C.D.T. Project P2569 IGE-255

CENTRE DE DÉVELOPPEMENT TECHNOLOGIQUE
TECHNICAL REPORT

DRAGON VERIFICATION: THE MODULES REQUIRED IN THE AECL CRITICAL PATH

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September, 2001

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SUMMARY

This report contains the results of applying the general verification plan to the DRAGON routines that are to be called during a typical execution at AECL. The type of verification that is considered for the various routines varies from a line by line analysis of the routine to the global verification of a set of routines by comparing the results of DRAGON with that expected using an independent analysis of the same problem.

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1 INTRODUCTION

The goal of this report is to perform the verification procedure that was proposed to AECL in order to ensure that the code DRAGON perform adequately when it is used for the evaluation of the incremental cross sections associated with CANDU reactivity devices.[2] As we described in the report *DRAGON/WIMS–AECL Coupled Execution: Critical Path and Interfaces* such calculations involved only a limited number of DRAGON modules.[3]

This report covers the general verification of the following modules that are called successively during a DRAGON supercell calculation.

- `GEO:` that reads a DRAGON geometry on the input file:

  The verification plan we applied to the `GEO:` module in Section 2 is the following:

  1. perform a line by line verification of GEOIN1 and compare the subroutines GEOIN2 and GEOIN3 with GEOIN1 and verify that the differences observed are those expected if one takes for granted that these subroutines are used to simulate a FORTRAN-77 recursive call;
  2. verify that the information stored on the GEOMETRY data structure generated is identical to that provided on the DRAGON input file.

- `EXCELT:` that analyzes a DRAGON geometry and generates the CP integration lines associated with this geometry:

  The verification process we used in Section 3 is:

  1. A line by line verification of the following subroutines: XELPRC XELPRP, LELCHK, XELCOP, XELEQN, LELCRN, XELCRN, XELPSI and XELPSC;
  2. A global verification of the geometry analysis routines by analyzing the TRACKING data structure generated by DRAGON for a variety of geometries;
  3. A verification of the contents of the binary tracking file.

- `ASM:` that reads the integration lines associated with a geometry and performs the multigroup CP integration:

  The overall verification process we considered in Section 4 has been divided into three parts:

  1. A line by line verification for the following routines: PIJRDG, PIJRGL, PIJRHL, PIJRNL, PIJABC, PIJSMD, PIJNOS and PIJCPL;
  2. A numerical verification for the collision probability matrices. Here we made use of the self-verification option already present in the `ASM:` module.

- `FLU:` that solves the multigroup CP flux equations for fixed, fission or leakage sources:

  For this module, the overall verification process was divided into four parts (see Section 5):

  1. A line by line verification for the following routines: FLUGET, FLUGPI , TRFICF, TRFICS, FLUQFX, FLUQFS, FLUGFL and FLUSFL;
  2. A global numerical verification for the following routines: TRFICF, TRFICS, FLUQFX, FLUQFS;
  3. A self-verification process for the following routines: FLUDB2 and B1DIFF.

- `EDI:` that performs the editing of condensed and homogenized macroscopic cross section:

  The overall verification process that will be presented in Section 6 has been divided as follows:

  1. A line by line verification for the following routines: EDIGET, EDIENE, EDIRAT and EDISCT;
  2. A global numerical verification for the following routines: EDIDTX, EDIPRR, EDIPXS, EDIDTS, EDISTA and EDIDEL;
  3. A self-verification process for EDIDTX using EDIDTS by comparing the homogenized and condensed cross sections generated by DRAGON with reference values generated manually.

2 VERIFICATION OF THE GEO: MODULE

This module is used to transfer the geometry description provided as input data to a GEOMETRY data structure. It is controlled by the subroutine `GEO` and involves only three additional subroutines namely: `GEOIN1`, `GEOIN2` and `GEOIN3`. In fact, `GEOIN1` and`GEOIN2` are nearly identical apart from the fact that they call the subroutines `GEOIN2` and `GEOIN3` respectively. In the same way, `GEOIN3` is very similar to `GEOIN2` apart from the fact that the definition of new sub-geometry is forbidden in this routine.

The second observation is that the three routines called by `GEO` are mainly there to read the information provided in the DRAGON input file and transfer it to the GEOMETRY data structure. The analytic capability of this module is therefore somewhat restricted. In fact some of the geometry that can be defined may turn out to be flagged as invalid in the `EXCELT:` tracking module because they cannot yet be analyzed by DRAGON. Other geometries are simply inconsistent or will never be available in DRAGON for processing.

This module has been verified using two straight forward techniques:

1. a line by line verification of `GEO` and `GEOIN1` followed by a comparison of subroutines `GEOIN2` and `GEOIN3` with `GEOIN1` to verify that the differences observed are those expected if one takes for granted that these subroutines are used to simulate a FORTRAN-77 recursive call;

2. a verification that the information stored on the GEOMETRY data structure generated by the `GEO:` module is identical to that provided on the DRAGON input file for typical geometries that can be processed by the `EXCELT:` module.

2.1 Line by Line Verification

2.1.1 Subroutine GEO

The listing of the subroutine `GEO.f` is provided in Appendix A.1.1. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-23 Comments describing the use of the subroutine and the parameters of the subroutine.

L:24-38 Definition of parameters used in the subroutine.

L:39-43 Write to the output file the module execution header and credits. The formats are provided in lines 89 (6900) and 91-93 (6910).

L:44-47 If there is not at least one data structure available to this module abort the execution.

L:49-50 If the first data structure is not a `LINKED_LIST` or `XSM_FILE` then abort the execution.

L:51-52 If the first data structure is not in creation or update mode then abort the execution.

L:53-54 Store in local variables `ITYPE` and `IPGEOM` the mode of the first data structure and the pointer to this structure.

L:56 Initialize the local variable for printing to the default value `IMPX=1`.

L:57-83 If-Then-Else for data structure processing.

L:57-65 If there is more than one data structure transferred to this module and if the first data structure is in creation mode. The code will first abort abort if the second data structure is not a `LINKED_LIST` or `XSM_FILE`. It will also abort if the the second data structure is not in a read-only mode. Finally, the pointer to the second data structure is stored in local variable `IPGEO2`.

L:66-67 Read (`LCMGET`) the signature of the data structure `IPGEO2` in the integer vector `KCHAR` (3 elements) and transfer this information to the `character*12` variable `TEXT12` using an internal `WRITE` instruction.

L:68-72 If this signature is not `L_GEOM␣␣␣␣␣␣`, then the program aborts.

L:73 Copy (`LCMEQU`) into the first data structure `IPGEOM` the contents of the second data structure `IPGEO2`.

L:74 Test if the first data structure is in update mode.

L:75-77 Read (`LCMGET`) the signature of the data structure `IPGEOM` in the integer vector `KCHAR` (3 elements) and transfer this information to the `character*12` variable `TEXT12` using an internal `WRITE` instruction.

L:78-82 If this signature is not `L_GEOM␣␣␣␣␣␣`, then the program aborts.

L:84-85 Store in `character*12` variable `TEXT12` the string `/␣␣␣␣␣␣␣␣␣␣␣` representing the name of

L:86 Call `GEOIN1` to read the input stream for the description of the geometry.

L:87 Write to the output file the module execution footer. The format (6901) is provided in lines 90.

L:88 Return control to the main DRAGON program.

L:89-93 Formats for printing the header, footer and credits.

L:94 End of subroutine

2.1.2 Subroutines GEOIN1, GEOIN2 and GEOIN3

The listing of the subroutine `GEOIN1.f` is provided in Appendix A.1.2. The differences between `GEOIN2.f` and `GEOIN1.f` are the following:

L:1-2 `GEOIN1` is replaced by `GEOIN2`

L:71 `GEOIN1` is replaced by `GEOIN2`

L:686 The call to `GEOIN2` is replaced by a call to `GEOIN3`

Similarly the differences between `GEOIN3.f` and `GEOIN1.f` are the following:

L:1-2 `GEOIN1` is replaced by `GEOIN3`

L:44-45 The local variables `MAXMI2` and `MAXMIX` which are defined as integer in `GEOIN1` are not defined nor used in `GEOIN3`.

L:71 `GEOIN1` is replaced by `GEOIN3`

L:668-688 These are absent from the routine `GEOIN3` since subgeometries cannot be defined in this subroutine.

Now here is the description of the subroutine `GEOIN1` that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-19 Comments describing the use of the subroutine and the parameters of the subroutine.

L:20-69 Definition of parameters used in the subroutine. Note that on there is an `EQUIVALENT` instruction on lines 59-60 to identify the local variables `LR`, `LX`, `LY`, `LZ` and `LREG` with `ISTATE(2)`, `ISTATE(3)`, `ISTATE(4)`, `ISTATE(5)` and `ISTATE(6)` respectively.

L:70-73 Initialize routine name parameter `NAMSBR=GEOIN1`, the minimum number of mixture required for this geometry `MINMIX`=0 and the minimum index `MINICO`=1 for imposed external albedos.

L:74 Store (`LCMLEN`) inside variable `ILONG` the length of the `SIGNATURE␣␣␣` record present on the geometry data structure.

L:75-99 If-Then-Else for data structure processing.

- L:75 If `ILONG`=0, then a new GEOMETRY data structure is to be created.
- L:76-82 For a new geometry, the state vector `ISTATE` is first initialized to 0 using the utility routine `XDRSET`. Then the logical variable `LHEX` is set to `.FALSE.` to indicate that by default the geometry will not be hexagonal in shape. Finally, the three vectors `NCODE`, `ICODE` and `ZCODE` associated with the boundary conditions are initialized to 0.
- L:83-90 If the signature exists on the data structure, read it (`LCMGET`). If the signature is not that associated with a GEOMETRY data structure (`L_GEOM␣␣␣␣␣␣`), the program aborts.
- L:91-92 Initialize the state vector `ISTATE` to 0 (`XDRSET`) before reading its contents (`LCMGET`) from the data structure.
- L:93-94 By looking at the first element of the state vector determine if the geometry is hexagonal in shape. If this is the case then set `LHEX` to `.TRUE.`, otherwise `LHEX` is initialize to `.FALSE.`.
- L:95-97 Read from the data structure the contents of the three vectors `NCODE`, `ICODE` and `ZCODE` associated with the boundary conditions.
- L:98 For a first level geometry (`ILEVEL`=1), the processing is transferred to line 270 (statement number 30). Note that for `GEOIN1` the test here is useless since `ILEVEL` is always 1. However, this test is needed by routines `GEOIN2` (`ILEVEL`=2) and `GEOIN3` (`ILEVEL`=3) to ensure an adequate processing of sub-geometries.

L:100-103 Use the free format reader (`REDGET`) to extract information from the input stream. Here a valid DRAGON geometry keyword is expected. The program will abort if the record returned by `REDGET` is not stored in the character variable `TEXT12` (`INDIC`≠3).

L:104-269 If-Then-Else for geometry type analysis.

- L:104-105 If a `VIRTUAL` geometry is specified `ISTATE(1)`=0 and the default number of regions in this case is `LREG=ISTATE(6)`=0.
- L:106-108 If a `HOMOGE` geometry is specified `ISTATE(1)`=1 and the default number of regions in this case is `LREG=ISTATE(6)`=1.
- L:109-113 If a `CAR1D` geometry is specified `ISTATE(1)`=2. Then read (`REDGET`) an integer variable containing `LX=ISTATE(3)` which represents the number of x directed mesh elements associated with this geometry. Finally compute `LREG=ISTATE(6)=LX`, the total number of regions.

L:114-118 If a TUBE geometry is specified ISTATE(1)=3. Then read (REDGET) an integer variable containing LR=ISTATE(2) that represents the number of radial mesh elements associated with this geometry. Finally compute the total number of regions LREG=ISTATE(6)=LR.

L:119-123 If a SPHERE geometry is specified ISTATE(1)=4. Then read (REDGET) an integer variable containing LR=ISTATE(2) that represents the number of radial mesh elements associated with this geometry. Finally compute LREG=ISTATE(6)=LR, the total number of regions.

L:124-130 If a CAR2D geometry is specified ISTATE(1)=5. Then read (REDGET) successively two integer variables containing LX=ISTATE(3) and LY=ISTATE(4) that represent the number of x and y directed mesh elements associated with this geometry. Finally compute the total number of regions LREG=ISTATE(6)=LX×LY.

L:131-137 If a TUBEZ geometry is specified ISTATE(1)=6. Then read (REDGET) successively two integer variables containing LR=ISTATE(3) and LZ=ISTATE(5) that represent the number of radial and z directed mesh elements associated with this geometry. Finally compute the total number of regions LREG=ISTATE(6)=LR×LZ.

L:137-146 If a CAR3D geometry is specified ISTATE(1)=7. Then read (REDGET) three integer variables containing LX=ISTATE(3), LY=ISTATE(4) and LZ=ISTATE(5) that represent the number of x, y and z directed mesh elements associated with this geometry. Finally the total number of regions LREG=ISTATE(6)=LX×LY×LZ is computed.

L:147-152 If a HEX geometry is specified ISTATE(1)=8. Then read (REDGET) an integer variable containing LX=ISTATE(3) that represents the number of hexagonal elements associated with this geometry. Finally the total number of regions LREG=ISTATE(6)=LX is computed.

L:153-160 If a HEXZ geometry is specified ISTATE(1)=9. Then read (REDGET) two integer variables containing LX=ISTATE(3) and LZ=ISTATE(5) that represents the number of hexagonal and z directed elements associated with this geometry. Finally the total number of regions LREG=ISTATE(6)=LX×LZ is computed.

L:161-220 If a CARCEL, CARCELX, CARCELY or CARCELZ geometry is specified, one first reads (REDGET) an integer variable containing LR=ISTATE(3) and then define the character variable DIR that contains w for a CARCELw geometry.

