0.00000E+00 1.66774E-02 0.00000E+00      5
 4.86733E-01 1.70156E-02 8.19439E-04 4.86733E-01 4.64957E-01 7.18764E-03      6
 4.48891E-03 0.00000E+00 0.00000E+00 2.31522E-04 0.00000E+00 2.50681E-02      7
 0.00000E+00 4.65152E-01 2.60428E-02 2.35941E-03 4.65152E-01 4.36374E-01      8
 4.76016E-03 2.55631E-05 1.04491E-05 0.00000E+00 0.00000E+00 0.00000E+00      9
 4.59806E-02 0.00000E+00 5.11446E-01 5.05260E-02 1.09759E-02 5.11446E-01     10
 4.58857E-01 2.73479E-03 2.23034E-07 0.00000E+00 0.00000E+00 0.00000E+00     11
 0.00000E+00 4.37522E-02 0.00000E+00 4.94730E-01 4.92832E-02 1.34459E-02     12
 4.94730E-01 4.45447E-01 2.06343E-03 0.00000E+00 2.10136E-10 0.00000E+00     13
=====================================================================
```

6.3 Contents of CVLIB File for Sample Run of CVTRAN

```
==============================================================================
  vel=                                                                  00010000
      0.32517E+08 0.10445E+08 0.29925E+07 0.85736E+06 0.23890E+06       00010000
      0.37103E+05                                                       00010000
  chi=                                                                  00010000
      0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00       00010000
      0.00000E+00                                                       00010000
                                                                      ; 00010000
      0.67338E+00 0.31642E+00 0.99686E-02 0.23109E-03 0.00000E+00       00010000
      0.00000E+00                                                       00010000
                                                                      ; 00010000
      0.68583E+00 0.30446E+00 0.94921E-02 0.22001E-03 0.00000E+00       00010000
      0.00000E+00                                                       00010000
                                                                      ; 00010000
      0.67337E+00 0.31643E+00 0.99687E-02 0.23109E-03 0.00000E+00       00010000
      0.00000E+00                                                       00010000
                                                                      ; 00010000
      0.67236E+00 0.31742E+00 0.99893E-02 0.23152E-03 0.00000E+00       00010000
      0.00000E+00                                                       00010000
                                                                      ; 00010000
    names=                                                              00010000
    "FEMT01" "UMET02" "MOXM03" "NATU04" "DEPU05" "                      00010000
    ebound=                                                             00010000
     1.0000E+07 1.0540E+06 8.6517E+04 7.1017E+03 5.8295E+02 1.3710E+01 00010000
     6.8256E-01                                                         00010000
                                                                        00010000
==============================================================================
```

References

1) Alcouffe R.E., Brinkley F.W., Marr D.R. and O'Dell R.D.: "User's Guide for TWODANT: A Code for Two-Dimensional, Diffusion Accelerated, Neutral Particle Transport", LA-10049-M Revised (1990).
2) Tsuchihashi K., Ishiguro Y., Kaneko K. and Ido M.: "Revised SRAC code system", JAERI 1302 (1986).
3) Okumura K., Kaneko K. and Tsuchihashi K.: "SRAC95; General Purpose Neutronics Code System", JAERI-Data/Code 96-015 (1996).
4) Lathlop K.D. and Briskley F.W.: "Theory and Use of the General Geometry TWOTRAN Program", LA-4432 (1970).

Appendix TWODANT and TWOTRAN

We shall describe some additional information to use the TWODANT for the users familiar to the TWOTRAN.

A1. Running Time of TWODANT and TWOTRAN

We give the running time and k-effective by the two codes for a sample case of 'Mock-up core'.

The common conditions are as follows;

5 Zones (materials), 6 Energy Groups

R-Z Geometry of 94.8 cm radius and 202.5 cm height

As described, replacement of fission spectrum is easy in TWODANT input. It causes the difference in k_{eff} for a leaky core in this case as shown below.

Code	cpu	k_{eff}	Remarks
TWOTRAN	115 s	0.86753	Chi for Depleted U
TWODANT	13 s	0.87041	Zone-Dependent Chi's
TWODANT	13 s	0.87138	Chi for MOX fuel
TWODANT	13 s	0.86823	Chi for Depleted U
TWODANT	13 s	0.86847	Chi for U-Metal fuel

It can be seen from the result that (1) the running time is much shorter by TWODANT, and (2) the hard fission spectrum of Pu-239 gives the higher k-eff value.

A2. Correspondence of TWODANT Input Requirements to TWOTRAN Ones

This section shows the correspondence of input items of TWODANT to those of TWOTRAN, for convenience of the user familiar to TWOTRAN.

TITLE CARD

Card 1 Title Card Control (3I6)

	TWODANT		TWOTRAN		
Word	Name	Comments	Name	Block	Comments
1	NHEAD		NTITLE	1	
2	NOTIY		-		
3	NOLIST		-		

Cards 2 through NHEAD+1: Title Cards in (12A6) NTITLE Cards for Title — NTITLE Cards for Title

BLOCK -I CONTROL AND DIMENSION

	TWODANT		TWOTRAN	
Name	Comments	Name	Block	Comments
IGEOM	=X-Y/R-Z/R-THETA	IGEOM	B3	1/2/3
NGROUP		IGM		No. of E Groups
ISN		ISN	B3	
NISO		MTPS	B3	possibly =MT
MT		-	B3	possibly = MT
NZONE		-		possibly =MT
IM		IM	B3	
IT		-		Sum of IHX
JM		JM	B3	
JT		-		Sum of IHY
MAXLCM		-		
MAXSCM		-		

BLOCK-II GEOMETRY DETAILS

TWODANT		TWOTRAN		
Name	Comments	Name	Block	Comments
XMESH[IM+1]		XRAD	B14	
YMESH[JM+]		YRAD	B15	
XINTS[IM]		IHX	B5	
YINTS[JM]		IHY	B6	
ZONES[IM;JM]		IDCS	B16	

BLOCK-III NUCLEAR DATA DETAILS

TWODANT		TWOTRAN		
Name	Comments	Name	Block	Comments
LIB	=xslib	-		= ISOTOX
CHIVEC	in NCVLIB	-		Chi of last fissionable material in ISOTOX
MAXORD		=ISCT		
IHM		IHM		Defaulted in SRAC
IHT	=8	IHT		=6 Defaulted in SRAC
IHS		IHS		Defaulted in SRAC
IFIDO	=0	-		
ITITLE	=1	-		
I2LP1	=0	-		Fixed in ISOTOX
SAVBXS		-		
NAMES[NISO]	in NCVLIB	-		
EDNAME[IHT-3]	=chi,n-fiss,cap,n2n,tnsptr	-		
NPTI	use defaulted option	-		
VEL	in NCVLIB	-		writen in ISOTOX
EBOUND[NGROUP+1]	in NCVLIB	-		

The entries underlined in BLOCK III are obligatory if the XSLIB is provided by CVTRAN

BLOCK-IV MIXING DETAILS

TWODANT		TWOTRAN		
Name	Comments	Name	Block	Comments
MATLS	=isos*	-		
ASSIGN	=matls*	-		

*If all the materials are prepared in XSLIB file

BLOCK-V SOLVER DETAILES

TWODANT			TWOTRAN		
Name	Comments		Name	Block	Comments
IEVT	=0/1/2/3/4 (=source/k-eff/alpha/con/thick)		IEVT	B3	=0/1/2
ISCT			ISCT	B3	
ITH	=0/1	direct/adjoint	ITH	B3	
IBL	=0//3	vacuum/ref/white	IBL	B3	Condition at x=0
IBR	=0/1/3		IBR	B3	
IBT	=0/1/2/3	vacuum/ref/per/white	IBT	B3	
IBB	=0/1/2/3		IBB	B3	Condition at y=0
EPSI			EPSI	B4	
IITL			IITL	B3	
IITM			-		
OITM			-		
ITLIM	(seconds limit)		ITLIM	B3	
FLUXP	=0/1/2(=no/isotropic/all)		I2	B3	=2/1/0
XSECTP	=0/1/2(=no/mixed/all)		I3	B3	=2/1/0
FISSRP	=0/1 (=no/yes)		I4	B3	=1/0
SOURCP	=0/1/2/3(=no/unnorm/norm/both)		I5	B3	=3/1/2/0
ANGP	=0/1	(=no/yes)	IANG	B3	=0/-1
BALP	=0/1/2/3	(=no/table/nega/both)	I6	B3	=1/0/-/-
RAFLUX	=0/1	(=no/yes)	IANG	B3	=0/-1
RMFLUX	=0/1		-		
TRCOR			-		
NORM			NORM	B4	fission source rate
BHGT			BHGT	B4	cm
CHI[NGROUP;M]		in NCVLIB	-		
DENX[IT]			XDF	B4	if ISDF=1
DENY[JT]			YDF	B4	if ISDF=1
DEN[IT;JT]			-		
IQUAD			-		Built-in constants

INFLUX =0/1 (=no/yes) read RTFLUX		ISTART B3		=0/6
IPVT	=0/1/2 no/k/alpha	IPVT	B3	
PV	k or alpha	PV	B4	
EVM		EVM	B4	
XLAL		XLAL	B4	
XLAH		XLAH	B4	
XLAX		XLAX	B4	
POD		POD	B4	
XM{IM}		XM		Suppressed in SRAC
YM[JM]		YM		Suppressed in SRAC
(Volume Source)				
INSORS =0/1	read from FIXSRC	Q		read from IFIXSR if IQOPT=5
Option 1				
SOURCE[NGROUP;NMQ]		Q	B7	if IPOPT=1
Option 2				
SOURCX[IT;NMQ]		-		
SOURCY[JT;NMQ]				
Option 3				
SOURCE[NGROUP;NMQ]		Q	B7	if IQOPT=4
SOURCX[IT;NMQ]				
SOURCY[JT;NMQ]				
Option 4				
SOURCF[IT;JT*NGROUP*NMQ]		Q	B7	if IQOPT=2
Option 5				
SOURCE[NGROUP;NMQ]		Q	B7	if IQOPT=3
SOURCF[IT;JT*NMQ]				
(Boundary Source)				
Option 1 : Isotropic Boundary Source				
SILEFT[NGROUP;JT]		-		
SIRITE[NGROUP:JT]		QR1&QR2	B8&B9	if MM=1
SIBOTT{NGROUP;IT}		QB1&QB2	B10&B11	if MM=1
SITOP{NGROUP:IT}		QT1&QT2	B12&B13	if MM=1

Option 2: Full Angular Boundary Source

SALEFT[2*MM;NGROUP*JT]	-
SARITE[2*MM;NGROUP*JT]	QR1&QR2 B8&B9
SABOTT[2*MM;NGROUP*IT]	QB1&QB2 B10&B11
SATOP [2*MM;NGROUP*IT]	QT1&QT2 B12&B13

Option 3: Boundary Source by Product of Vectors

BSLFTG, BSRITG, BSBOTG, BSTOPG	-
BSLFTY, BSRITY, BSBOTX, BSTOPX,	-
BSLFTA,BSRITA, BSBOTA, BSTOPA	-

BLOCK VI EDIT INPUT DETAILS

TWODANT		TWOTRAN		
Name	Comments	Name	Block	Comments
PTED	=0/1	-		
ZNED	=0/1	-		
Many other options exist		There is no correspondence for EDIT input in TWOTRAN		

A3. Sample Input for TWODANT

We give a list of a sample input for the case of 'CCC Mock-up core'