- L:165-181
  In the case where DIR=␣, ISTATE(1)=20 and LX=ISTATE(3), LY=ISTATE(4) are initialized to 1. Similarly the input flag IRLXY is initialized to 1. Then read (REDGET) the next record on the input stream. If this record contains a character variable (L:171-172), then the default value for LX and LY are preserved and IRLXY=0 to indicate that the variable TEXT12 contains the next keyword to be processed. If this record contains a real variable (L:173-174), then the program is aborted. Finally, if this record contains an integer variable (L:175-178), the information is stored in LX=ISTATE(3) and a second an integer variable associated with LY=ISTATE(4) is also taken from the input stream. The total number of regions LREG=ISTATE(6)=(LR+1)×LX×LY is then computed. Finally, if IRLXY is 0 (L:181), the program is transferred to instruction 35 (L:272) for the processing of the keyword present in the variable TEXT12.
- L:182-216
  In the case where DIR is X, Y or Z then LX=ISTATE(3), LY=ISTATE(4) and LZ=ISTATE(5) are initialized to 1. Then read (REDGET) the next record on the input stream which must contain an integer variable. This information is then stored temporarily in the variable LX=ISTATE(3). This is followed by a second call to REDGET. If this record contains a character variable (L:190-191), then the default

value for LY and LZ are preserved and IRLXY=0 to indicate that the variable TEXT12 contains the next keyword to be processed. If this record contains a real variable (L:192-193), then the program is aborted. Finally, if this record contains an integer variable (L:194-198), the information is stored in LY=ISTATE(4) and a second integer variable associated with LZ=ISTATE(5) is also taken from the input stream and IRLXY=1. The total number of regions LREG=ISTATE(6)=(LR+1)×LX×LY×LZ is then computed. Finally, ISTATE(1)=21 if DIR=X, ISTATE(1)=22 if DIR=Y and ISTATE(1)=23 if DIR=Z. Note that in the case where IRLXY=1, the value of LX, LY, and LZ were read explicitly. However, in the case where IRLXY=0, only one parameter was read (temporarily stored in LX). In the case where DIR=X, the information remains in LX. For the cases where DIR=Y and DIR=Z, the contents of LX is transferred to LY and LZ respectively while LX is re-initialized to 1 (L:206-209 and L:213-216). The control is the transferred to statement number 35 (L:272) for the processing of the keyword present in the variable TEXT12.

- L:217-220
  In the case where DIR is neither ␣ nor one of the values X, Y and Z, the control is transferred to instruction number 500 (L:716) where the program will abort.

L:221-237 If a HEXCEL or HEXCELZ geometry is specified one first reads (REDGET) an integer variable containing LR=ISTATE(3) and initialize the number of hexagonal regions LX=1.

- L:226-228
  In the case where TEXT12(7:7)=␣, ISTATE(1)=24 and the number of regions LREG=ISTATE(6)=LR+LX=LR+1 is computed.
- L:229-234
  In the case where TEXT12(7:7)=Z, ISTATE(1)=25. Then read (REDGET) an integer variable containing LZ=ISTATE(5) and evaluates the number of regions LREG=ISTATE(6)=(LR+LX)×LZ=(LR+1)×LZ.
- L:235-237
  In the case where DIR is neither ␣ nor Z, the control is transferred to instruction number 500 (L:716) where the program will abort.

L:238-243 If a do-it-yourself geometry is specified (keyword GROUP), then ISTATE(1)=30. Then read (REDGET) an integer variable containing LX=ISTATE(3) and evaluates the number of regions LREG=ISTATE(6)=LX.

L:244-267 If a geometry name is specified then all the information associated with this geometry is transferred in the current geometry. Such an option is only possible is for a sub- or sub-sub-geometry and the program aborts if LEVEL=1 (L:247:248). Then:

- L:249-267
  These lines are used to verify if the geometry identified by TEXT12 exists and to transfer its contents to the new subgeometry. One first exits from the current sub-geometry and return to the previous hierarchical level (LCMSIX(a,b,2)). Then verify the presence of the record with the name specified in the variable TEXT12 (LCMLEN). In the case where a value of ILONG=0 is returned, then the record is absent and the the program will abort. Otherwise, one will first export (LCMEXP(a,b,c,1)) the contents of the geometry on a sequential binary file called DUMMYSQ (using L:252-256) before importing (LCMEXP(a,b,c,2)) this file inside the adequate sub geometry (L:252-261). Finally (L:262-267) the main geometry information is recovered (LCMGET) and stored in local variables (see L:92-97).

L:270-272 Using REDGET, read the next record and verify that it is a character variable. If it is a character variable, we will next test if it is a valid keyword. The keyword is stored in TEXT12. The statement number 30 (L:270) is used as an infinite loop control to process successively keywords. The statement 35 (L:272)

is an alternate entry point to this infinite do loop in the case where the keyword has already been stored in TEXT12 by a previous call to REDGET (see L:161-220 for example).

L:272-691 If-Then-Else for keyword processing.

L:272-274 If the keyword in TEXT12 is EDIT then read (REDGET) an integer variable containing IMPX form the input stream.

L:275-292 If the keyword in TEXT12 is MIX then read the mixture associated with each region. Here (L:277) one first allocate memory (SETARA) for a vector of dimension LREG to store this information this vector being initialized to 0 (XDRSET on L:278). Then, one reads (REDGET on L:281) for each region I, until a character variable is encountered (transfer to instruction 50 in L:282), a maximum number of LREG (transfer to instruction 500 on L:284) integers (abort for non integer in L:283). Store (L:285) the mixture number inside the previously allocated vector for the current region number, then evaluate (L:284-287) ISTATE(7) and MINMIX which represent the maximum and minimum mixture number used respectively before returning to instruction 40 and reading the mixture associated with the next region. The variable LREG=ISTATE(6)=I-1 is then recomputed (it represents the maximum length of the mixture vector) before the vector containing a description of the mixtures associated with each region is saved (LCMPUT on L:290) on the geometry data structure and the allocated memory is released (RLSARA on L:291). Since the TEXT12 contains the next keywords, return to instruction 35 (L:292).

L:293-316 If the keyword in TEXT12 is MESHX, MESHY or MESHZ then read the Cartesian spatial mesh. After verifying the direction selected (X, Y or Z on L:295, L:298 and L:301) is valid (transfer to instruction 500 on L:305 for invalid instruction), the number of mesh position to read (LMESH on L:297, L:300 and L:303) is evaluated provided the meshing in this direction for a specific geometry has been initialized (L:296, L:299 and L:302). Then allocate memory to store LMESH real variables (SETARA on L:307) before reading exactly LMESH real variables (L:308-310) which must be increasing in values (L:311-313). Finally save (LCMPUT) this information on a record with name TEXT12 on the geometry data structure before releasing (RLSARA) the memory allocated.

L:317-331 If the keyword in TEXT12 is RADIUS then read the radial spatial mesh. After verifying that the number of radial mesh position to read (LMESH on L:297, L:300 and L:303) is valid for the geometry (L:319), memory is allocated to store (SETARA on L:321) LCYL=LR+1 (L:320) real variables. Then exactly LCYL real variables (L:322-328) which must be increasing in values are read (REDGET on L:323). Finally verify is the first radial mesh is identically 0.0 (L:329), save (LCMPUT) this information on a record with name RADIUS on the geometry data structure before releasing (RLSARA) the memory allocated.

L:332-345 If the keyword in TEXT12 is OFFCENTER then read the displacement with respect to the cell center of the annular regions in a CARCEL, CARCELX, CARCELY and CARCELZ geometry. After verifying that the number of radial region (LR on L:334) is valid, memory is allocated to store (SETARA on L:335) 3 real variables which are first initialized to 0.0 (L:336). Up to 3 real variables and one character variable (L:337-342) are read (REDGET on L:338 and L:341). Then save (LCMPUT) this information on a record with name OFFCENTER on the geometry data structure before releasing (RLSARA) the memory allocated. Finally return to instruction 35 to process the last character variable read.

Note: For a more coherent processing, a test on INDIC=3 should be provided after L:344 to ensure that the last information obtained by REDGET is a character variable. *This should be corrected in version 3.05 of DRAGON.*

L:346-351 If the keyword in TEXT12 is SIDE then read the dimension of one side of an hexagon. After verifying that the geometry is hexagonal in shape, one real variable is read (REDGET on L:349) and saved (LCMPUT on L:350) on a record with name SIDE on the geometry data structure.

L:352-379 If the keyword in `TEXT12` is `SPLITR`, `SPLITX`, `SPLITY` or `SPLITZ` then read the automatic mesh splitting parameters. First one initializes `ISTATE(11)=1` (L:354) to indicate that automatic mesh splitting parameters will be available. Then the number of integer parameters to be read (`LMESH`) is selected (L:355-369) depending on the type of splitting (`TEXT12(6:6)` is `R`, `X`, `Y` or `Z`). Memory is allocated (`SETARA` on L:370) to store `LMESH` integer variables that then are then read (`REDGET` on L:372). Here, the splitting parameter must be greater than 0 if the splitting is related to the Cartesian mesh while it must be different that 0 for the radial splitting. Finally, this information is saved (`LCMPUT` on L:378) on a record with the name specified in `TEXT12` before the memory is released (`RLSARA` on L:379).

L:380-419 If the keyword in `TEXT12` is `CELL` then assume that each region in the current geometry is filled with a sub-geometry rather that with a mixture. First initialize `ISTATE(8)=1` (L:382) to indicate that the current geometry is filled with a sub-geometry rather that with a mixture. Then allocate (`SETARA` L:383-384) a "simulated" character vector (`ICELL`) of dimensions 3×`LREG` that will contain the name of the independent sub-geometries that will be used to fill the various region in the current geometry and an integer vector (`IIGEN`) of dimensions `LREG` that contains a cross reference between region position and the reference sub-geometry names. Read and process (L:385-414) the `LREG` sub-geometry present in the current geometry using an infinite do-loop controlled by the the instruction 100 (L:387, L:405 and L:413), namely:

- L:388-397
  Get next parameter from input stream, and verify if it is stored in a character variable (abort if this is not the case). Then if the contents of `TEXT12` is a keyword, transfer to instruction 120 to exit this implicit do-loop.
- L:398-407
  If the current sub-geometry name is identical to a precedent sub-geometry name , store in the vector associated with `IIGEN` a pointer to the old sub-geometry and return to instruction 110 to read the next sub-geometry.
- L:408-414
  Otherwise, `IKG` is increased by 1 this information being stored in the vector associated with `IIGEN` and the new sub-geometry name is transferred to the "simulated" character vector associated with `ICELL` at location `IKG`.

Finally, this information is saved (`LCMPUT` on L:415-416) on a the records `CELL` and `GENERATING` before the memory is released (`RLSARA` on L:417-418) and control is transferred to instruction 35.

L:420-435 If the keyword in `TEXT12` is `MERGE` then assume that for a geometry filled with sub-geometries, cell merging can take place. First initialize `ISTATE(10)=1` (L:422) to indicate that cell merging can take place. Then allocate (`SETARA` L:423) an integer vector (`IMERGE`) of dimensions `LREG` that will contain a cross reference between the initial region number and the merged region number. Read and process (L:424-432) a maximum of `LREG` merged region numbers. Finally, save (`LCMPUT` on L:433) the cell merging information and release (`RLSARA` on L:434) the memory allocated before the control is transferred to instruction 35.

L:436-457 If the keyword in `TEXT12` is `TURN` then the sub-geometries filling a geometry can change orientation. First allocate (`SETARA` L:438) an integer vector (`ITURN`) of dimensions `LREG` that will contain a cross reference between the initial region number and the rotation index. Read and process (L:440-453) a maximum of `LREG` rotation parameter. To each rotation parameter (see L:64) a rotation index is associated corresponding to the location of the parameter in the `CTURN` vector. In the case where the rotation parameter is preceded by a `-` sign, then the rotation index is that associated with the turn parameter added

to the maximum number of turn parameter possible (`MAXTUR` defined on L:25). Finally, save (`LCMPUT` on L:455) the cell rotation information and release (`RLSARA` on L:456) the memory allocated before the control is transferred to instruction 35.

L:458-481 If the keyword in `TEXT12` is `CLUSTER` then assume that a series of cluster sub-geometries will be super-imposed on the current geometry. This option is only possible (L:460) if the original geometry contains annular sub-regions (`LR`$\neq$0). First allocate (L:461) a "simulated" character vector (`ICELL`) of dimensions 3$\times$`MXCL` (see L:25) that will contain the name of the independent sub-geometries that will super-imposed on the current geometry. Read and process (L:463-477) a maximum of `MXCL` cluster names (these must differ from the keyword used in `GEOIN1` as tested on L:465-472). Finally, save (L:478) the cluster names, store in `ISTATE(13)` the total number of cluster names used and release (L:480) the memory allocated before the control is transferred to instruction 35.

L:482-487 If the keyword in `TEXT12` is `NPIN` then read the number of times the current geometry is duplicated inside a main geometry. This option is only used if the current geometry is super-imposed on a reference geometry using the `CLUSTER` keyword and for `TUBE` and `TUBEZ` format geometries (L:484). Read an integer value for `NPIN` and save it on the geometry data structure (L:485-487).

L:488-493 If the keyword in `TEXT12` is `RPIN` or `APIN` then read the radial or angular position of the current geometry when duplicated inside a main geometry. These options are only used if the current geometry is super-imposed on a reference geometry using the `CLUSTER` keyword and for `TUBE` and `TUBEZ` format geometries (L:490). Read a real value for either of `RPIN` or `APIN` and save it on the geometry data structure (L:491-493).

L:494-599 If the keyword in `TEXT12` is `BIHET` (`ISTATE(12)`=1), `POURCE` or `PROCEL` then double-heterogeneity (define `ISTATE(12)`=1) or do-it-yourself assemblies (`ISTATE(1)`=30 required) are to be built. Such assemblies cannot be analyzed by the `EXCELT` module of DRAGON.

L:600-664 If the keyword in `TEXT12` is `R+`, `X-`, `X+`, `Y-`, `Y+`, `Z-`, `Z+` or `HBC` then the boundary conditions are to be taken from the input file. The first step is to associate to each boundary a surface number `ISURF` (L:604-640) and to verify if such a surface can be identified in the current geometry. For example the keywords `X-` and `X+` are valid only if `LX`$\neq$0. Similarly, the keywords `Y-` and `Y+` are valid only if `LY`$\neq$0 while `LZ`$\neq$0 and `LR`$\neq$0 are required respectively for the options `Z-` or `Z+` and `R+`. Finally, the use of `HBC` is permitted only if `LHEX` is `.TRUE.` and this keyword must be followed by a hexagonal symmetry keyword. This symmetry must be selected from the vector `CHEX` (defined in L:62-63). What is saved here (L:637) is the index corresponding to the location in `CHEX` of the keyword stored in `TEXT12` (L:627). One then reads (`TEXT4` on L:641) the type of boundary condition and stores in `NCODE(ISURF)` the position of the keyword stored in `TEXT4` in the vector `COND` (see L:61). In the case where `TEXT4=ALBE`, a real value for the albedo can be provided and stored in vector `ZCODE` (L:655-656) or the index of a physical albedo that will be stored in `ICODE` (L:652-654). Finally in the case where `TEXT4` is `REFL` or `VOID`, real values of 1.0 or 0.0 respectively are automatically supplied and stored in vector `ZCODE` (L:660-664).