```
==============================================================
    2     0     0
 sample problem  for cvtrant
 standard k calculation,  all input by means of card-images

 /   geometry       - R- Z
 /   cross sections - 6 group, isotropic scatter
 /                    isotope data on XSLIB
 /   nomixing         -
 /
 /                  - materials assigned to make zones named core
 /                    blankt and shield
 /   solver         - card input supplied
 /   edits          - none
 /
 /
 / * * * * block i * * * *
   igeom=r-z, ngroup=6, isn=8 niso= 5 mt= 5
   nzone= 5 im=11 it=41 jm= 6 jt=23 t
 /
 / * * * * block ii (geometry) * * * *
    xmesh=0.0,9.343,16.22, 23.267, 29.38, 30.67, 38.16, 46.819, 54.109,
    61.623, 74.809, 94.809
    xints= 6, 4,4,4,1,5,4,3,3,3,4
    ymesh=0.0, 20.0, 35.24, 55.56, 70.80, 86.04, 101.28
    yints= 4,2,5,3r4
    zones= 11r 1 ;
          4r5 7r1            ;
          4r5 6r4 1          ;
          4r2 3r 3 3r4 1      ;
          4r2 3r 3 3r4 1      ;
          4r2 3r 3 3r4 1
                   t
```

```
/
/
/ * * * * block iii (cross sections) * * * *
   lib= xslib
   maxord=0 ihm=13 iht=8 ihs=9 ifido=0 ititl=1
   balxs= 0
/  savbxs=0
 vel=
     0.58833E+01 0.18316E+02 0.63929E+02 0.22313E+03 0.80078E+03
     0.51560E+04
   names=
   "FEMT01" "UMET02"  "MOXM03" "NATU04" "DEPU05"
   edname="edit1" "fiss" "capt" "n2n" "trnspt"
   ebound=
    1.0000E+07 1.0540E+06 8.6517E+04 7.1017E+03 5.8295E+02 1.3710E+01
    6.8256E-01
 t
/
/ ******* end of cross section data ******
/ **** note that there is no terminal "t" since the cross sections are
/     in los alamos (dtf) format (ifido=0) ****
/
/
/ * * * * block iv (mixing) * * * *
   matls= isos
   assign= matls
 t
/
/ * * * * block v (solver) * * * *
   ievt=1  isct=0  ibl=1 ibr=0 ibt=1 ibb=0
   norm=1    fluxp=0  xsectp=2  fissrp=1
   chi=
     0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
     0.00000E+00 /FEMT01
                                                                ;
     0.67338E+00 0.31642E+00 0.99686E-02 0.23109E-03 0.00000E+00
     0.00000E+00 /UMET02
```

```
                                                                ;
     0.68583E+00 0.30446E+00 0.94921E-02 0.22001E-03 0.00000E+00
     0.00000E+00 /MOCM03
                                                                ;
     0.67337E+00 0.31643E+00 0.99687E-02 0.23109E-03 0.00000E+00
     0.00000E+00 /NATU04
                                                                ;
     0.67236E+00 0.31742E+00 0.99893E-02 0.23152E-03 0.00000E+00
     0.00000E+00 /DEPU05
/                                                               ;
   t
/
/ * * * * block vi (edits) * * * *
    pted=0    zned=0
    t
/ no further information supplied
/*eof
==============================================================
```

A4. Corresponding TWOTRAN Input

We give the corresponding TWOTRAN input in SRAC for the same sample as follows;

```
==============================================================================
CCCM                                                                    01030001
 SRAC TWOTRAN FOR TESTING OF TWODANT CCC RZ CASE                        01040007
 0 0 0 0 0  0 0 0 0 0  0 3 0 0 1  0 1 0 0 0 / SRAC CONTROL              01050001
 .00001 /  TEMPORARY BUCKLING                                           01060001
PFASTJ32          OLD      File                                        01070001
PTHMLJ32          0        F                                           01080001
PMCRCJ32          0        F                                           01090001
FASTU             Scratch  Core                                        01100001
THERMALU          S        C                                           01110001
UMCROSS           S        C                                           01120001
MACROWRK          NEW      C                                           01130001
MACRO             S        C                                           01140001
FLUX              S        C                                           01150001
MICREF            S        C                                           01160001
6 0 0  0 / FINE FEW GROUP NUMBER                                        01170001
 9 10 10 10 15 16 / FAST FINE                                           01180001
                                                                        01190001
     2/ TWOTRAN INPUT START                                             01200007
 ---  S12P0 GR6-MESH(STANDARD)/REAL                                     01210007
     5 materials                                                        01211007
     0     0     8     6    11     6     1     0     0     1     1     001220010
     5  5  0     0     5     6    11     0     0 0 0 0     0    20     001230007
     0   225     2     0     0 1 0 0 1 3 0     1     0     0     1 /42I 01240006
         0.0         0.0         0.0         0.0         0.0         0.001250001
       1.E-4         1.0         0.0         0.0 /10 FLOAT              01260001
  6 3(4) 1 5 4 3(3) 4 /FINE R MESH                                      01290001
  4 2 5 3(4)          / FINE Z MESH                                     01320007
& COARSE R MESH                                                         01350001
      0.000       9.343      16.022      23.267      29.380      30.670 01360001
     38.160      46.819      54.109      61.623      74.809      94.809/ 01370001
```

```
& 1  202.56 3 COARSE Z MESH                                          01391001
      0.00       20.00       35.24       55.56       70.80       86.04 01392001
    101.28 /                                                         01393007
& CROSS SECTION ID                                                   01395001
 11(1 )                                          & ROW 1             01396007
  4( 5)  7( 1)                                   & ROW 2             01397007
  4( 5)  6( 4)   1                               & ROW 3             01398007
  4( 2)  3( 3)   3(4)   1                      &                     01399007
  4( 2)  3( 3)   3(4)   1                      &                     01399107
  4( 2)  3( 3)   3(4)   1                      &                     01399207
 & FISSION SPECTRUM                                                  01399901
  66(1)/ X-REG                                                       01400008
 & 0.583052    0.405708    0.010859    0.000384    0.0         0.0/  01400101
 & VOLOCITIES                                                        01400201
 & 6(1.0)    /                                                       01400301
  5/NMAT                                                             01400407
FEMT0010 0  5 300.  1000. 0. /  FE 01                                01400501
MC020000 0 0 0.15870E-02                                             01400601
MCRN0000 0 0 0.13340E-02                                             01400701
MFEN0000 0 0 0.74805E-01                                             01400801
MNIN0000 0 0 0.62900E-03                                             01400901
MMON0000 0 0 0.51200E-03                                             01401001
UMET0020 0  5 300.  1000. 0. / U METAL 02                            01401101
MU050000 0 0 0.25000E-03                                             01401201
MU080000 0 0 0.34400E-01                                             01401301
MCRN0000 0 0 0.70800E-03                                             01401401
MFEN0000 0 0 0.64640E-02                                             01401501
MNIN0000 0 0 0.16820E-02                                             01401601
MOXM0030 0 11 300.  1000. 0. /  MOX 03                               01402907
MPU90000 0 0 0.10458E-02                                             01403001
MPU00000 0 0 0.93250E-04                                             01403101
MPU10000 0 0 0.10690E-04                                             01403201
MU050000 0 0 0.14700E-02                                             01403301
MU080000 0 0 0.58359E-02                                             01403401
MO060000 0 0 0.13101E-01                                             01403501
MNA30000 0 0 0.81341E-02                                             01403601
```

```
MAL70000 0 0 0.88295E-02                                          01403701
MCRN0000 0 0 0.32734E-02                                          01403801
MFEN0000 0 0 0.11950E-01                                          01403901
MNIN0000 0 0 0.15345E-02                                          01404001
NATU0040 0  5 300.  1000. 0. / NAT U 04                           01406507
MU050000 0 0 0.28910E-03                                          01406601
MU080000 0 0 0.39890E-01                                          01406701
MCRN0000 0 0 0.18270E-02                                          01406801
MFEN0000 0 0 0.66250E-02                                          01406901
MNIN0000 0 0 0.79640E-03                                          01407001
DEPU0050 0  5 300.  1000. 0. / DEP U 05                           01408907
MU050000 0 0 0.14910E-03                                          01409001
MU080000 0 0 0.39890E-01                                          01409101
MCRN0000 0 0 0.18270E-02                                          01409201
MFEN0000 0 0 0.66250E-02                                          01409301
MNIN0000 0 0 0.79640E-03                                          01409401
                                                                  01414901
                                                                  01415001
=====================================================================
```

A5. Sample JCL for TWODANT Execution on MSP OS

```
==================================================================
   T(04) I(04) W(03) C(08) E(01) MSGCLASS(S)                      00010005
//*******************************************************          00020009
//*                                      T.YAMANE        *        00030009
//* TWVX88       => TWODANT JAERI VERSION                  *      00040009
//* MINIMUM REQUIRED FILE;  INPUT  : FT05F001 J2218.TDNINP *       00050009
//*                         OUTPUT : FT03F001 J2218.ODNOUT *       00060009
//*                         OUTPUT : FT06F001 SYSOUT=*     *       00070009
//*******************************************************          00080009
//*====== compile main program & link ======================       00090009
//TWVX88  EXEC FORTEX,A='SOURCE'                                   00100005
//SYSIN DD *                                                       00110005
CFACDS   --- MAIN PROGRAM FOR SETTING ARRAY SIZE OF SCM AND LCM ---  00120005
C   NLCM = NFALSE - NSCM                                           00130005
C     IMPLICIT DOUBLE PRECISION ( A-H, O-Z )                       00140005
C     COMMON / IBMPCM / XFALSE (500000)                            00150005
C     NFALSE = 500000                                              00160005
C     NSCM   = 100000                                              00170005
C     CALL CONTRL ( NFALSE , NSCM )                                00180005
C     STOP                                                         00190005
C     END                                                          00200005
CYYS                                        NOV.17,1993    T.YAMANE  00210007
CYY HTHEAD IS SET IN SMALL MAIN PROGRAM (NEWLY ADDED)  NOV.17,1993  00220003
CYY   HTHEAD='JNNNN.' ; JNNNN IS USER ID IN JAERI FACOM SYSTEM      00230003
CYYE                                                               00240007
CFACDS   === MAIN PROGRAM FOR SETTING ARRAY SIZE OF SCM AND LCM ===  00250007
C   NLCM = NFALSE - NSCM                                           00260007
      IMPLICIT DOUBLE PRECISION ( A-H, O-Z )                       00270007
      COMMON / IBMPCM / XFALSE (400000)                            00280007
CYYS    FOR STORE I/O FILE NAMES AND STATUS INFORMATION            00290007
      COMMON / LJAERI / HTHEAD, HHNAME                             00300007
      CHARACTER  HTHEAD*6, HHNAME*14                               00310007
      HTHEAD='J2218.'                                              00320007
CYYE                                                               00330007
```