L:665-667 If the keyword in `TEXT12` is `;` then the description of the geometry is complete and the program transfers to instruction 320 (L:694).

L:668-688 If the keyword in `TEXT12` is `:::` then the information that follows involves the description of a sub-geometry. Here one first reads the name `TEXT12` (L:670-672) of the subgeometry and verify if this name is followed by the sets of characters `:=` and `GEO:` (L:673-676). One also verify that this sub-geometry has not already been defined (L:677-683). In the case where the sub-geometry is indeed new, `ISTATE(9)` is increased by 1. Then after positioning the data structure on the new geometry using `LCMSIX` (L:684), the subroutine

GEOIN2 is called. Finally, after the control has return from GEOIN2, the data structure is returned to the reference geometry using a second LCMSIX (L:687). Finally, the maximum number of mixture ICODE(7) is recomputed to take into account the information processed by the routine GEOIN2 (L:688).

L:689-690 If the keyword is not one of the above then the routine will abort.

L:692 Last statement of the infinite do-loop initiated on L:270.

L:693-714 Finish the processing of the current geometry and save the general parameters associated with this geometry namely, the SIGNATURE, the STATE-VECTOR and the three vector associated with boundary conditions namely NCODE, ICODE and ZCODE (L:694-700). Then one verifies if negative mixture numbers or external albedos have been used (L:701-704) or if the CELL option has been used but no sub-geometry defined (L:714). Finally, the maximum number of mixtures currently in use MAXMIX is computed and some output is generated.

L:715 Return control to the calling subroutine.

L:716 Return point for abort on error.

L:717-735 Formats for printing the name of the geometry and the contents of the state vector for this geometry.

L:736 End of subroutine.

2.2 Processing Geometries Using the GEO: Module

The second part of the verification consists in comparing the contents of a GEOMETRY data structure (created by the GEO: module) with the information provided by the user in the DRAGON input data file. The various 2–D and 3–D geometries we will consider here are presented in Figure 1 to 16. The DRAGON input deck for each of these geometries can be found in Appendix B. In this Appendix one will find, in addition to the DRAGON input data file that is required to define each geometry, the contents of the GEOMETRY and TRACKING data structure, in an ASCII format, as generated by the modules GEO: and EXCELT: of DRAGON respectively. Here we will concentrate our discussions on the comparison of the DRAGON input data file and the GEOMETRY data structure. The analysis of the TRACKING data structure will be left to Section 3. A discussion on how to interpret the contents of a DRAGON data structure in an ASCII format can be found in Appendix C.

2.2.1 Geometry G21F2DZ1

This simple Cartesian 2–D geometry containing annular sub-regions is illustrated in Figure 1. As one can see the information following the keywords MESHX, MESHY, RADIUS and MIX is identical to the information stored in the records with the same names on the GEOMETRY data structure. The information related to the boundary conditions (X-, X+, y- and Y+) has been transferred in the records NCODE, ICODE and ZCODE. The first four elements in the record NCODE are initialized to 2 indicating reflection at the X-, X+, y- and Y+ surfaces respectively. As a consequence the geometrical albedo for each of these 4 directions are also initialized to 1.0 (see record ZCODE). Finally, no physical albedos are used in this case as indicated by the fact that the record ICODE is initialized to 0.

The record STATE-VECTOR mainly contain dimensioning information. Here:

- STATE-VECTOR(1)=20 indicating that the geometry is a CARCEL.
- STATE-VECTOR(2)=5 indicating that the annular region is divided into 5 concentric rings.
- STATE-VECTOR(3)=1 indicating that the x direct Cartesian mesh contains only one region.
- STATE-VECTOR(4)=1 indicating that the y direct Cartesian mesh contains only one region.

- STATE-VECTOR(6)=6 indicating that the maximum number of independent region that can be associated with this geometry is 6 (before splitting takes place).
- STATE-VECTOR(7)=14 indicating that the maximum mixture number present in the geometry is 14.

Finally the record SIGNATURE is initialized to L_GEOM␣␣␣␣␣␣ to indicate that this is a GEOMETRY data structure.

2.2.2 Geometry G21F2DZ2

This geometry is illustrated in Figure 2. As one can see, it is very similar to geometry G21F2DZ1 except for the additional presence of the SPLITX and SPLITY instructions in the DRAGON input data file. As a consequence, the only differences in the information stored in the geometry data structure for G21F2DZ2 and G21F2DZ1 is the following:

- The presence of the records SPLITX and SPLITY which contains the same information as that following they keywords SPLITX and SPLITY respectively.
- STATE-VECTOR(11)=1 indicating the presence of splitting records on this data structure.

2.2.3 Geometry G21F2DZ3

This geometry is illustrated in Figure 3. As one can see, it is similar to geometry G21F2DZ2 except for the Cartesian mesh splitting in this case is not uniform. This requires an explicit definition of the x and y directed Cartesian mesh. Here, the MESHX and MESHY records on the GEOMETRY data structure each contains 5 elements. This is also reflected in the components 3 and 4 of the record STATE-VECTOR which are now initialized to 4 and in the component 6 which now takes a value of 96 ($6 \times 4 \times 4$) to indicate the maximum number of independent region that can be associated with this geometry. Note that STATE-VECTOR(6) also represents the dimension of the MIX vector since we must associate with each possible region a mixture number.

2.2.4 Geometry G21F2DZ4

This geometry is illustrated in Figure 4. As one can see, it is physically identical to geometry G21F2DZ3. However, G21F2DZ4 is defined as an assembly of cells, namely a two level geometry, while G21F2DZ3 was defined in term of a unique cell. This assembly contains 6 different cells (c1, c2, c3, c4, c5 and c6) as indicated by the CELL keyword in the DRAGON input file. The name and location of these cells are stored in the records CELL and GENERATING on level 1 of the GEOMETRY data structure. Here the contents of the GENERATING vector is used to locate a given cell type at each location in the 3×2 Cartesian mesh. The information stored in the records associated with boundary conditions (NCODE, ZCODE and ICODE) is identical to that found in the on level 1 of the GEOMETRY data structure for G21F2DZ3. One can also note the absence of the MIX record on level 1 of the GEOMETRY data structure since the geometry is filled with cell, not mixtures. Finally the contents of the STATE-VECTOR on level 1 of the GEOMETRY data structure is also modified as follows to reflect the fact the CELL option is used:

The record STATE-VECTOR mainly contain dimensioning information. Here:

- STATE-VECTOR(1)=5 indicating that the geometry is a CAR2D.
- STATE-VECTOR(2)=0 indicating that annular cells are absent from the assembly.
- STATE-VECTOR(3)=3 indicating the number of possible x direct Cartesian cell positions.

- `STATE-VECTOR`(4)=2 indicating the number of possible y direct Cartesian cell positions.
- `STATE-VECTOR`(6)=6 indicating the maximum number of cells that can be associated with this assembly.
- `STATE-VECTOR`(7)=14 indicating the maximum mixture number present in the geometry.
- `STATE-VECTOR`(8)=1 indicating that the geometry contains cell sub-geometries.
- `STATE-VECTOR`(9)=6 indicating the number of sub-geometry defined for this geometry.

The GEOMETRY data structure also contains the description (level 2 information) of each of the 6 different geometry types required (level 2 information stored in a level 1 sub-directory) to complete the definition of the assembly. The contents of these level 1 sub-directory reflect explicitly the information provided in the DRAGON input data file:

- The `SIGNATURE` record indicates that the sub-directory also contains a GEOMETRY data structure.
- The `MESHX`, `MESHY`, `RADIUS` (if required), and `MIX` records reflect the information provided in the input file.
- The records associated with boundary conditions (`NCODE`, `ZCODE` and `ICODE`) are all initialized to 0. Since the boundary conditions are associated with the assembly, these level 2 records will are not used.
- The `STATE-VECTOR` record for each sub-geometry reflects the properties of this sub-geometry. For example the geometry `c6` is a 1×3 Cartesian geometry containing mixture 1. Accordingly we will have:
  - `STATE-VECTOR`(1)=5 indicating that the geometry is a `CAR2D`.
  - `STATE-VECTOR`(2)=0 indicating that there are no annular sub-regions to be found in this geometry.
  - `STATE-VECTOR`(3)=3 indicating that the x direct Cartesian mesh contains only one region.
  - `STATE-VECTOR`(4)=1 indicating that the y direct Cartesian mesh contains only one region.
  - `STATE-VECTOR`(6)=3 indicating that the maximum number of independent region that can be associated with this geometry is 6 (before splitting takes place).
  - `STATE-VECTOR`(7)=1 indicating that the maximum mixture number present in the geometry is 14.

2.2.5 Geometry G21F3D1

This geometry which is illustrated in Figure 5 is a 3–D extension of G21F2DZ1. As one can see the main difference in the contents of the GEOMETRY data structure between G21F2DZ1 and G21F3D1 is the presence in the later of the record `MESHZ`, the fact that the boundary condition records `NCODE`, `ICODE` and `ZCODE` now include the information related indicating that the surfaces `Z-` and `Z+` are reflective (`NCODE`(5)=`NCODE`(6)=2 and `ZCODE`(5)=`ZCODE`(6)=1.0).

The following elements of the `STATE-VECTOR` records have also been changed:

- `STATE-VECTOR`(1)=23 indicating that the geometry is a `CARCELZ`.
- `STATE-VECTOR`(5)=1 indicating that the z direct Cartesian mesh contains only one region.

2.2.6 Geometry G21F3D2

This geometry (see Figure 6) is a 3–D extension of G21F2DZ2. It is also very similar to geometry G21F3D1 except for the additional presence of the `SPLITX`, `SPLITY` and `SPLITZ` instructions in the DRAGON input data file. As a consequence, the only differences in the information stored in the geometry data structure for G21F3D2 and G21F3D1 is the following:

- The presence of the records `SPLITX`, `SPLITY` and `SPLITZ`.
- `STATE-VECTOR`(11)=1 indicating the presence of splitting records on this data structure.

2.2.7 Geometry G21F3D3

This geometry is illustrated in Figure 7. It is similar to geometry G21F3D2 except for the Cartesian mesh splitting in this case is not uniform. This requires an explicit definition of the x, y and z directed Cartesian mesh. Here, the `MESHX`, `MESHY` and `MESHZ` records on the GEOMETRY data structure contain 5, 5 and 3 elements respectively. This is also reflected in the components 3, 4 and 5 of the record `STATE-VECTOR` which are now initialized to 4, 4 and 2 respectively and in the component 6 which now takes a value of 192 ($6 \times 4 \times 4 \times 2$) to indicate the maximum number of independent region that can be associated with this geometry. Note that `STATE-VECTOR`(6) also represents the dimension of the `MIX` vector since we must associate with each possible region a mixture number.

2.2.8 Geometry G21F3D4

This geometry (see Figure 8) is physically identical to geometry G21F3D4 apart from the fact that it is defined in terms of an assembly of cells. This assembly is a combination of 12 cells some of which being identical, namely the two different planes of cells in the z direction are have the same cell contents (`c1`, `c2`, `c3`, `c4`, `c5` or `c6`). The name and location of these cells are stored in the records `CELL` and `GENERATING` on level 1 of the GEOMETRY data structure. Here the contents of the `GENERATING` vector is used to locate a given cell type at each location in the $3 \times 2 \times 2$ Cartesian mesh. The information stored in the records associated with boundary conditions (`NCODE`, `ZCODE` and `ICODE`) is identical to that found in the on level 1 of the GEOMETRY data structure for G21F3D3. One can also note the absence of the `MIX` record on level 1 of the GEOMETRY data structure since the geometry is filled with cell, not mixtures. Finally the contents of the `STATE-VECTOR` on level 1 of the GEOMETRY data structure is also modified as follows to reflect the fact the `CELL` option is used:

The record `STATE-VECTOR` mainly contain dimensioning information. Here:

- `STATE-VECTOR`(1)=7 indicating that the geometry is a `CAR3D`.
- `STATE-VECTOR`(2)=0 indicating that annular cells are absent from the assembly.
- `STATE-VECTOR`(3)=3 indicating the number of possible x direct Cartesian cell positions.
- `STATE-VECTOR`(4)=2 indicating the number of possible y direct Cartesian cell positions.
- `STATE-VECTOR`(5)=2 indicating the number of possible z direct Cartesian cell positions.
- `STATE-VECTOR`(6)=12 indicating the maximum number of cells that can be associated with this assembly.
- `STATE-VECTOR`(7)=14 indicating the maximum mixture number present in the geometry.
- `STATE-VECTOR`(8)=1 indicating that the geometry contains cell sub-geometries.
- `STATE-VECTOR`(9)=6 indicating the number of sub-geometry defined for this geometry.

The GEOMETRY data structure also contains the description of each of the 6 different sub-geometry required to complete the definition of the assembly. As discussed in Section 2.2.4 the contents of these sub-directories reflect explicitly the information provided in the DRAGON input data file.

2.2.9 Geometry G22F2DZ1

This Cartesian 2–D assembly containing 3 cells two of which have annular sub-regions is illustrated in Figure 9. Since it is a two level geometry, one will first find on level 1 of the GEOMETRY data structure the name and location of the cells (records `CELL` and `GENERATING`). The information stored in the records associated with boundary conditions (`NCODE`, `ZCODE` and `ICODE`) is identical to that found in the on level 1 of the GEOMETRY data structure for G21F2DZ1 (namely reflection at surfaces `X-`, `X+`, `Y-` and `Y+`). Finally the contents of the `STATE-VECTOR` on level 1 of the GEOMETRY data structure is also modified as follows to reflect the fact the `CELL` option is used:

The record `STATE-VECTOR` mainly contain dimensioning information. Here:

- `STATE-VECTOR`(1)=5 indicating that the geometry is a `CAR2D`.
- `STATE-VECTOR`(2)=0 indicating that annular cells are absent from the assembly.
- `STATE-VECTOR`(3)=3 indicating the number of possible x direct Cartesian cell positions.
- `STATE-VECTOR`(4)=1 indicating the number of possible y direct Cartesian cell positions.
- `STATE-VECTOR`(6)=3 indicating the maximum number of cells that can be associated with this assembly.
- `STATE-VECTOR`(7)=14 indicating the maximum mixture number present in the geometry.
- `STATE-VECTOR`(8)=1 indicating that the geometry contains cell sub-geometries.
- `STATE-VECTOR`(9)=3 indicating the number of sub-geometry defined for this geometry.