```
      NFALSE = 400000                                                   00340007
      NSCM   = 100000                                                   00350007
      CALL CONTRL ( NFALSE , NSCM )                                     00360007
      STOP                                                              00370007
      END                                                               00380007
/*                                                                      00390005
//TWVX88  EXEC LKEDITEX,LM='J2218.TWODANTV',A='AMODE(31)',RGN=3M        00400006
//SYSPRINT DD DUMMY                                                     00410005
/*                                                                      00420005
//*====== twodant go ======================================             00430005
//TWVX88  EXEC GO                                                       00440005
//FT05F001 DD DSN=J2218.SRACINPT.DATA(TWDNTPNC),DISP=SHR                00450005
//*FT05F001 DD DSN=J2218.TWDNTVX8.N.DATA(SAMPLE3),DISP=SHR              00460005
/*FT05F001 DD DSN=J2218.TWDNTVX8.N.DATA(SAMPLE4),DISP=SHR               00470005
//FT06F001 DD SYSOUT=*,DCB=(RECFM=FBA,LRECL=137,BLKSIZE=137)           00480005
/*======= file allocation for later use ====================           00490009
/*** Other TWODANT output files must be allocated to keep them.        00500005
//                                                                      00510007
==============================================================================
```

A6. Sample Shell Script for TWODANT Execution on UNIX OS

```
# TWODANT sample run with xslib file created by CVTRAN
#!/bin/csh -f
#### set NQS options ###
#@&-q vpps
#@&-lM 96mb
#@&-lT 10:00
#@&-C twdntpnc
#@&-eo
#@&-me
#######################
#
# set input data: file name (INPF) and directory (INPD)
set INPF = twdntpnc
set INPD = /dg02/ufs02/j3812/TWVX88/sample.input
# set output directory
set OUTD = /dg02/ufs02/j3812/TWVX88/sample.output
#
# set  xslib (cross-section file)
set XSLIB = /dg02/ufs02/j3812/TWVX88/xslib/xslib
#
# set  work directory for twodant run
set WRKD = &HOME/vfl/tmptwvx
#
# set load module
set LM = /dg02/ufs02/j3812/TWVX88/bin/twvx88mod.lm
#
# change directory and copy input data to odninp
 cd &WRKD
 /usr/bin/rm &WRKD/*
 /usr/bin/cp &INPD/&INPF &WRKD/odninp
 /usr/bin/cp &XSLIB &WRKD/xslib
#
# run twodant
timex -H &LM < odninp > &OUTD/&INPF.log
```

```
#
# copy output results
 /usr/bin/cp &WRKD/odnout &OUTD/&INPF.odnout
#
# copy output files if required
 /usr/bin/cp &WRKD/edgbal &OUTD/&INPF.edgbal
## /usr/bin/cp &WRKD/rtflux &OUTD/&INPF.rtflux
#
# remove all temporary files
 /usr/bin/rm &WRKD/*
```

A7. Output on TTY (FT06) File for Sample Run

```
running generalized input module. version 02-05-90
    2 card title is -
 ***********************************************
  sample problem  for cvtran
  standard k calculation,  all input by means of card-images
 ***********************************************
 running twodant solver. version 02-05-90
 * sample problem  for cvtran
 * standard k calculation,  all input by means of card-images
 *
 * scm used =   14042,max =  100000,transport =   11039,diffusion =   13999
 * lcm used =   44696,max =  300000,flux to disk?   no ,matrix to disk? no
 * lcm with disk for: none    44696,flux moments  44696,matrix        27986
   44696 words lcm required lcmadd
*
 * time outer       sub     k-eff                max ptwise max ptwise  inners
 * (sec) no. inners outs     ev       lambda-1  flux change fiss change convrgd
    2.9    0
    3.5    1    0    5    0.84694373  6.1941E-03  0.000E+00  3.324E+00 **no**
    4.9    2    6    4    0.87636977  2.0670E-02  5.829E-01  1.063E-01 **no**
    6.2    3    6    3    0.87593510 -1.3346E-03  1.386E-01  1.257E-02 **no**
    7.4    4    6    3    0.87223475 -2.7712E-03  1.347E-01  2.527E-02 **no**
    8.7    5    6    3    0.87214748 -1.0597E-05  2.045E-02  1.559E-03 **no**
    9.8    6    6    2    0.87221886  5.7472E-05  6.724E-03  5.354E-04 **no**
   13.7    7   24    1    0.87222753  6.6042E-06  7.622E-05  5.934E-05  yes

     &&&all convergence criteria satisfied&&&
  particle balance =  6.34313E-08
 ..interface file rtflux written..
  twodant iteration time, mins  2.3514E-01
running edit module
  ****************************************
 *  I/O FILE INFORMATION <==  by T.YAMANE *
 ****************************************
```

```
*                          TATAL NUMBER OF I/O FILES = 18
*                             odninp =  5 : input
*                             odnout =  3 : full output
*                ** tty   =  6 : short output summary (standard output for print)
                 ************************************************************
*                *                    OPEN (LATEST)      CLOSE (LATEST)    *
*                * NO.   FILE  NAME   ----------------  ----------------- *
*                *     J2218.XXXXXXXX TIMES UNIT STATUS  TIMES UNIT STATUS *
*                * 1  J2218.altinp      1   54  old       1   54  <keep> *
*                * 2  J2218.odnout      1    3  old       1    3  <keep> *
*                * 3  J2218.bcdout      1   60  old       1   60  <keep> *
*                * 4  J2218.bcdoux      1   61  old       1   61  <keep> *
*                * 5  J2218.geodst      7   31  old       7   31  keep-q *
*                * 6  J2218.bxslib      4   99  old       4   99  delete *
*                * 7  J2218.xslib       1   31  old       1   31  keep-q *
*                * 8  J2218.ndxsrf      3   31  old       3   31  keep-q *
*                * 9  J2218.znatdn      3   32  old       3   32  keep-q *
*                * 10 J2218.asgmat      3   33  old       3   33  keep-q *
*                * 11 J2218.macrxs      5   32  old       5   32  keep-q *
*                * 12 J2218.snxedt      3   30  old       3   30  keep-q *
*                * 13 J2218.solinp      4   30  old       4   30  keep-q *
*                * 14 J2218.editit      3   30  old       3   30  keep-q *
*                * 15 J2218.fissrc      2   30  new       2   30  keep-q *
*                * 16 J2218.edgbal      2   30  new       2   30  keep-q *
*                * 17 J2218.rtflux      3   31  old       3   31  keep-q *
*                * 18 J2218.sncons      2   30  new       2   30  keep-q *
*                ************************************************************
*                  Note: IOSTAT check in sub. dst4c was reactivated.
*                  keep-q FOR close statement executed in subroutines closeq or
                     aun4c(aun4c willbe never called).
*                  <keep> FOR close statement executed in subroutine TJAERI.
*                  UNIT=99 for scratch file.
*****************************************************************************
```

A8. Output on EDGBAL File for Sample Run

The following is the content of edgbal file after executing the sample run.

```
================================================================================
balance table for 2-d case -
 sample problem  for cvtrant
source              groups 1 to ngroup
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
fission source      groups 1 to ngroup
 6.73380E-01 3.16420E-01 9.96860E-03 2.31090E-04 0.00000E+00 0.00000E+00
in scatter          groups 1 to ngroup
 3.05311E-16 5.18015E-01 5.07298E-01 1.58908E-01 2.61605E-02 3.18286E-03
self scatter        groups 1 to ngroup
 1.12265E+00 1.67537E+01 9.97631E+00 2.34275E+00 3.47317E-01 9.20310E-02
out scatter         groups 1 to ngroup
 5.40917E-01 4.82843E-01 1.57278E-01 2.61273E-02 3.18235E-03 7.39570E-08
net leakage         groups 1 to ngroup
 3.24953E-04 2.38138E-02 1.10281E-02 2.14778E-03 7.32341E-04 2.38150E-04
absorption          groups 1 to ngroup
 1.32138E-01 3.27779E-01 3.48960E-01 1.30864E-01 2.22458E-02 2.94466E-03
particle bal        groups 1 to ngroup
 4.07074E-08 7.06029E-08 6.57636E-08 1.03025E-07-2.03474E-07-2.83296E-08
right leakage       groups 1 to ngroup
 2.99655E-04 1.99602E-02 8.96403E-03 1.71338E-03 5.71482E-04 1.81277E-04
horizontal leakage groups 1 to ngroup
 2.99655E-04 1.99602E-02 8.96403E-03 1.71338E-03 5.71482E-04 1.81277E-04
top leakage         groups 1 to ngroup
 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
vertical leakage    groups 1 to ngroup
 2.52975E-05 3.85363E-03 2.06404E-03 4.34403E-04 1.60859E-04 5.68727E-05
```

A9. Brief Contents of Output File ODNOUT for Sample Run

```
*****************************************************************************************************************
 *                          generalized input module run on   9/24/98 with version  02-05-90
 *****************************************************************************************************************
*                  *                  ...listing of cards in the input stream...                          *
                                      (Listing of 88 input cards is omited)
 *****************************************************************************************************************
 *                                                   case title
 *****************************************************************************************************************
*key start case input  *
 ************************
 *                                    2  nhead   number of title cards to follow
 *                                    0  notty   0/1  no/yes  suppress on-line terminal output
 *                                    0  nolist  0/1  no/yes  suppress input listing
 *                       ************************************************************************
 *                      *  sample problem  for cvtran                                            *
 *                      *  standard k calculation,  all input by means of card-images             *
 *                       ************************************************************************
*key end   block i read*
 ************************
 *                                         ...block i - controls and dimensions...
 *****************************************************************************************************************
 *
 *                                         ...dimensions (array name = dimens)...
 *
 *                       7  igeom   6/7/9/11 x-y/r-z/triangles/r-theta
 *                       6  ngroup  number of energy groups
 *                       8  isn     angular quadrature order
 *                       5  niso    number of input isotopes (from isotxs, grupxs, or cards)
 *                       5  mt      number of permanent materials
 *                       5  nzone   number of zones
 *                      11  im      number of coarse mesh x intervals
```

```
*                        41  it      number of fine mesh intervals
*                         6  jm      number of coarse mesh y intervals
*                        23  jt      number of fine mesh y intervals
*
*                           ...storage...         maxlcm=  300000      maxscm=  100000
*
*****************************************************************************************************************
*key end   block ii read-geom*
******************************
*                         7  igeom    1/2/3/6/7/8/9/11/14
*key end   block iii read-xs *
******************************
*****************************************************************************************************************
*                                      ...block iii - cross section library...
*****************************************************************************************************************
*                                                 ...library source...
*                                                     lib=xslib
*
*                                    ...card library parameters (array name = cards)...
*
*                        0  maxord  maximum legendre order to be found in input cross sections
*                       13  ihm     last position in cross section table
*                        8  iht     position of total cross section
*                        9  ihs     position of self scatter cross section
*                        0  ifido   0/1/2 - dtf/fixed fido/free fido library
*                        1  ititl   0/1 - no/yes there is a title card before each table
*                        0  i2lp1   0/1 - no/yes library higher order scattering contains 2l+1 factor
*                        0  savbxs  0/1 - no/yes save binary xslib file (filename=bxslib)
*                        1  kwikrd  0/1 - full fido read/quick fido read (default=quick)
*
*                                                ...energy structure...
*   group      chi          vel       lower bound   upper bound   group      chi          vel       lower bound   upper bound
*   -----  -----------  -----------  -----------   -----------   -----  -----------  -----------  -----------   -----------
*       1  0.00000E+00  5.88330E+00  1.05400E+06   1.00000E+07       4  0.00000E+00  2.23130E+02  5.82950E+02   7.10170E+03
```

```
*      2   0.00000E+00   1.83160E+01   8.65170E+04   1.05400E+06      5   0.00000E+00   8.00780E+02   1.37100E+01   5.82950E+02
*      3   0.00000E+00   6.39290E+01   7.10170E+03   8.65170E+04      6   0.00000E+00   5.15600E+03   6.82560E-01   1.37100E+01
 *                                        last neutron group(lng) is number   6
*
*                       0  balxs   -1/0/1 - adjust absorption/no/adjust self scatter to force xs balance
*
*                                            ...edit position names...
*
 *                                           position edname position
*                                           -------- ------ --------
*                                                1   chi
*                                                2   nusigf     7
*                                                3   total      8
*                                                4   abs        6
*                                                5   editl      1
*                                                6   fiss       2
*                                                7   capt       3
*                                                8   n2n        4
*                                                9   trnspt     5
 *key start card libe read    *
*****************************

alternate cross section input taken from file xslib
 *
*                                       ...header cards from the card library...
*                           isotope isotope
*                            number   name   order            header card
*                            ------  ------- -----     ------------------------
*                                 1.  FEMT01  p0    -  FEMTF012:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/
*                                 2.  UMET02  p0    -  UMETF022:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/
*                                 3.  MOXM03  p0    -  MOXMF032:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/
*                                 4.  NATU04  p0    -  NATUF042:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/
*                                 5.  DEPU05  p0    -  DEPUF052:P-0 IGM= 6 IHT= 8 IHS= 9 IHM= 13 (SRAC TO TWODANT  16:55 21/09/
* key end   card libe read    *
```

```
*****************************
* key end   block iv read-mats*
*****************************
*
 ************************************************************************************************************************
*                                        ... mixing instructions ...
 ************************************************************************************************************************
 *          mix    comp       density    comp       density etc.
 *          ---    ----       -------    ----       -------
 *     matls
 *     ------
 *       1. FEMT01  FEMT01   1.00000E+00,
 *       2. UMET02  UMET02   1.00000E+00,
 *       3. MOXM03  MOXM03   1.00000E+00,
 *       4. NATU04  NATU04   1.00000E+00,
 *       5. DEPU05  DEPU05   1.00000E+00,
 ************************
 * key start mix card xs *
************************
 * key end   mix card xs *
************************************************************************************************************************
 * key end   block v read-solvr*
 *****************************
 * key end   block vi read-edit*
 *****************************
 * key end   input module*
 ************************
 *
```