The GEOMETRY data structure also contains the description (level 2 information) of each of the 3 different geometry types required (level 2 information stored in a level 1 sub-directory) to complete the definition of the assembly. The contents of these level 1 sub-directory reflect explicitly the information provided in the DRAGON input data file as described in Section 2.2.1.

2.2.10 Geometry G22F2DZ2

This Cartesian 2–D assembly is in fact identical to that described in Section 2.2.9 (see Figure 9 and 10). The main difference is in the way the geometry has been defined, namely, the DRAGON user realized that cell `c3` of geometry G22F2DZ2 is identical to cell `c1` apart from a rotation of π around its center. Accordingly, instead of defining the assembly in terms of cells `c1`, `c2` and `c3`, here it is defined assembly in terms of cells `c1`, `c2` the last element in the assembly (`c1` again) being rotated by π around its center (option `E` following the `TURN` keyword). Since it is a two level geometry, one will first find on level 1 of the GEOMETRY data structure the name, location and transformation of the cells (records `CELL`, `GENERATING` and `TURN`). The information stored in the records associated with boundary conditions (`NCODE`, `ZCODE` and `ICODE`) is identical to that found in the on level 1 of the GEOMETRY data structure for G22F2DZ1. Finally the contents of the `STATE-VECTOR` on level 1 of the GEOMETRY data structure is identical to that generated for G22F2DZ1 except for the following change:

- `STATE-VECTOR`(9)=2 indicating the number of sub-geometry defined for this geometry.

2.2.11 Geometry G22F2DZ3

This Cartesian 2–D assembly is also identical to that described in Section 2.2.9 and Section 2.2.10 (see Figure 10 and 11). The main difference here is that the DRAGON user realized that assembly is symmetric with respect to the center of the assembly in both the x and y direction. Accordingly, instead of defining the assembly completely, only one half of the assembly is defined and the `X+` and `Y+` boundary conditions are are modified to

reflect this fact. The information stored in the records associated with boundary conditions (NCODE, ZCODE and ICODE) for direction X- and Y- is identical to that found in G22F2DZ2. However, now NCODE(2)=NCODE(4)=5 to indicate the presence of symmetry conditions at these surfaces. Finally the contents of the STATE-VECTOR on level 1 of the GEOMETRY data structure is identical to that generated for G22F3DZ2 except for the following change:

- STATE-VECTOR(3)=2 indicating the number of possible x direct Cartesian cell positions.
- STATE-VECTOR(6)=2 indicating the number of cells that were associated with this assembly.

2.2.12 Geometry G22F2DZ4

This Cartesian 2–D assembly is similar to that described in Section 2.2.11 (see Figure 12). The main difference here is that the spatial discretization inside each cell has been refined (either explicitly using the MESH option or automatically using the SPLIT option). As a results, all the records appearing on level 1 of this GEOMETRY data structure are identical to those found found in G22F2DZ3. The main difference is that the sub-geometries for G22F2DZ4 are now different from those found in G22F2DZ3.

2.2.13 Geometry G22F3D1

This Cartesian 3–D assembly containing 3 cells 2 of which have z directed annular sub-regions with the central cell containing y directed annular sub- (see Figure 13). Since it is a two level geometry, one will first find on level 1 of the GEOMETRY data structure the name and location of the cells (records CELL and GENERATING). The information stored in the records associated with boundary conditions (NCODE, ZCODE and ICODE) is identical to that found in the on level 1 of the GEOMETRY data structure for G21F3D1 (namely reflection at surfaces X-, X+, Y-, Y+, Z- and Z+). Finally the contents of the STATE-VECTOR on level 1 of the GEOMETRY data structure is also modified as follows to reflect the fact the CELL option is used:
The record STATE-VECTOR mainly contain dimensioning information. Here:

- STATE-VECTOR(1)=7 indicating that the geometry is a CAR3D.
- STATE-VECTOR(2)=0 indicating that annular cells are absent from the assembly.
- STATE-VECTOR(3)=3 indicating the number of possible x direct Cartesian cell positions.
- STATE-VECTOR(4)=1 indicating the number of possible y direct Cartesian cell positions.
- STATE-VECTOR(5)=1 indicating the number of possible z direct Cartesian cell positions.
- STATE-VECTOR(6)=3 indicating the maximum number of cells that can be associated with this assembly.
- STATE-VECTOR(7)=14 indicating the maximum mixture number present in the geometry.
- STATE-VECTOR(8)=1 indicating that the geometry contains cell sub-geometries.
- STATE-VECTOR(9)=3 indicating the number of sub-geometry defined for this geometry.

The GEOMETRY data structure also contains the description (level 2 information) of each of the different 3–D geometries required to complete the definition of the assembly. The contents of these sub-directory reflect explicitly the information provided in the DRAGON input data file as described in Section 2.2.5.

2.2.14 Geometry G22F3D2

This Cartesian 3–D assembly is in fact identical to that described in Section 2.2.13 (see Figure 13 and 14). Again, the DRAGON user realized that cell `c3` of geometry G22F3D2 is identical to cell `c1` apart from a rotation of $\phi = \pi$ around a z axis located at the center of the cell (see Section 2.2.10) and decided to make use of the `TURN` keyword. The information stored in the records associated with boundary conditions (`NCODE`, `ZCODE` and `ICODE`) is identical to that found in the on level 1 of the GEOMETRY data structure for G22F3D1. The contents of the `STATE-VECTOR` on level 1 of the GEOMETRY data structure is identical to that generated for G22F3D1 except for the following change:

- `STATE-VECTOR`(9)=2 indicating the number of sub-geometry defined for this geometry.

2.2.15 Geometry G22F3D3

This Cartesian 3–D assembly is also identical to that described in Section 2.2.13 (see Figure 15). However, the DRAGON user now relies on the intrinsic symmetry of the assembly (reflection symmetry in x, y and z). The information stored in the records associated with boundary conditions (`NCODE`, `ZCODE` and `ICODE`) for direction `X-` and `Y-`, `z-` is identical to that found in G22F3D2. However, `NCODE`(2)=`NCODE`(4)=`NCODE`(6)=5 indicates the presence of symmetry conditions at these surfaces. Finally the contents of the `STATE-VECTOR` on level 1 of the GEOMETRY data structure is identical to that generated for G22F3D2 except for the following change:

- `STATE-VECTOR`(3)=2 indicating the number of possible x direct Cartesian cell positions.
- `STATE-VECTOR`(6)=2 indicating the number of cells that were associated with this assembly.

2.2.16 Geometry G22F3D4

This assembly is similar to that described in Section 2.2.15 (see Figure 15 and 16) apart from the fact that spatial discretization considered inside each cell has been refined (either explicitly using the `MESH` option or automatically using the `SPLIT` option). As a results, all the records appearing on level 1 of this GEOMETRY data structure are identical to those found found in G22F3D3. The main difference is that the sub-geometries for G22F3D4 are now different from those found in G22F3D3.

3 VERIFICATION OF THE EXCELT: MODULE

This module is used for 2–D and 3–D geometry analysis and line tracking in DRAGON. It uses three different tracking routine subsets, namely the XELTRK, XCWTRK and the XHXTRK tracking options. The subset of routines associated with XCWTRK is required for 2–D cluster geometry analysis and the verification of the routines associated with this tracking subset will not be considered here. Similarly, we will not verify the subset of routines associated with XHXTRK since they are only required for 2–D and 3–D hexagonal geometry analysis. Accordingly, the main subset of routines we will need to consider is that associated with XELTRK.

A second observation is that the XELTRK routine has two different functions. First, it is used to analyze a mixed Cartesian/cylindrical 2–D or 3–D assembly of cell. Then, line tracking is performed by the highly specialized routines such as XELTI2, and by XELTI3 for 2–D and 3–D geometries with isotropic integration lines respectively.

The overall verification process we have suggested is relatively simple since the `EXCELT:` module already contains a large number of self-verification features including the comparison of a reference TRACKING data structure with that generated by `EXCELT:` after the analysis of a new GEOMETRY and a comparison between the numerically computed region volume and surface area (using the information stored on the binary tracking file) and those evaluated analytically and stored on the TRACKING data structure.

Finally here is the complete verification process we propose for the `EXCELT:` module.

1. A line by line verification of the following subroutines: XELPRC, XELPRP, LELCHK, XELCOP, XELEQN, LELCRN, XELCRN, XELPSI and XELPSC;
2. A global verification of the geometry analysis routines;
3. A verification of the contents of the binary tracking file.

3.1 Line by Line Verification

3.1.1 Subroutine XELPRC

The listing of the subroutine `XELPRC.f` is provided in Appendix A.2.6. This subroutine is used to read the information stored on a GEOMETRY data structure and to verify if this information is adequate for processing with the `EXCELT` module. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-29 Comments describing the use of the subroutine and the parameters of the subroutine.

L:30-55 Definition of parameters used in the subroutine.

L:56-58 Read the length of each record specified in `LCMNM` on the geometry data structure and store in `LNLCM`.

L:59-66 Test if there are records present on the geometry data structure which are invalid when a `EXCELT:` processing of the geometry is performed. The list of invalid option is identified by the index vector `INVLCM` where the indexing follows the record names order as specified in `LCMNM`. In the case where an invalid record contains a number of element which is larger than 0, the code will abort.

L:67-70 Verify if the record containing the state vector is present on the geometry data structure. Abort if it is absent and read its content in array `ISTATE` if it is present.

L:71-74 Test if some elements in the array `ISTATE` are invalid when a `EXCELT:` processing of the geometry is performed. The list of invalid option is identified by the index vector `INVSTA`. In the case where an invalid option is detected the code will abort.

L:75-82 Transfer the information from the array `ISTATE` to local variables.

L:83-133 Compute the explicit number of mesh regions in each direction (`JX`, `JY`, `JZ` and `JR`) taking into account the mesh splitting specified in the geometry.

- L:86-97 Compute the explicit number of radial mesh region. If the record `SPLITR` is absent from the geometry data structure then `JR=LR`, otherwise `JR` is taken as the sum of the elements (absolute value) of the array containing the record `SPLITR`.
- L:98-109 Compute the explicit number of x directed mesh region. If the record `SPLITX` is absent from the geometry data structure then `JX=LX`, otherwise `JX` is taken as the sum of the elements of the array containing the record `SPLITX`.
- L:110-121 Compute the explicit number of y directed mesh region. If the record `SPLITY` is absent from the geometry data structure then `JY=LY`, otherwise `JY` is taken as the sum of the elements of the array containing the record `SPLITY`.
- L:122-133 Compute the explicit number of z directed mesh region. If the record `SPLITZ` is absent from the geometry data structure then `JZ=LZ`, otherwise `JZ` is taken as the sum of the elements of the array containing the record `SPLITZ`.

L:134-139 No mesh splitting is required and the explicit number of mesh regions in each direction (`JX`, `JY`, `JZ` and `JR`) is identical to the number of mesh regions in each direction specified in the state vector (`LX`, `LY`, `LZ` and `LR` respectively).

L:140-217 Compute the following dimensioning variables:

- `NNVOL`, the maximum number of regions in the geometry
- `NNSUR`, the maximum number of outer surfaces in the geometry
- `NNCYL`, the number of cylindrical region locations in the cell
- `NAXREM`, the number of elements that will be required in the `REMESH` vector to store the geometry spatial description vector. For each Cartesian direction i, $N_i + 1$ positions will be required in `REMESH` to store the spatial information containing N_i mesh regions. In the case where the geometry contain a cylindrical region, `JR`+3 positions will be required to store the location of the center of the cylindrical regions as well as the square radius (r^2) of the concentric radial sub-region for the cylindrical sub-geometry.

L:141-147 In the case where the geometry being considered is virtual, namely `ITYPE=ISTATE(1)`=0, initialize the dimensioning variables to 0.

L:148-158 For a `CAR2D` geometry (`ITYPE=ISTATE(1)`=5),

- `NNVOL=JX`$\times$`JY`
- `NNSUR=`2$\times$(`JX+JY`)
- `NNCYL=`0
- `NAXREM=JX+JY+`4

L:159-169 For a `TUBE` geometry (`ITYPE=ISTATE(1)`=3),

- `NNVOL=JR+`1
- `NNSUR=`4
- `NNCYL=`1
- `NAXREM=JR+`9

since JX=1 and JY=1 are required in this case (L:163-164)

L:170-181 For a CARCEL geometry (ITYPE=ISTATE(1)=20),

- NNVOL=(JR+1)×JX×JY
- NNSUR=2×(JX+JY)
- NNCYL=1
- NAXREM=JR+JX+JY+7

L:182-191 For a CAR3D geometry (ITYPE=ISTATE(1)=7),

- NNVOL=JX×JY×JZ
- NNSUR=2×(JY×JX+JY×JZ+JX×JZ)
- NNCYL=0
- NAXREM=JX+JY+JZ+3

L:192-211 For a TUBEZ geometry (ITYPE=ISTATE(1)=6),

- NNVOL=(JR+1)×JZ
- NNSUR=(2+4×JZ)
- NNCYL=1
- NAXREM=JR+JZ+8

since JX=1 and JY=1 are required in this case (L:197-200). For a CARCELX, CARCELY, or CARCELZ, geometry (ITYPE=ISTATE(1)=21, 22, 23),

- NNVOL=(JR+1)×JX×JY×JZ
- NNSUR= 2×(($\delta_{i,23}$JR+1)×JY×JX+ ($\delta_{i,21}$JR+1)×JY×JZ+ ($\delta_{i,22}$JR+1)×JX×JZ)
- NNCYL=1
- NAXREM=JR+JX+JY+JZ+7

where $\delta_{i,j}$ is the Kroneker delta and i=ITYPE.

L:212-216 Abort for all the other geometry types.

L:218-219 Return control to the calling program.

L:220 End of subroutine

3.1.2 Subroutine XELPRP

The listing of the subroutine XELPRP.f is provided in Appendix A.2.7. This subroutine is used to read the information stored on a GEOMETRY data structure and to generate the dimensioning information required for memory allocation by the EXCELT module. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-5 Main entry point to the subroutine.

L:6-44 Comments describing the use of the subroutine and the parameters of the subroutine.

L:45-76 Definition of parameters used in the subroutine.

L:77 Initialize IFCSYM for the number of symmetry in full assembly. This line is useless since it is repeated on L:81

L:78-80 Read the length of each record specified in LCMNM on the geometry data structure and store in LNLCM.

L:81-85 Initialize `IFCSYM` for the number of symmetry in full assembly. Also initialize the arrays `LCLSYM` and `LCLTRA` for symmetry and translation properties of the cell by direction.

L:86-93 Test if there are records present on the geometry data structure which are invalid when a `EXCELT:` processing of the geometry is performed. The list of invalid option is identified by the index vector `INVLCM` where the indexing follows the record names order as specified in `LCMNM`. In the case where an invalid record contains a number of element which is larger than 0, the code will abort.

L:94-96 Verify if the record containing the state vector is present on the geometry data structure. Abort if it is absent and read its content in array `ISTATE` if it is present.

L:97-101 Test if some elements in the array `ISTATE` are invalid when a `EXCELT:` processing of the geometry is performed. The list of invalid option is identified by the index vector `INVSTA`. In the case where an invalid option is detected the code will abort.

L:102-107 Initialize the following arrays:

- `SWALBE`, for the possibility of having a boundary condition in each direction. The value `.FALSE.` for `SWALBE(I)` indicates that the boundary conditions associated with direction `I` will not be required. Initially we assume that no boundary condition is required in our calculations.
- `ALBEDO`, for the geometric albedo at the external surface in each direction.
- `MRGSUR`, for merging the external surface in each direction according to the geometry symmetry options.
- `ICODE`, for the type of boundary conditions used at the external surface in each direction.

The relation between surfaces and direction `I` is as follows:

- `X-` is associated with `I`=1
- `X+` and `R+` are associated with `I`=2
- `Y-` is associated with `I`=3
- `Y+` is associated with `I`=4
- `Z-` is associated with `I`=5
- `Z+` is associated with `I`=6

L:108-114 Transfer the information from the array `ISTATE` to local variables.

L:115-116 Initialize the number of subgeometries `NEXTGE` already processed to 0.

L:117-143 For an assembly containing sub-geometries, only two geometry types are allowed, namely `ITYPE`=5 or 7 representing respectively a `CAR2D` or `CAR3D` geometry. First the logical variable `L1CELL` is initialize to `.FALSE.` because this geometry is made up of subgeometries. Then the routine stores in `MAXGRI` the maximum number of subgeometries that the assembly can accommodate in each direction and `NTYPO=ISTATE(9)` represents the number of sub-geometry defined in this geometry. In the case where the geometry is of type `CAR2D`, the spatial dimension of the problem `NDIM`=2, and the array `ICODE` associated with the boundary types is initialized to 0 for the elements associated with the z direction (`ICODE(5)` and `ICODE(6)`). In addition `SWALBE(I)=.TRUE.` for 1≤`I`≤4. In the case where the geometry is of type `CAR3D`, the spatial dimension of the problem `NDIM`=3, and `SWALBE(I)=.TRUE.` for all directions `I`.

L:144-193 For an assembly containing no sub-geometries, 8 geometry types are allowed, namely `ITYPE`=3, 5, 6, 7, 20, 21, 22 and 23 representing respectively a `TUBE`, `CAR2D`, `TUBEZ`, `CAR3D`, `CARCEL`, `CARCELX`, `CARCELY` and a `CARCELZ`. First the logical variable `L1CELL` is initialize to `.TRUE.` because this geometry does not contain subgeometries. Then the routine stores in `MAXGRI` the maximum mesh

spacing in each direction (1 here) and the local variable `NTYPO` is initialize to 1. In the case where the geometry is of type `TUBE`, `CAR2D` or `CARCEL`, the spatial dimension of the problem `NDIM`=2, otherwise `NDIM`=3. Then the arrays `ICODE` and `SWALBE` are initialized differently for each type of geometries, namely:

- for a `TUBE` geometry, all the values of `ICODE` are set to 0 except `ICODE(2)`; `SWALBE(2)` is initialized to `.TRUE.` since only `R+` boundary conditions are allowed.
- for a `CAR2D` and a `CARCEL` geometry, `ICODE(I)` is set to 0 for 5≤`I`≤6 and `SWALBE(I)` is initialized to `.TRUE.` for 1≤`I`≤4 since the boundary conditions allowed are `X-`, `X+`, `Y-` and `Y+`.
- for a `TUBEZ` geometry, all the values of `ICODE` are set to 0 except `ICODE(2)`, `ICODE(5)` and `ICODE(6)`; `SWALBE(2)`, `SWALBE(5)` and `SWALBE(6)` are initialized to `.TRUE.` the boundary conditions allowed are `R+`, `Z-` and `Z+`.
- for the other types of geometry, `SWALBE` is initialized to `.TRUE.` since the boundary conditions allowed are `X-`, `X+`, `Y-`, `Y+`, `Z-` and `Z+`.

L:194-198 Extract form the geometry data structure the 3 arrays (`ICODE`, `NCODE` and `ZCODE`) containing the information on the boundary condition imposed.

L:199-228 Scan array `ICODE` (stored in `JCODE`) to detect the use of physical boundary conditions (`JCODE`≠ 0). If physical boundary conditions are used, then `ICODE`=`JCODE` and `ZCODE`=1.0, otherwise abort if no other type of boundary conditions defined for this surface (`NCODE`=0). Then scan `NCODE` to identify surfaces where geometrical boundary conditions are considered, namely:

- if `NCODE`=1, void boundary conditions are used and no special treatment is required here
- if `NCODE`=2, surface reflection boundary conditions are used and `ZCODE` is initialized to 1.0
- if `NCODE`=3, diagonal symmetry conditions are used. Since these boundary conditions must be paired, increase `I2` by 1 to collect the number of occurrences of a diagonal symmetry condition for this geometry.
- if `NCODE`=4, periodic boundary conditions are used. Since these boundary conditions must be paired, increase `ITRAN` by 1 to collect the number of occurrences of a periodic boundary condition for this geometry.
- if `NCODE`=5, half cell symmetry conditions are used and no special treatment is required here
- if `NCODE`=6, albedo boundary conditions are used. Reset `NCODE`=1 locally to indicate that no special treatment of the boundary conditions is required here.
- if `NCODE`>6, the boundary conditions are invalid and the program will abort.

L:229-262 Verify that the diagonal symmetry conditions are used used adequately (only `I2`=2 permitted) and the pairing possible are either (`X+`,`Y-`) for `LL1` to be `.TRUE.` or (`X-`,`Y+`) for `LL2` to be `.TRUE.`. In the case where the pairing (`X+`,`Y-`) is requested, then the explicit boundary that will be used after the geometry is unfolded are:

- `ICODE(2)=ICODE(4)`,`NCODE(2)=NCODE(4)`,`ZCODE(2)=ZCODE(4)` since the `X+` plane associated with the unfolded geometry must be identical to plane `Y+`.
- `ICODE(3)=ICODE(1)`,`NCODE(3)=NCODE(1)`,`ZCODE(3)=ZCODE(1)` since the `Y-` plane associated with the unfolded geometry must be identical to plane `X-`.
- The array `MRGSUR` states that all the surfaces located on the plane `X+` must be combined with the surfaces on the `Y+` plane (`MRGSUR(-2)`=-4). Similarly, all the surfaces located on the plane `Y-` must be combined with the surfaces on the `X+` plane (`MRGSUR(-3)`=-1).

In the case where the pairing (`X-`,`Y+`) is requested, then the explicit boundary that will be used after the geometry is unfolded are:

- `ICODE(4)=ICODE(2),NCODE(4)=NCODE(2),ZCODE(4)=ZCODE(2)` since the `Y+` plane associated with the unfolded geometry must be identical to plane `X+`.
- `ICODE(1)=ICODE(3),NCODE(1)=NCODE(3),ZCODE(1)=ZCODE(3)` since the `X-` plane associated with the unfolded geometry must be identical to plane `Y-`.
- The array `MRGSUR` states that all the surfaces located on the plane `X-` must be combined with the surfaces on the `Y-` plane (`MRGSUR(-1)`=-3). Similarly, all the surfaces located on the plane `Y+` must be combined with the surfaces on the `X+` plane (`MRGSUR(-1)`=-3).

L:263-286 Verify that the periodic boundary conditions are used adequately. In this case `ITRAN`, must be even. The following coupling are allowed:

- (`X-`,`X+`) in which case `LCLTRA(1)`=1 to indicate the type of coupling in direction `I`=1 (x). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-1)`=-2 and `MRGSUR(-2)`=-1 to indicate that neutron leaving the region in direction `X-` (-1) should re-enter the region in direction `X+` (-2) and vice-versa.
- (`Y-`,`Y+`) in which case `LCLTRA(2)`=1 to indicate the type of coupling in direction `I`=2 (y). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-3)`=-4 and `MRGSUR(-4)`=-3 to indicate that neutron leaving the region in direction `Y-` (-3) should re-enter the region in direction `Y+` (-4) and vice-versa.
- (`Z-`,`Z+`) in which case `LCLTRA(3)`=1 to indicate the type of coupling in direction `I`=3 (z). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-5)`=-6 and `MRGSUR(-6)`=-5 to indicate that neutron leaving the region in direction `Z-` (-5) should re-enter the region in direction `Z+` (-6) and vice-versa.

L:287-315 Verify that the half-cell symmetry conditions are used adequately. Only one symmetry can be used for each spatial direction. Since this symmetry will required unfolding the cell the effective number of directional mesh elements containing cells in the assembly will change. The following coupling are allowed:

- `X-` in which case `LCLTRA(1)`=-1 to indicate the type of coupling in direction `I`=1 (x). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-1)`=-2 to indicate that a after unfolding the cell the new `X-` plane has properties that are identical to the old `X+` plane. The array elements `ICODE(1)` and `ALBEDO(1)` are also modified to reflect this effect. The maximum number of subgeometries that the assembly can accommodate in direction x thereby becomes: `MAXGRI(1)`=2×`MAXGRI(1)`-1
- `X+` in which case `LCLTRA(1)`=1 to indicate the type of coupling in direction `I`=1 (x). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-2)`=-1 to indicate that a after unfolding the cell the new `X+` plane has properties that are identical to the old `X-` plane. The array elements `ICODE(2)` and `ALBEDO(2)` are also modified to reflect this effect. The maximum number of subgeometries that the assembly can accommodate in direction x thereby becomes: `MAXGRI(1)`=2×`MAXGRI(1)`-1
- `Y-` in which case `LCLTRA(2)`=-1 to indicate the type of coupling in direction `I`=2 (y). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-3)`=-4 to indicate that a after unfolding the cell the new `Y-` plane has properties that are identical to the old `Y+` plane. The array elements `ICODE(3)` and `ALBEDO(3)` are also modified to reflect this effect. The maximum number of subgeometries that the assembly can accommodate in direction y thereby becomes: `MAXGRI(2)`=2×`MAXGRI(2)`-1
- `Y+` in which case `LCLTRA(2)`=1 to indicate the type of coupling in direction `I`=2 (y). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-4)`=-3 to indicate that a after unfolding the cell the new `Y+` plane has properties that are identical to the old `Y-` plane. The array elements `ICODE(4)` and `ALBEDO(4)` are also modified to reflect this effect. The maximum

number of subgeometries that the assembly can accommodate in direction y thereby becomes: `MAXGRI(2)`=2×`MAXGRI(2)`-1

- `Z-` in which case `LCLTRA(3)`=-1 to indicate the type of coupling in direction `I`=3 (z). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-5)`=-6 to indicate that a after unfolding the cell the new `Z-` plane has properties that are identical to the old `Z+` plane. The array elements `ICODE(5)` and `ALBEDO(5)` are also modified to reflect this effect. The maximum number of subgeometries that the assembly can accommodate in direction z thereby becomes: `MAXGRI(3)`=2×`MAXGRI(3)`-1
- `Z+` in which case `LCLTRA(3)`=1 to indicate the type of coupling in direction `I`=3 (z). For the surface coupling array `MRGSUR`, we will define `MRGSUR(-6)`=-5 to indicate that a after unfolding the cell the new `Z+` plane has properties that are identical to the old `Z-` plane. The array elements `ICODE(6)` and `ALBEDO(6)` are also modified to reflect this effect. The maximum number of subgeometries that the assembly can accommodate in direction z thereby becomes: `MAXGRI(3)`=2×`MAXGRI(3)`-1

L:316-322 Compute the total number of sub-geometries `NBLOCK` required to fill for this geometry and determine from the `ALBEDO` array if neutron can leak out of this geometry.

L: When required (`IPRT`>2) send to the output file a description of the final set of boundary conditions associated with this cell after symmetries have been taken into account.

L:349 Return control to the calling program.

L:350 End of subroutine

3.1.3 Function LELCHK

The listing of the function `LELCHK.f` is provided in Appendix A.2.1. This function is used to compare the main contents of an reference TRACKING data structure which that generated from the current analysis of a geometry. Here follows a description of the function that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-4 Main entry point to the function.

L:5-33 Comments describing the use of the function and the parameters of the function.

L:34-40 Definition of parameters used in the function.

L:41 Assume that the result of the function will be true by initializing `LELCHK` to `.TRUE.`.

L:42-50 Verify that the number of zones in the reference data structure is compatible with that generated for the new geometry.

L:51-59 Verify that the number of surfaces in the reference data structure is compatible with that generated for the new geometry.

L:60-73 Verify that the boundary conditions index vector in the reference data structure is compatible with that generated for the new geometry.

L:74-85 Verify that the new geometry has valid boundary conditions.

L:60-73 Verify that the boundary conditions index vector in the reference data structure is compatible with that generated for the new geometry.

L:86-100 Verify that the regional volume and surface area (VOLSUR) in the reference data structure is compatible with that generated for the new geometry. Also verify that the albedo associated with each surface and the mixture present inside each region (MATALB) are compatible. If some differences are observed, count the number of such differences NERROC.

L:101-131 When required (IPRT>0) send to the output file a confirmation that the two geometries are compatible if NERROC=0, otherwise send to the output file a description of the region or surface properties which are different.

L:132-133 Return control to the calling program.

L:134 End of function

3.1.4 Subroutine XELCOP

The listing of the subroutine XELCOP.f is provided in Appendix A.2.3. This subroutine is used duplicate a binary tracking file.[9] Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-25 Comments describing the use of the subroutine and the parameters of the subroutine.