```
*****************************************************************************************************************
                                this twodant problem run on  9/24/98 with solver version 02-05-90
* sample problem  for cvtrant
* standard k calculation,  all input by means of card-images
*****************************************************************************************************************
*                                        ...block v -- solver input...
*****************************************************************************************************************
*            raw     as
*           input  defaulted
*           -----  --------
*                                        ...required input(array name = solin)...
*           1         1      ievt   0/1/2/3/4 - type of calculation
*                                       0 inhomogeneous source
*                                       1 k-effective
*                                       2 alpha or time absorption search
*                                       3 concentration search
*                                       4 delta(i.e. dimension) search
*           0         0      isct   legendre order of scattering
*           0         0      ith    0/1 - direct/adjoint - mode of calculation (default=direct)
*           1         1      ibl    0/1/3 - left boundary condition        vacuum/reflective/white
*           0         0      ibr    0/1/3 - right boundary condition       vacuum/reflective/white
*           1         1      ibt    0/1/2/3 - top boundary condition       vacuum/reflective/periodic/white
*           0         0      ibb    0/1/2/3 - bottom boundary condition    vacuum/reflective/periodic/white
*
*                                        ...convergence controls(array name = iter)...
*       0.000E+00 1.000E-04  epsi   inner iteration convergence criterion (default=0.0001)
*           0         1      iitl   maximum number of inner iterations per group until fission source is near
*                                   convergence, i.e. lambda is near convergence.(default=1)
*           0        30      iitm   maximum number of inner iterations per group when close to fission source convergence
*                                   (default calculated)
*           0        20      oitm   maximum number of outer iterations (default=20)
*           0         0      itlim  iteration time limit (seconds)
*****************************************************************************************************************
*                                   ...block v -- solver input (continued)...
```

```
*****************************************************************************************************************
*          raw     as
*         input  defaulted
*         -----  --------
*                                        ...miscellaneous parameters(array name = misc)...
*     0.000E+00 0.000E+00  bhgt   buckling height
*     1.000E+00 1.000E+00  norm   normalization factor
*         0         0      influx 0/1 no/yes - read input flux from file rtflux (atflux for adjoint)
*         0         0      insors 0/1 no/yes - read input source from file fixsrc
*         0         1      iquad  -3/-2/1/2/3 - source of quadrature constants (default=1)
*                                  -3 sncon file
*                                  -2 hybrid product set (triangular arrangement)
*                                   1 old twotran built-in set
*                                   2 product set (rectangular arrangement)
*                                   3 card input
*
*                                        ...output controls(array name = solout)...
*                      0  fluxp  0/1/2   none/isotropic/all moments - flux print
*                      2  xsectp 0/1/2   none/principal/all - macroscopic cross section print
*                      1  fissrp 0/1     no/yes - print final fission source rate
*                      0  sourcp 0/1/2/3 no/as read/normalized/both - print inhomogeneous source
*                      0  angp   0/1     no/yes - print angular fluxes
*                      0  raflux 0/1     no/yes - write angular fluxes to file raflxm or aaflxm(if ith=1)
*                      0  rmflux 0/1     no/yes - write flux moments to file rmflux
*                      0  balp   0/1     no/yes - print coarse mesh balances
*
*                                        ...parameters inferred from input arrays...
*                                  2  inchi  0/1/2 none/one chi/zonewise chi
*                                  0  isdenx 0/1/n - none/x density vector/full matrix
*                                  0  isdeny 0/1 no/yes - use y density vector
*                                  0  iqan   source anisotropy
*                                  0  isorse number of source moments input
*                                  0  isorsx number of sourcx moments input
*                                  0  isorsy number of sourcy moments input
```

```
*                                0  isorsf number of sourcf moments input
*                                0  iql    -1/0/1/2 isotropic/none/all angles/vectors -left boundary source
*                                0  iqr    -1/0/1/2 isotropic/none/all angles/vectors -right boundary source
*                                0  iqt    -1/0/1/2 isotropic/none/all angles/vectors -top boundary source
*                                0  iqb    -1/0/1/2 isotropic/none/all angles/vectors -bottom boundary source
*

*****************************************************************************************************************
*                                  ...parameters from block i...
*                         7  igeom   6/7/11  x-y/r-z/r-theta
*                         6  ngroup  number of energy groups
*                         8  isn     angular quadrature order
*                         5  mt      number of permanent materials
*                         5  nzone   number of zones
*                        11  im      number of coarse mesh x intervals
*                         6  jm      number of coarse mesh y intervals
*                        41  it      number of fine mesh x intervals
*                        23  jt      number of fine mesh y intervals
*
*****************************************************************************************************************
*                                    ...material assignments to zones...
*key start matls to zones    *
 ****************************
  *                                          zone     material
 *                                        no. name   no. name
 *
 *                                         1 zone1    1 FEMT01
 *                                         2 zone2    2 UMET02
 *                                         3 zone3    3 MOXM03
 *                                         4 zone4    4 NATU04
 *                                         5 zone5    5 DEPU05
 ************************
 *key start storage map *
 ************************
```

```
 *  scm storage summary...
 *
 *     total scm required for this problem  14042
 *     maximum scm available (maxscm= )    100000
 *     scm required for transport           11039
 *     scm required for diffusion           13999
 *
 *  lcm storage summary...
 *
 *     lcm selected for this problem                44696
 *     maximum lcm specified (maxlcm= )            300000
 *      needed for all in lcm (no disk)              44696
 *     with higher flux moments to disk             44696
 *     diffusion parameters also to disk            27986
 *     higher flux moments on disk?                 no
 *     diffusion parameters on disk?                no

  44696 words lcm required lcmadd
 *
 * zero flux

 * key start sn constants*
 ************************
  * s 8 constants
 *                mu             eta            weight
*     1      0.19232750E+00  0.96229947E+00  0.29197112E-01
 *     2      0.57735026E+00  0.79352176E+00  0.23313805E-01
 *     3      0.19232750E+00  0.79352176E+00  0.23313805E-01
 *     4      0.79352176E+00  0.57735026E+00  0.23313805E-01
 *     5      0.57735026E+00  0.57735026E+00  0.22525802E-01
 *     6      0.19232750E+00  0.57735026E+00  0.23313805E-01
 *     7      0.96229947E+00  0.19232750E+00  0.29197112E-01
 *     8      0.79352176E+00  0.19232750E+00  0.23313805E-01
 *     9      0.57735026E+00  0.19232750E+00  0.23313805E-01
```