L:26-41 Definition of parameters used in the subroutine.

L:44 Initialize the counter for the number of records to be read next on the reference binary tracking file.

L:45-46 Read first record containing a character*4 signature CTRK, the number of comments records stored on the reference file NCOMNT and the number of integration lines NTRK and transfer this information to the new tracking file.

L:47-45 Read the NCOMNT character*80 comments records stored on the reference file and transfer this information to the new tracking file.

L:52-58 Read the dimensioning parameters the reference file and transfer this information to the new tracking file. The dimensioning parameters are

- NDIM, the problem dimension.
- ISPEC, the type of tracking considered.
- NV, the maximum number of region in the geometry considered
- NS, the maximum number of surfaces in the geometry considered
- NALBG, the number of geometrical albedo stored on the file
- NCOR, the number of initial or final surfaces that can be crossed with by a track
- NANGL, the number of tracking direction
- MXSEG, the maximum number of segments in each tracking line

Then transfer this information to the new tracking file. Finally compute NUNKNO, the dimension of the VOLSUR and MATALB vectors.

L:59-68 Allocate memory for temporary storage of the various array to be transferred from the reference to the new tracking file.

L:69-73 Read from the reference tracking file the array containing the surface area and region volume `VOLSUR` and transfer this information to the new tracking file.

L:74-76 Read from the reference tracking file the array containing the albedo type associated with each surface and the mixture number associated with each region `MATALB` and transfer this information to the new tracking file.

L:77-79 Read from the reference tracking file the array containing the geometrical albedo identifier `ICODE` and transfer this information to the new tracking file.

L:80-82 Read from the reference tracking file the array containing the geometrical albedo value `ZCODE` and transfer this information to the new tracking file.

L:83-85 Read from the reference tracking file the array direction cosine for each tracking direction `ANGLES` and transfer this information to the new tracking file.

L:86-88 Read from the reference tracking file the array containing the track density associated with each tracking direction `DENSTY` and transfer this information to the new tracking file.

L:89-102 Since the remaining records on the reference tracking should each represent an integration line, read each track information until the end of the reference file is reached and transfer this information to the new tracking file.

L:103-113 Release the memory allocated for temporary storage of the various array that have been transferred from the reference to the new tracking file.

L:114-115 Rewind both binary tracking file

L:116 Return control to the calling program.

L:117-126 Instructions for fatal errors on read or write.

L:127 End of subroutine

3.1.5 Subroutine XELEQN

The listing of the subroutine `XELEQN.f` is provided in Appendix A.2.5. This subroutine is used to generate the integration angles for 2–D and 3–D tracking of a geometry. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-24 Comments describing the use of the subroutine and the parameters of the subroutine.

L:25-144 Definition of parameters used in the subroutine.

L:145-232 Selection of angles for 3–D tracking (`NDIM`=3).[11]

> L:146-156 If the number of angles requested (N_a=`NANGLE`) is different from that requested when the routine was last called (`NANG`) then select a new set of tracking directions in 3–D and reset `NANG` to `NANGLE`. Also initialize `INDEL`=0 to indicate that no angle has been returned yet. Here `NO2`=`NANGLE`/2 must be such that 1≤`NO2`≤8 meaning that only an even number of angles will be returned. The variable `NO2` is also used to locate in the vectors `INSN` and `JNMU`, the variables `IPOS` that provides the position in the vectors `SNT` where the information concerning this set of tracking directions starts, `ICUR`+1 that provides the

position in the vectors `MUT`, `ETT` and `XHT` where these tracking directions are stored and `IEND` that provides the last position in the vectors `MUT` , `ETT` and `XHT` where these tracking directions can be located. In fact `SNT` contains the director cosines for each of the tracking direction $(\cos\mu, \cos\eta, \cos\chi)$ in the first octant of the sphere ($0 < \mu < \pi/2$,$0 < \eta < \pi/2$,$0 < \chi < \pi/2$). The number of direction N_d selected in an octant is

$$N_d = \frac{N_a(N_a + 2)}{8}$$

for a total of $4N_d$ for the upper half-sphere. Because, the tracking lines will be generated in a Cartesian surface normal to the tracking direction, three different such planes will be generated here for each tracking direction. The first of these tracking line will have one of the side of the Cartesian surface that lies in the $x - y$ plane, the second tracking line will have one of the side of the Cartesian surface that lies in the $z - x$ plane while the last line will have one of the side of the Cartesian surface that lies in the $y - z$ plane.

L:157 Select the next angle to return `INDEL=INDEL+1`.

L:157-202 First select the tracking direction and then generate the direction of the sides of a normal Cartesian surface such that one of these sides that lies in the $x - y$ plane. In L:159-174, a tracking direction in the first octant will be generated ($0 < \mu < \pi/2$,$0 < \eta < \pi/2$), in L:175-177, a tracking direction in the second octant ($\pi/2 < \mu < \pi$,$0 < \eta < \pi/2$) will be generated, in L:178-180, a tracking direction in the forth octant ($0 < \mu < \pi/2$,$\pi/2 < \eta < \pi$) will be generated and finally in L:181-184, a tracking direction in the third octant ($\pi/2 < \mu < \pi$,$\pi/2 < \eta < \pi$) will be generated. Once the direction cosines (X, Y, Z) have been generated for one quadrant, then the line that lies in the $x - y$ will have the following director cosines: $(\alpha, \beta, 0)$ such that:

$$\begin{aligned} X^2 + Y^2 + Z^2 &= 1 \\ X\alpha + Y\beta &= 0 \\ \alpha^2 + \beta^2 &= 1 \end{aligned}$$

accordingly:

$$\begin{aligned} \alpha &= -\frac{Y}{\sqrt{1 - Z^2}} \\ \beta &= \frac{X}{\sqrt{1 - Z^2}} \end{aligned}$$

The directions of the second side of the normal tracking surface (a, b, c) is obtained using the vector product of (X, Y, Z) with $(\alpha, \beta, 0)$:

$$\begin{aligned} a &= \frac{XZ}{\sqrt{1 - Z^2}} \\ b &= \frac{YZ}{\sqrt{1 - Z^2}} \\ c &= -\sqrt{1 - Z^2} \end{aligned}$$

L:202-216 Using the same tracking direction, generate the direction of the sides of a normal Cartesian surface such that one of these sides that lies in the $z - x$ plane. This line will have the

following director cosines: $(\alpha, 0, \beta)$ such that:

$$X^2 + Y^2 + Z^2 = 1$$
$$X\alpha + Z\beta = 0$$
$$\alpha^2 + \beta^2 = 1$$

accordingly:

$$\alpha = -\frac{Z}{\sqrt{1-Y^2}}$$
$$\beta = \frac{X}{\sqrt{1-Y^2}}$$

The directions of the second side of the normal tracking surface (a, b, c) is obtained using the vector product of (X, Y, Z) with $(\alpha, 0, \beta)$:

$$a = \frac{XY}{\sqrt{1-Y^2}}$$
$$b = -\sqrt{1-Y^2}$$
$$c = \frac{YZ}{\sqrt{1-Y^2}}$$

L:217-231 Using the same tracking direction, generate the direction of the sides of a normal Cartesian surface such that one of these sides that lies in the $y - z$ plane. This line will have the following director cosines: $(0, \alpha, \beta)$ such that:

$$X^2 + Y^2 + Z^2 = 1$$
$$Y\alpha + Z\beta = 0$$
$$\alpha^2 + \beta^2 = 1$$

accordingly:

$$\alpha = -\frac{Z}{\sqrt{1-X^2}}$$
$$\beta = \frac{Y}{\sqrt{1-X^2}}$$

The directions of the second side of the normal tracking surface (a, b, c) is obtained using the vector product of (X, Y, Z) with $(0, \alpha, \beta)$:

$$a = -\sqrt{1-X^2}$$
$$b = \frac{XY}{\sqrt{1-X^2}}$$
$$c = \frac{XZ}{\sqrt{1-X^2}}$$

L:233-256 Selection of angles for 2–D tracking (`NDIM=2`).

L:234-244 If the number of angles requested (NANGLE) is different from that requested when the routine was last called (NANG) then select a new set of angles and reset NANG to NANGLE. The spacing between the angles is DTHETA=$\Delta\theta = \pi/$NANGLE and the first angle is THETA=$\theta = -\Delta\theta/2$ if NANGLE<0 and THETA=$\theta = \Delta\theta/2$ if NANGLE>0. Also initialize the variable INDEL=0 to indicate that no angle has been returned yet.

L:245-246 Select the next angle to return INDEL=INDEL+1 and abort if NANG angles have already been returned.

L:247 Compute the next angle $\theta + \Delta\theta$

L:248-251 Compute the direction cosine of this angle with respect to the x (ANGEQN(1,1)) and y axis (ANGEQN(2,1)).

L:252-255 Compute the direction cosine for $\theta + \pi/2$ with respect to the x (ANGEQN(1,2)) and y axis (ANGEQN(2,2)).

L:257-258 Abort when problem dimension (NDIM) is not 2 or 3.

L:259 Return control to the calling program.

L:260 End of subroutine

3.1.6 Function LELCRN

The listing of the function LELCRN.f is provided in Appendix A.2.2. This function is used decide if an annular ring intersect one of the sides of a rectangular region. Here follows a description of the function that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the function.

L:3-24 Comments describing the use of the function and the parameters of the function.

L:25-31 Definition of parameters used in the function.

L:32-33 Initialization of the number of corners of the rectangle located inside (NBINT) or outside (NBEXT) the annular region.

L:34-40 For each corner, determine the square of the radial position R of this corner with respect to the center of the annular region. If R$\leq$RAYON(1) then the corner is located inside the ring (NBINT=NBINT+1) while if R$\geq$RAYON(2), the corner is located outside the ring (NBEXT=NBEXT+1).

L:41-44 If NBINT=4, then the four corners of the rectangle are located inside the ring and LELCRN=.FALSE. since none of the rectangle sides intersect the ring.

L:45-65 If NBEXT=4, then the four corners of the rectangle are located outside the ring and there are still some possibilities that some sides of the rectangle intersect the ring.

L:46-53 In the case where the center of the ring is located between the top and bottom faces of the rectangle then:

- if the center of the ring is located to the left of the left side of the rectangle then an intersection will occur only if R=(X(1)-CENTEC(1))^2 <RAYON(2).
- the center of the ring is located to the right of the right side of the rectangle then an intersection will occur only if R=(X(2)-CENTEC(1))^2 <RAYON(2).
- for all the other cases an intersection will always occur.

L:54-62 In the case where the center of the ring is located between the left and right faces of the rectangle then:

- if the center of the ring is located below the bottom side of the rectangle then an intersection will occur only if R=(`Y(1)-CENTEC(2)`)^2 <`RAYON(2)`.
- if the center of the ring is located above the top side of the rectangle then an intersection will occur only if R=(`Y(2)-CENTEC(2)`)^2 <`RAYON(2)`.
- for all the other cases an intersection will always occur.

L:63-64 For all the other cases an intersection will never occur

L:65-67 If neither `NBEXT`=4 nor `NBINT`=4, then at least one corners of the rectangle is located inside and one corner is located outside the ring. Then `LELCRN=.TRUE.` since at least one of the rectangle sides intersects the ring.

L:68-69 Return control to the calling program.

L:700 End of function

3.1.7 Subroutine XELCRN

The listing of the subroutine `XELCRN.f` is provided in Appendix A.2.4. This subroutine is used to compute the surfaces of intersection between an annular region and a series of rectangles defined by a regular mesh in x and y as illustrated in Figure 17.[10] Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-35 Comments describing the use of the subroutine and the parameters of the subroutine.

L:36-52 Definition of parameters used in the subroutine.

L:53-66 Initialization of various parameters including the vector `AREAI(I,J)` which will contain the annular surface located in the mesh located at position `I` in the x direction and `J` in the y direction.

L:67-84 In the case where `IPRINT`≥10, write on the output file a description of the annular region and of the Cartesian mesh used during the execution of the routine.

L:85-89 Initialize to 0.0 the element of vector V_t=`SPXY` representing the surface intersection between the annular region and the half-plane located above the last y directed mesh element.

L:90 Begin the do-loop over the `NMY` y directed planes starting with the last plane and going down to the first plane. This do-loop ends at instruction 110 (L:229). It can also be terminated by inserting a `GO TO 112` statement (L:217 transfers to L:230).

L:91-92 Initialize `XYPOS(2,1)` (and `XYPOS2(2,1)` which is the square of `XYPOS(2,1)`) to the y location of current plane.

L:93-116 Determine what part of the annular region lies below surface located at y=`XYPOS(2,1)`. In the case where `XYPOS(2,1)`≥`RANN` then the entire annular region lies below the plane described by y=`XYPOS(2,1)` and `SPXY`=$V_b = \pi r^2$ =`SURANN`. The type of intersection `IRP(2,1)` for this plane is set to -1. In the case where `XYPOS(2,1)`≤-`RANN` then the entire annular region lies above the plane described by y=`XYPOS(2,1)` and `SPXY`=0. The type of intersection `IRP(2,1)` for this plane is set to 1. Finally, in the case where -`RANN`≤`XYPOS(2,1)`≤`RANN` then the annular region lies partly below and partly above the plane described by y=`XYPOS(2,1)` and `SPXY`=`XELPSC` (see Section 3.1.8). The type of intersection `IRP(2,1)` for this plane is set to 0.

L:117-122 In the case of the last plane or if `IRP(2,1)`=-1 (the entire annular region lies below the current plane) go to instruction 111 (L:218) since the annular region does intersect the region `XYPOS(2,1)`$\leq y \leq$`XYPOS(2,2)`.

L:123-129 Initialize to 0.0 the element of vector V_r=`SPXY` representing the surface intersection between the annular region and the half-plane located to the right of the last x directed mesh element. Similarly initialize `SIXY` representing the intersection between the V_r and V_t ($V_{r,t}$=`SIXY(2,2)`) and between the V_r and V_b ($V_{r,b}$=`SIXY(2,1)`).

L:130 Begin the do-loop over the `NMX` x directed planes starting with the last plane and going down to the first plane. This do-loop ends at instruction 120 (L:211). It can also be terminated by inserting a `GO TO 122` statement (L:197 transfers to L:212).

L:131-132 Initialize `XYPOS(1,1)` (and `XYPOS2(1,1)` which is the square of `XYPOS(1,1)`) to the x location of current plane.

L:133-163 Initialize to 0.0 the element of vector V_l=`SPXY` representing the surface intersection between the annular region and the half-plane located to the left of the last x directed mesh element. Similarly initialize `SIXY` representing the intersection between the V_l and V_t ($V_{l,t}$=`SIXY(1,2)`) and between the V_l and V_b ($V_{l,b}$=`SIXY(1,1)`.

L:164-178 Determine what part of the annular region lies below surface located at x=`XYPOS(1,1)`. In the case where `XYPOS(2,1)`$\geq$`RANN` then the entire annular region lies to the left of the plane described by x=`XYPOS(1,1)` and `SPXY`=$V_l = \pi r^2$ =`SURANN`. The type of intersection `IRP(1,1)` for this plane is set to -1. In the case where `XYPOS(1,1)`$\leq$-`RANN` then the entire annular region lies to the right of the plane described by x=`XYPOS(1,1)` and `SPXY`=0. The type of intersection `IRP(1,1)` for this plane is set to 1. Finally, in the case where -`RANN`$\leq$`XYPOS(2,1)`$\leq$`RANN` then the annular region lies partly to the left and partly to the right of the plane described by x=`XYPOS(1,1)` and `SPXY=XELPSC` (see Section 3.1.8). The type of intersection `IRP(1,1)` for this plane is set to 0. In the case where `IRP(2,1)`=0, find the intersection between V_b and V_l using `XELPSI` (see Section 3.1.9). Similarly for the case where `IRP(2,2)`=0, find the intersection between V_t and V_l using `XELPSI`.

L:179-184 In the case of the last plane or if `IRP(1,1)`=-1 (the entire annular region lies to the left of the current plane) go to instruction 121 (L:198) since the annular region does intersect the region `XYPOS(1,1)`$\leq x \leq$`XYPOS(1,2)`.

L:185-192 Compute the surface of intersection V_a=`AERAI` between the annular region and the rectangular region located in the region `XYPOS(1,1)`$\leq x \leq$`XYPOS(1,2)` and `XYPOS(2,1)`$\leq y \leq$`XYPOS(2,2)` using:

$$V_a = \pi r^2 - (V_l + V_r + V_b + V_t) + (V_{l,b} + V_{r,b} + V_{l,t} + V_{r,t})$$

L:193-197 When the annulus is all located to the right of the left surface of the rectangle exit the do-loop by going to instruction 122 (L:212).

L:198-210 Evaluate the surfaces V_r=`SPXS(1,2)`, $V_{r,b}$=`SIXS(2,1)` and $V_{r,t}$=`SIXS(2,2)` using:

$$V_r \pi r^2 - V_l$$
$$V_{r,b} = V_b - V_{l,b}$$
$$V_{r,t} = V_t - V_{l,t}$$

The position of the left hand side of the current rectangle becomes the position of the right hand side of the next rectangle and the type of intersection changes sign.

L:211-212 End of the do-loop on the x directed surfaces.

L:213-217 When the annulus is all located above the top surface of the rectangle exit the do-loop by going to instruction 112 (L:230).

L:219-228 Evaluate the surfaces V_t=`SPXS(2,2)` using:

$$V_t \pi r^2 - V_b$$

The position of the bottom side of the current rectangle becomes the position of the top side of the next rectangle and the type of intersection changes sign.

L:229-230 End of the do-loop on the y directed surfaces.

L:231-238 In the case where `IPRINT`≥10, write on the output file the surface of intersection computed.

L:239-242 Return control to the calling program.

L:243-249 Output formats.

L:250 End of subroutine

3.1.8 Function XELPSC

The listing of the function `XELPSC.f` is provided in Appendix A.2.8. This function is used to compute the surface of an annular annular region located to the left V_l of a plane parallel to the y axis (a $x = u$ constant plane) or below V_b a plane parallel to the x axis (a $y = u$ constant plane) as illustrate in Figure 18.[10] Here follows a description of the function that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the function.

L:3-22 Comments describing the use of the function and the parameters of the function.

L:23-29 Definition of parameters used in the function.

L:30-39 Comments describing the calculation procedure used. Here the plane is located at a position u=`PLANE` with respect to the center of an annular region of radius r=`RANN`.

L:40 Compute r^2

L:41 Compute $u_b^2 = y^2$ or $u_l^2 = x^2$

L:42 Compute the angular sector associated with the one intersection points between the line and the annular region (see Figure 18)

$$\alpha_{b/l} = \arccos(-\frac{u_{b/l}}{r})$$

L:43 Compute the region surface using:

$$V_{b/l} = \alpha_{b/l} r^2 + u_{b/l}\sqrt{r^2 - u_{b/l}^2}$$

Note that the surfaces to the right of a plane perpendicular to the x axis (V_b) or above a plane perpendicular to the y axis (V_t) are computed using:

$$V_{r/t} = \pi r^2 - V_{b/l}$$

L:44 Return control to the calling program.

L:45 End of function

3.1.9 Function XELPSI

The listing of the function `XELPSI.f` is provided in Appendix A.2.9. This function is used to compute the surface of an annular annular region located: 1) to the left of a plane parallel to the y axis (a $x = u$ constant plane) and above a plane parallel to the x axis (a $y = u$ constant plane) or 2) to the left of a plane parallel to the y axis (a $x = u$ constant plane) and below a plane parallel to the x axis (a $y = u$ constant plane) as illustrated in Figure 19.[10] Here follows a description of the function that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the function.

L:3-38 Comments describing the use of the function and the parameters of the function. The comments on line L:20-21 are in error. They should read (see Section 3.1.7)

```
20 |C                =1 -> BELOW Y-PLANE
21 |C                =2 -> ABOVE Y-PLANE
```

L:39-47 Definition of parameters used in the function.

L:48-51 Comments describing the calculation procedure used. Two main options are considered here. First the case where the point of intersection of the two planes is inside the annular region (L:52-67), then the case where the point of intersection of the two planes is outside the annular region (L68-90)

L:52-67 If the point of intersection for the two perpendicular planes is located inside the annular region then compute:

$$V_{l,b}\frac{(V_l + V_b)}{2} + xy - \frac{\pi}{4}r^2$$

$$V_{l,t} = \frac{(V_l + V_t)}{2} - xy - \frac{\pi}{4}r^2$$

where V_l, V_b and V_t are defined in Section 3.1.8.

L:68-78 If the point of intersection for the two perpendicular planes is not located located inside the annular region and $V_{l,b}$ is to be computed then:

- L:70-71 If the x plane is located on the left of the annulus center and the y plane is below the the annulus center $V_{l,b} = 0$.
- L:72-73 If the x plane is located on the right of the annulus center and the y plane is above the the annulus center $V_{l,b} = V_l + V_b - \pi r^2$.
- L:72-73 If the x plane is located on the left of the annulus center and the y plane is above the the annulus center $V_{l,b} = V_l$.
- L:72-73 If the x plane is located on the right of the annulus center and the y plane is below the the annulus center $V_{l,b} = V_b$.

L:68-78 If the point of intersection for the two perpendicular planes is not located located inside the annular region and $V_{l,t}$ is to be computed then:

L:80-81 If the x plane is located on the left of the annulus center and the y plane is below the the annulus center $V_{l,t} = V_l$.

L:82-33 If the x plane is located on the right of the annulus center and the y plane is above the the annulus center $V_{l,b} = V_t$.

L:72-73 If the x plane is located on the left of the annulus center and the y plane is above the the annulus center $V_{l,b} = 0$.

L:72-73 If the x plane is located on the right of the annulus center and the y plane is below the the annulus center $V_{l,b} = V_l + V_t - \pi r^2$.

L:91 Return control to the calling program.

L:92 End of function

3.2 Global Verification of the Geometry Analysis Routines

The second part of the verification consists in comparing the contents of a TRACKING data structure (created by the `EXCELT:` module) with the information provided on the GEOMETRY data structure. The various 2–D and 3–D geometries we will consider here are presented in Figure 1 to 16. The DRAGON GEOMETRY and TRACKING data structures for each of these geometries can be found in Appendix B. Again, a discussion on how to interpret the contents of a DRAGON data structure in an ASCII format can be found in Appendix C.

Before going into a discussion of each of the geometries, let us recall what is the information stored in the TRACKING data structure.[6] This is a two level data structure. The following records can be found in the first level:

- `SIGNATURE` which contains the signature of the data structure (here `L_TRACK␣␣␣␣␣`).
- `TRACK-TYPE` which contains the type of tracking considered (here `EXCELL␣␣␣␣␣␣`).
- `TITLE` which contains the title defined in the input stream for the `EXCELT:` module of DRAGON.
- `BC-REFL+TRAN` which contains a list of integer for the coupling of surfaces according to the boundary conditions. When external reflection boundary conditions are considered, each surface is coupled to itself (`BC-REFL+TRAN` contains a list of integer from 1 to N_s=`STATE-VECTOR`(5), where N_s is the number of surfaces. For periodic boundary conditions, the 2 surfaces of contact i and j will be identified and we will have `BC-REFL+TRAN`(i)=j and `BC-REFL+TRAN`(j)=i.
- `MATCOD` contains the mixture number reference vector for regions.
- `VOLUME` contains the region volume vector.
- `KEYFLX` contains the location in the flux vector where the information associated with a specific region will be stored.

The main information stored in the `STATE-VECTOR` is the following:

- `STATE-VECTOR`(1)=N_r is the number of regions.
- `STATE-VECTOR`(2)=N_u is the number of unknowns for which storage in the flux vector must be reserved.
- `STATE-VECTOR`(3)=I_L is the geometrical leakage flag. Here all cell are extended to infinity using the boundary conditions and $I_L = 1$.
- `STATE-VECTOR`(4)=M_m is the maximum number of mixture used in the `MATCOD` vector.
- `STATE-VECTOR`(5)=N_r is the number of external surface on which boundary conditions are to be applied.

These TRACKING data structures contain a sub-directory called `EXCELL` which also contains a `STATE-VECTOR`:

- `STATE-VECTOR`(1)=D represents the number of dimensions for this problem.
- `STATE-VECTOR`(2)=M_s is the maximum number of surfaces that could have been generated by this geometry.
- `STATE-VECTOR`(3)=M_r is the maximum number of regions that could have been generated by this geometry.
- `STATE-VECTOR`(4)=N_d is the dimension of the records `MINDIM`, `MAXDIM` and `ICORD`.
- `STATE-VECTOR`(5)=N_d is the dimension of the record `REMESH`.
- `STATE-VECTOR`(6)=M_i=$M_s + M_r + 1$ is the dimension of the record `VOLSUR`.

and the following records:

- `MINDIM`(i) which contains the location in the `REMESH` vector associated with the lower position of the x, y and z Cartesian meshes (for i=1, 2 and 3) or the location in the `REMESH` of the inner radius for each set of cylindrical regions ($i = 4, N_d$) all centered at the same position in space.
- `MAXDIM`(i) which contains the location in the `REMESH` vector associated with the upper position of the x, y and z Cartesian meshes (for i=1, 2 and 3) or the location in the `REMESH` of the outer radius for each set of cylindrical regions ($i = 4, N_d$) all centered at the same position in space.
- `ICOORD`(i) which contains the direction of the axis for each set of cylindrical region. Note that `ICOORD`(i)=i for i=1, 2 and 3. Moreover, for 2–D geometries, `ICOORD`(i)=3 for $i = 4, N_d$ since we then assume that the cylinders are always z directed. Finally, for 3–D geometries we will use `ICOORD`(i)=k where k will take the values 1, 2 or 3 for x, y and z directed cylinders respectively.
- `REMESH`(i) which contains the overall dimensioning of the geometry:
  - the x directed mesh can be found in at positions: i=`MINDIM`(1) to `MAXDIM`(1)
  - the y directed mesh can be found in at positions: i=`MINDIM`(2) to `MAXDIM`(2)
  - the z directed mesh can be found in at positions: i=`MINDIM`(3) to `MAXDIM`(3)
  - for a set of cylinders j ($j = 4, N_d$), the outer square radius (r^2) of the successive annular regions is located at positions: i=`MINDIM`(j) to `MAXDIM`(j). One can also locate the location of the cylinder center in the Cartesian mesh using the information stored at positions: k=`MINDIM`(j)-2 and $k + 1$=`MINDIM`(j)-1. Note that: for `ICOORD`(j)=3, `REMESH`(k) and `REMESH`($k + 1$) contain the x and y location of the cylinder center; for `ICOORD`(j)=1, `REMESH`(k) and `REMESH`($k + 1$) contain the y and z location of the cylinder center; finally, for `ICOORD`(j)=2, `REMESH`(k) and `REMESH`($k+1$) contain the z and z location of the cylinder center.
- `VOLSUR`(i) contains $S/4$ where S is the surface area for each of the possible external cell surfaces ($i = 1, M_s$) that could be generated from the geometry description. It also contains V, the volume for each of the possible regions ($i = M_s + 2, M_s + M_r$) that could be generated from the geometry description. One will note that `VOLSUR`($M_s + 1$)=0. Moreover, each value of i for which `VOLSUR`(i)=0 indicates a location in space which is outside the current geometry.
- `MATALB`(i) contains $-j$ where j refers to the location in the array `ZCODE` where the geometrical albedo associated with this external cell surface ($i = 1, M_s$) can be found. It also contains j, the mixture number present in this region ($i = M_s + 2, M_s + M_r$).
- `KEYMRG`(i) contains $-j$ where j refers to final external surface number with the current external cell surface ($i = 1, M_s$). It also contains j, the final region number associated with the present region ($i = M_s + 2, M_s + M_r$). Note that in the case where symmetries are imposed on a geometry, the merging index `KEYMRG` is used to automatically combine into a single final region many disconnected spatial regions.