```
 *    10      0.19232750E+00  0.19232750E+00  0.29197112E-01
*****************************************************zones map*****************************************************
*key start zones map   *
 ************************
0       z                                zones by coarse mesh, origin at lower left.
    row   m                              m is number of fine intervals per coarse mesh.
   101.2800  rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr
             r    *    *    *    *    *    *    *    *    *    *    v
      6   4  r  2 *  2 *  2 *  2 *  3 *  3 *  3 *  4 *  4 *  4 *  1 v
             r    *    *    *    *    *    *    *    *    *    *    v
    86.0400  r*****************************************************************v
             r    *    *    *    *    *    *    *    *    *    *    v
      5   4  r  2 *  2 *  2 *  2 *  3 *  3 *  3 *  4 *  4 *  4 *  1 v
             r    *    *    *    *    *    *    *    *    *    *    v
    70.8000  r*****************************************************************v
             r    *    *    *    *    *    *    *    *    *    *    v
      4   4  r  2 *  2 *  2 *  2 *  3 *  3 *  3 *  4 *  4 *  4 *  1 v
             r    *    *    *    *    *    *    *    *    *    *    v
    55.5600  r*****************************************************************v
             r    *    *    *    *    *    *    *    *    *    *    v
      3   5  r  5 *  5 *  5 *  5 *  4 *  4 *  4 *  4 *  4 *  4 *  1 v
             r    *    *    *    *    *    *    *    *    *    *    v
    35.2400  r*****************************************************************v
             r    *    *    *    *    *    *    *    *    *    *    v
      2   2  r  5 *  5 *  5 *  5 *  1 *  1 *  1 *  1 *  1 *  1 *  1 v
             r    *    *    *    *    *    *    *    *    *    *    v
    20.0000  r*****************************************************************v
             r    *    *    *    *    *    *    *    *    *    *    v
      1   4  r  1 *  1 *  1 *  1 *  1 *  1 *  1 *  1 *  1 *  1 *  1 v
             r    *    *    *    *    *    *    *    *    *    *    v
     0.0000  rvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvvv
       r     0.    9.   16.   23.   29.   30.   38.   46.   54.   61.   74.   94.
           0000  3430  2200  2670  3800  6700  1600  8190  1090  6230  8090  8090
0      m       6    4    4    4    1    5    4    3    3    3    4
```

```
   column      1     2     3     4     5     6     7     8     9    10    11
*****************************************************************************************************************
 *                    ...cross section related data from file macrxs  165037092498 version  1 ...
*****************************************************************************************************************
*
 *  1 FEMT01    2 UMET02    3 MOXM03    4 NATU04    5 DEPU05
 *
 ******************************************************************************************************************
 *****************************************************************************************************************
 *
 *                                        ...cross sections for legendre orders up to p0...
 *                                                (Omitted)
 *****************************************************************************************************************
*****************************************************************************************************************
 * *                                ...iteration controls and criteria...
*****************************************************************************************************************
 *
 *                                      ***iteration criteria***
 *
 *                                          transport inners
 *                                          ----------------
 *         criterion    quantity to test                        value     action taken if value exceeded
 *         ---------    ----------------                        -----     ------------------------------
 *            iitl  - inner iteration count until near lambda      1          terminates inners
 *                    (i.e. fission source) convergence
 *            iitm  - inner iteration count when near lambda      30          terminates inners
 *                    (i.e. fission source) convergence
 *            epsi  - fractional ptwise flux change           1.00E-04       does another inner
 *                    per inner
 *
 *                                         diffusion sub-outers
 *                                         --------------------
 *         criterion    quantity to test                        value     action taken if value exceeded
 *         ---------    ----------------                        -----     ------------------------------
```

```
*          oitmd - sub-outer iteration count                  40          terminates sub-outers
*          eps   - diffusion lambda-1.0 (see note below)    1.00E-04      does another sub-outer
*          eps   - fractional ptwise fission change         1.00E-04      does another sub-outer
*                    per sub-outer (see note below)
*
*          note: eps, when the problem is finally converged, will equal epsi, the value shown above. however,
*                early in the iteration process, a larger value may be used to avoid unneccessary iterations.
*
*                                    final convergence criteria
*                                    --------------------------
*        criterion    quantity to test                        value     action taken if value exceeded
*        ---------    ----------------                        -----     ------------------------------
*          oitm  - outer iteration count                      20          quits with error message
*          epsi  - transport lambda-1.0                     1.00E-04      does another outer
*
*****************************************************************************************************************
```

```
*****************************************************************************************************************
*                    ...flux and eigenvalue convergence as monitored by twodant...
*****************************************************************************************************************
*key start iteration monitor *
*****************************

* cpu time outer       diffusion      k-eff                  max ptwise   max ptwise   inners
*  (sec)    no. inners sub-outers  eigenvalue   lambda-1    flux change  fiss change converged
*   2.91     0
*   3.53     1      0       5      0.84694373  6.19413E-03  0.00000E+00  3.32394E+00  **no**
*   4.91     2      6       4      0.87636977  2.06697E-02  5.82876E-01  1.06344E-01  **no**
*   6.16     3      6       3      0.87593510 -1.33461E-03  1.38578E-01  1.25683E-02  **no**
*   7.40     4      6       3      0.87223475 -2.77116E-03  1.34655E-01  2.52719E-02  **no**
*   8.65     5      6       3      0.87214748 -1.05967E-05  2.04523E-02  1.55864E-03  **no**
*   9.80     6      6       2      0.87221886  5.74717E-05  6.72431E-03  5.35361E-04  **no**
*
*     ------------------------------------------------------------------
*
*              -- inner iteration summary for outer iteration no.   7 --
*                                (Omitted)
* cpu time outer       diffusion      k-eff                  max ptwise   max ptwise   inners
*  (sec)    no. inners sub-outers  eigenvalue   lambda-1    flux change  fiss change converged
*  13.70     7     24       1      0.87222753  6.60422E-06  7.62174E-05  5.93388E-05   yes
*                $$$$$$ all convergence criteria satisfied
*  particle balance =  6.34313E-08     total inners all outers =   54
*****************************************************************************************************************
*  I/O FILE INFORMATION <==  by T.YAMANE *
*****************************************
*                                TATAL NUMBER OF I/O FILES = 18
*
*                                  odninp =  5 : input
*                                  odnout =  3 : full output
*                                ** tty   =  6 : short output summary (standard output for print)
*
```

```
*                    ************************************************************
*                    *                      OPEN (LATEST)      CLOSE (LATEST)   *
*                    * NO.   FILE  NAME    ----------------- ----------------- *
*                    *     J2218.XXXXXXXX  TIMES UNIT STATUS  TIMES UNIT STATUS *
*                    *  1  J2218.altinp      1   54  old       1   54  <keep> *
*                    *  2  J2218.odnout      1    3  old       1    3  <keep> *
*                    *  3  J2218.bcdout      1   60  old       1   60  <keep> *
*                    *  4  J2218.bcdoux      1   61  old       1   61  <keep> *
*                    *  5  J2218.geodst      7   31  old       7   31  keep-q *
*                    *  6  J2218.bxslib      4   99  old       4   99  delete *
*                    *  7  J2218.xslib       1   31  old       1   31  keep-q *
*                    *  8  J2218.ndxsrf      3   31  old       3   31  keep-q *
*                    *  9  J2218.znatdn      3   32  old       3   32  keep-q *
*                    * 10  J2218.asgmat      3   33  old       3   33  keep-q *
*                    * 11  J2218.macrxs      5   32  old       5   32  keep-q *
*                    * 12  J2218.snxedt      3   30  old       3   30  keep-q *
*                    * 13  J2218.solinp      4   30  old       4   30  keep-q *
*                    * 14  J2218.editit      3   30  old       3   30  keep-q *
*                    * 15  J2218.fissrc      2   30  new       2   30  keep-q *
*                    * 16  J2218.edgbal      2   30  new       2   30  keep-q *
*                    * 17  J2218.rtflux      3   31  old       3   31  keep-q *
*                    * 18  J2218.sncons      2   30  new       2   30  keep-q *
*                    ************************************************************
*                    Note: IOSTAT check in sub. dst4c was reactivated.
*                          keep-q FOR close statement executed in subroutines closeq or aun4c(aun4c willbe never called).
*                          <keep> FOR close statement executed in subroutine TJAERI.
*                    UNIT=99 for scratch file.
*****************************************************************************************************************************
```

国際単位系 (SI) と換算表

表 1　SI 基本単位および補助単位

量	名　称	記　号
長　さ	メートル	m
質　量	キログラム	kg
時　間	秒	s
電　流	アンペア	A
熱力学温度	ケルビン	K
物質量	モル	mol
光　度	カンデラ	cd
平面角	ラジアン	rad
立体角	ステラジアン	sr

表 2　SI と併用される単位

名　称	記　号
分，時，日	min，h，d
度，分，秒	°，′，″
リットル	l，L
トン	t
電子ボルト	eV
原子質量単位	u

$1\ \mathrm{eV} = 1.60218 \times 10^{-19}\ \mathrm{J}$

$1\ \mathrm{u} = 1.66054 \times 10^{-27}\ \mathrm{kg}$

表 5　SI 接頭語

倍数	接頭語	記　号
10^{18}	エクサ	E
10^{15}	ペタ	P
10^{12}	テラ	T
10^{9}	ギガ	G
10^{6}	メガ	M
10^{3}	キロ	k
10^{2}	ヘクト	h
10^{1}	デカ	da
10^{-1}	デシ	d
10^{-2}	センチ	c
10^{-3}	ミリ	m
10^{-6}	マイクロ	μ
10^{-9}	ナノ	n
10^{-12}	ピコ	p
10^{-15}	フェムト	f
10^{-18}	アト	a

表 3　固有の名称をもつ SI 組立単位

量	名　称	記号	他の SI 単位による表現
周波数	ヘルツ	Hz	s^{-1}
力	ニュートン	N	$m \cdot kg/s^2$
圧力，応力	パスカル	Pa	N/m^2
エネルギー，仕事，熱量	ジュール	J	N·m
工率，放射束	ワット	W	J/s
電気量，電荷	クーロン	C	A·s
電位，電圧，起電力	ボルト	V	W/A
静電容量	ファラド	F	C/V
電気抵抗	オーム	Ω	V/A
コンダクタンス	ジーメンス	S	A/V
磁束	ウェーバ	Wb	V·s
磁束密度	テスラ	T	Wb/m^2
インダクタンス	ヘンリー	H	Wb/A
セルシウス温度	セルシウス度	℃	
光束	ルーメン	lm	cd·sr
照度	ルクス	lx	lm/m^2
放射能	ベクレル	Bq	s^{-1}
吸収線量	グレイ	Gy	J/kg
線量当量	シーベルト	Sv	J/kg

表 4　SI と共に暫定的に維持される単位

名　称	記　号
オングストローム	Å
バーン	b
バール	bar
ガル	Gal
キュリー	Ci
レントゲン	R
ラド	rad
レム	rem

$1\ \text{Å} = 0.1\ \mathrm{nm} = 10^{-10}\ \mathrm{m}$

$1\ \mathrm{b} = 100\ \mathrm{fm}^2 = 10^{-28}\ \mathrm{m}^2$

$1\ \mathrm{bar} = 0.1\ \mathrm{MPa} = 10^5\ \mathrm{Pa}$

$1\ \mathrm{Gal} = 1\ \mathrm{cm/s}^2 = 10^{-2}\ \mathrm{m/s}^2$

$1\ \mathrm{Ci} = 3.7 \times 10^{10}\ \mathrm{Bq}$

$1\ \mathrm{R} = 2.58 \times 10^{-4}\ \mathrm{C/kg}$

$1\ \mathrm{rad} = 1\ \mathrm{cGy} = 10^{-2}\ \mathrm{Gy}$

$1\ \mathrm{rem} = 1\ \mathrm{cSv} = 10^{-2}\ \mathrm{Sv}$

（注）

1. 表 1 − 5 は「国際単位系」第 5 版，国際度量衡局 1985 年刊行による。ただし，1 eV および 1 u の値は CODATA の 1986 年推奨値によった。
2. 表 4 には海里，ノット，アール，ヘクタールも含まれているが日常の単位なのでここでは省略した。
3. bar は，JIS では流体の圧力を表わす場合に限り表 2 のカテゴリーに分類されている。
4. EC 閣僚理事会指令では bar，barn および「血圧の単位」mmHg を表 2 のカテゴリーに入れている。

換　算　表

力	N(=10^5dyn)	kgf	lbf
	1	0.101972	0.224809
	9.80665	1	2.20462
	4.44822	0.453592	1

粘　度　1 Pa·s(N·s/m^2) = 10 P(ポアズ)(g/(cm·s))

動粘度　1 m^2/s = 10^4St(ストークス)(cm^2/s)

圧力	MPa(=10 bar)	kgf/cm^2	atm	mmHg(Torr)	lbf/in^2(psi)
	1	10.1972	9.86923	7.50062×10^3	145.038
	0.0980665	1	0.967841	735.559	14.2233
	0.101325	1.03323	1	760	14.6959
	1.33322×10^{-4}	1.35951×10^{-3}	1.31579×10^{-3}	1	1.93368×10^{-2}
	6.89476×10^{-3}	7.03070×10^{-2}	6.80460×10^{-2}	51.7149	1

エネルギー・仕事・熱量	J(=10^7erg)	kgf·m	kW·h	cal(計量法)	Btu	ft·lbf	eV
	1	0.101972	2.77778×10^{-7}	0.238889	9.47813×10^{-4}	0.737562	6.24150×10^{18}
	9.80665	1	2.72407×10^{-6}	2.34270	9.29487×10^{-3}	7.23301	6.12082×10^{19}
	3.6×10^6	3.67098×10^5	1	8.59999×10^5	3412.13	2.65522×10^6	2.24694×10^{25}
	4.18605	0.426858	1.16279×10^{-6}	1	3.96759×10^{-3}	3.08747	2.61272×10^{19}
	1055.06	107.586	2.93072×10^{-4}	252.042	1	778.172	6.58515×10^{21}
	1.35582	0.138255	3.76616×10^{-7}	0.323890	1.28506×10^{-3}	1	8.46233×10^{18}
	1.60218×10^{-19}	1.63377×10^{-20}	4.45050×10^{-26}	3.82743×10^{-20}	1.51857×10^{-22}	1.18171×10^{-19}	1

1 cal = 4.18605 J (計量法)
= 4.184 J (熱化学)
= 4.1855 J (15 °C)
= 4.1868 J (国際蒸気表)

仕事率　1 PS (仏馬力)
= 75 kgf·m/s
= 735.499 W

放射能	Bq	Ci
	1	2.70270×10^{-11}
	3.7×10^{10}	1

吸収線量	Gy	rad
	1	100
	0.01	1

照射線量	C/kg	R
	1	3876
	2.58×10^{-4}	1

線量当量	Sv	rem
	1	100
	0.01	1

(86 年 12 月 26 日現在)

A FORTRAN CODE CVTRAN TO PROVIDE CROSS-SECTION FILE FOR TWODANT BY USING MACROSCOPIC FILE WRITTEN BY SRAC