- `INDEX`(i,j) (here $j = 1, 4$) can be used to locate inside the record `REMESH` the position and dimensions of each non voided surface or region in space. In fact:
  - `INDEX`(i,1) refers to the x location of the region or surface. The case where `INDEX`(i,1)$<$`MINDIM`(1) refers to a surface located on the left hand side of the cell (`X-` surface) while `INDEX`(i,1)=`MAXDIM`(1) refers to a surface located on the right hand side of the cell (`X+` surface).
  - `INDEX`(i,2) refers to the y location of the region or surface. The case where `INDEX`(i,2)$<$`MINDIM`(2) refers to a surface located on the back the cell (`Y-` surface) while `INDEX`(i,2)=`MAXDIM`(2) refers to a surface located on the front of the cell (`Y+` surface).
  - `INDEX`(i,3) refers to the x location of the region or surface. The case where `INDEX`(i,3)$<$`MINDIM`(3) refers to a surface located on the bottom of the cell (`Z-` surface) while `INDEX`(i,3)=`MAXDIM`(3) refers to a surface located on the top of the cell (`Z+` surface).
  - `INDEX`(i,4) refers to a radial location. The case where `INDEX`(i,4)=0 means that this region is outside all the cylindrical regions in the cell. For the case where `INDEX`(i,4)=$l \neq 0$ then l can be used to locate the specific cylindrical ring j associated with this region. In fact if `MINDIM`(j)$\leq l + 1 \leq$ `MAXDIM`(j), then l is associated with sub-annulus $l + 2-$`MINDIM`(j) (sub-annulus number are increasing as one moves outwards form the center of the cylinder).

The TRACKING data structure is one on the most widely used structure in the code DRAGON. The information available on the first level of this structure is required by the `ASM:`, `FLU:`, `EDI:` and `EVO:` modules. Moreover, some utility modules of DRAGON, including `MRG:` and `PSP:` can also use the information available in the `EXCELL` sub-directory.

During the process of verifying DRAGON we wrote an additional utility module called `TST:` which also processes the TRACKING data structure. The `MTH` option of `TST:` can be used to produce a Mathematica program that will generate a graphical representation of the geometry described in the TRACKING data structure.[16] The graphics presented in Figure 1 to 16 were produced by executing these programs inside the Mathematica software. The `CTR` option of `TST:` can be used to compare 2 different TRACKING data structure. This is very useful in the verification process since there are generally more than one way to define a specific geometry in the `GEO:` module of DRAGON. In general, the TRACKING data structure will change from model to model and this utility can be used to identify the changes in region/surface numbering and to verify that the two geometries considered are physically identical.

3.2.1 Geometry G21F2DZ1

One can easily rebuilt this simple Cartesian 2–D geometry containing annular sub-regions using the contents of the TRACKING data structure. The records `MINDIM`, `MAXDIM` and `REMESH` provide the spatial description while by combining the records `INDEX`, `MATALB` and `ALBEDO`, the boundary conditions and contents (mixture) of each region can be identified. For example, `MESHX`, `MESHY`, `RADIUS` and `MIX` can be identified as follows:

```
MESHX REMESH(MINDIM(1)) REMESH(MAXDIM(1))
MESHY REMESH(MINDIM(2)) REMESH(MAXDIM(2))
RADIUS 0.0 SQRT(REMESH(MINDIM(4))) SQRT(REMESH(MINDIM(4)+1))
           SQRT(REMESH(MINDIM(4)+2)) SQRT(REMESH(MINDIM(4)+3))
           SQRT(REMESH(MAXDIM(4)))
MIX    MATALB(NS+2) MATALB(NS+3) MATALB(NS+4) MATALB(NS+5)
       MATALB(NS+6) MATALB(NS+NV+1)
```

where `NS`=M_s=4 is the number of surfaces and `NV`=M_r=6 is the number of regions. One can also note that for such a 2–D geometry we have assumed:

$$0.0 \leq z \leq 1.0$$

However this information is not used explicitly for the analysis of for 2–D geometry.

The first 4 elements of the record VOLSUR represent the length of each side of the geometry divided by 4.0 ($7.14375 = 28.575/4$) while the last 6 elements contain the volume of each region (which in 2–D is a surface):

```
VOLSUR( 6)=Pi*REMESH(MINDIM(4))
VOLSUR( 7)=Pi*(REMESH(MINDIM(5))-REMESH(MINDIM(4)))
VOLSUR( 8)=Pi*(REMESH(MINDIM(6))-REMESH(MINDIM(5)))
VOLSUR( 9)=Pi*(REMESH(MINDIM(7))-REMESH(MINDIM(6)))
VOLSUR(10)=Pi*(REMESH(MINDIM(8))-REMESH(MINDIM(7)))
VOLSUR(11)=(REMESH(MAXDIM(1))-REMESH(MINDIM(1)))*
            (REMESH(MAXDIM(2))-REMESH(MINDIM(2)))
           -Pi*REMESH(MINDIM(8))
```

where Pi=π.

Finally, because the record KEYMRG associates each fine mesh region in the original geometry with a final region for which an independent flux solution will be required, the contents of the VOLUME and MATCOD records are identical to the last 6 elements of the records VOLSUR and MATALB respectively.

3.2.2 Geometry G21F2DZ2

As we noted in Section 2.2.2 this geometry is similar to G21F2DZ2 except for the additional presence of the SPLITX and SPLITY instructions in the DRAGON input data file. In TRACKING data structure, the effect of spatial mesh splitting is already applied as can be seen by the contents of the MINDIM, MAXDIM and REMESH records, namely:

```
9.525  =28.575/3
       =REMESH(MINDIM(1)+1)-REMESH(MIMDIM(1))
       =REMESH(MINDIM(1)+2)-REMESH(MIMDIM(1)+1)
       =REMESH(MAXDIM(1))-REMESH(MIMDIM(1)-1)
7.14375=28.575/4
       =REMESH(MINDIM(2)+1)-REMESH(MIMDIM(2))
       =REMESH(MINDIM(2)+2)-REMESH(MIMDIM(2)+1)
       =REMESH(MINDIM(2)+3)-REMESH(MIMDIM(2)+2)
       =REMESH(MAXDIM(2))-REMESH(MIMDIM(2)-1)
```

The first 14 elements of the record VOLSUR represent the length of each surface divided by 4 (9.525/4 for FRONT and BACK surface and 7.14375/4 for a LEFT and RIGHT surface). Out of the 72 elements of the record VOLSUR associated with region volume (elements 16 to 87) only 30 have non-vanishing values. The reason for the presence of vanishing volume regions is that we determined before hand the maximum number of regions that could be generated in this geometry based on the assumption that each 2-D Cartesian region could contain 6 subregions (5 concentric annular region + 1). By looking at Figure 2, one immediately realizes that there is no intersection between the annular rings and the cartesian mesh located in the region

$$0.0 < x < 9.525$$
$$0.0 < y < 7.14375$$

As a result, the elements $i = 16, 20$ of VOLSUR vanish while element i=21 has a volume of 9.525×7.14375. In fact the explicit region numbering that will be used in further processing of this data structure by DRAGON can be extracted from KEYMRG.

Table 1: Comparison of surface and region numbers for G21F2DZ3 and G21F2DZ4

G21F2DZ3	G21F2DZ4	G21F2DZ3	G21F2DZ4	G21F2DZ3	G21F2DZ4	G21F2DZ3	G21F2DZ4
-1	-1	-2	-3	-3	-4	-4	-5
-5	-2	-6	-6	-7	-7	-8	-13
-9	-8	-10	-14	-11	-9	-12	-15
-13	-10	-14	-11	-15	-12	-16	-16
6	1	12	2	18	3	24	4
30	5	31	8	32	9	33	10
34	11	35	12	36	13	37	14
38	15	39	16	40	17	41	18
42	19	48	44	54	6	55	20
56	21	57	22	58	23	59	24
60	25	61	26	62	27	63	28
64	29	65	30	66	31	72	45
78	7	84	37	90	43	96	46

3.2.3 Geometry G21F2DZ3

This geometry is similar to G21F2DZ2 except for for the fact that the Cartesian mesh splitting in this case is not uniform. Because this geometry requires an explicit definition of the x and y directed Cartesian mesh, one can easily rebuilt from the TRACKING data structure the explicit `GEO:` input information provided in Appendix B.2 using the procedure described in Section 3.2.1.

As it was the case for G21F2DZ2, the first 16 elements of the record `VOLSUR` can be associated with the length of each surface divided by 4. Out of the 96 elements of the record `VOLSUR` associated with region volume now 36 have non-vanishing values. One can easily identify the location of these non void regions in Figure 2 by looking at the contents of the `INDEX` record where the x, y, z, and r location of each region is identified with respect to the records `MINDIM`, `MAXDIM` and `REMESH`.

3.2.4 Geometry G21F2DZ4

This geometry is physically identical to geometry G21F2DZ3. This observation is reflected in the TRACKING data by the fact that the records `MINDIM`, `MAXDIM` and `REMESH` for G21F2DZ4 are identical to the same records in G21F2DZ3. However, G21F2DZ4 is defined as an assembly of cells, namely a two level geometry, while G21F2DZ3 was defined in term of a unique cell. As a result, the technique for region numbering in G21F2DZ4 is different from that used in the analysis of G21F2DZ3, namely a local numbering by cell is considered before the global numbering is generated. The relation between the surfaces and volumes in geometry G21F2DZ3 and G21F2DZ4 is presented in Table 1 where the negative values identify surfaces and positive values regions.

3.2.5 Geometry G21F3D1

This geometry which is illustrated in Figure 5 is a 3–D extension of G21F2DZ1. As one can see the main difference in the contents of the TRACKING data structure between G21F2DZ1 and G21F3D1 is the fact that $D = 3$ rather than 2 and accordingly `REMESH(6)`=49.53 which is the extension of this cell in the z direction. The last 6 elements of the record `VOLSUR` in G21F3D1 are equal to the last 6 elements of G21F2DZ1 multiplied by a factor `REMESH(6)`. The surfaces in G21F3D1 are also related to the surfaces and volumes in G21F2DZ1 according to the following relation:

```
VOLSUR(17+IV,G21F3D1)=VOLSUR(5-IV,G21F2DZ1)/4
```

```
VOLSUR(7+IV,G21F3D1)=VOLSUR(5-IV,G21F2DZ1)/4
VOLSUR(11+IS,G21F3D1)=49.53*VOLSUR(5+IS,G21F2DZ1)
```

where `IV`=-1 to -6 and `IS`=-1 to -4, for a total of 16 surfaces.

3.2.6 Geometry G21F3D2

This geometry being a 3–D extension of G21F2DZ2, its TRACKING data structure is also similar to that generated for geometry G21F2DZ2. For the region elements of the `VOLSUR` record we will have:

```
VOLSUR(173+IV,G21F3D2)=49.53*VOLSUR(15+IV,G21F2DZ2)/2
VOLSUR(203+IV,G21F3D2)=49.53*VOLSUR(15+IV,G21F2DZ2)/2
```

where `IV`=1 to 30. For the left, right, back and front surfaces we will have:

```
VOLSUR(143+IS,G21F3D2)=49.53*VOLSUR(15+IS,G21F2DZ2)/2
VOLSUR(129+Is,G21F3D2)=49.53*VOLSUR(15+IS,G21F2DZ2)/2
```

where `IV`=-1 to -14. For the top and bottom surfaces the problem is slightly more complex because the part of the `VOLSUR` vector associated with these surfaces for G21F2DZ2 has been renumbered. However a direct identification of the various regions `IV`>0 of geometry G21F2DZ1 with the top `IST`<0 and bottom `ISB`<0 surfaces of G21F3D2 is still possible. In fact we will have something like:

```
VOLSUR(173+IST,G21F3D2)=VOLSUR(15+IV,G21F2DZ2)/4
VOLSUR(173+ISB,G21F3D2)=VOLSUR(15+IV,G21F2DZ2)/4
```

3.2.7 Geometry G21F3D3 and G21F3D4

These two geometries are physically identical (they are in fact 3–D extensions of G21F2DZ3 and G21F2DZ4). This is reflected in the TRACKING data by the fact that the records `MINDIM`, `MAXDIM` and `REMESH` in G21F3D3 are identical to those associated with G21F3D4. Ai in it was the case for G21F2DZ3 and G21F2DZ4 (G21F3D3 and G21F3D4 are 3–D extensions of G21F2DZ3 and G21F2DZ4) there is a one to one correspondence between the surface and regions on G21F3D3 and G21F3D4. In fact the relation between the regions of G21F3D3 and G21F3D4 is presented in Table 2.

3.2.8 Geometry G22F2DZ1, G22F2DZ2 and G22F2DZ3

As we have seen in Section 2.2.9 and Section 2.2.10, G22F2DZ1 and G22F2DZ2 are two different representations of the same geometry. This is confirmed by the fact that the TRACKING data structure for these two geometry are identical apart from the record `TITLE`. The geometry G22F2DZ3 is also similar G22F2DZ1 except from the fact that it should reflect the internal symmetries of the geometry since it was constructed using `SYME` boundary conditions. This is also confirmed by the fact that the TRACKING data structure for G22F2DZ1 and G22F2DZ3 are identical except for the records `KEYMRG`, `BC-REFL+TRAN`, `MATCOD`, `VOLUME` and `KEYFLX`. In fact the main record to consider here is the record `KEYMRG` which identifies the various surfaces and regions in the cell which are formally identical due to the presence of the intrinsic symmetry. For G22F2DZ3, one formally identifies regions 8 to 13 (located at $x > 35.575$) with regions 1 to 6 (located at $x < 21.575$). Similarly all the surfaces located at located at $x > 35.575$ are identified as being identical to the reflected surface at $x < 21.575$ (see Table 3). This illustrate the fact that the right and front surfaces of are identical to the left and back surfaces of G22F2DZ3 respectively because of the presence of the three symmetries in x and y.

Table 2: Comparison of region numbers for G21F3D3 and G21F3D4

G21F3D3	G21F3D4	G21F3D3	G21F3D4	G21F3D3	G21F3D4	G21F3D3	G21F3D4
6	1	12	2	18	3	24	4
30	5	31	8	32	9	33	10
34	11	35	12	36	13	37	14
38	15	39	16	40	17	41	18
42	19	48	44	54	6	55	20
56	21	57	22	58	23	59	24
60	25	61	26	62	27	63	28
64	29	65	30	66	31	72	45
78	7	84	37	90	43	96	46
102	47	108	48	114	49	120	50
126	51	127	54	128	55	129	56
130	57	131	58	132	59	133	60
134	61	135	62	136	63	137	64
138	65	144	90	150	52	151	66
152	67	153	68	154	69	155	70
156	71	157	72	158	73	159	74
160	75	161	76	162	77	168	91
174	53	180	83	186	89	192	92

Table 3: Comparison of surface numbers for G22F2DZ1 and G22F2DZ3

G22F2DZ1	G22F2DZ3	G22F2DZ1	G22F2DZ3	G22F2DZ1	G22F2DZ3	G22F2DZ1	G22F2DZ3
-8	-3	-7	-2	-6	-3	-5	-1
-4	-1	-3	-3	-2	-2	-1	-3

3.2.9 Geometry G22F2DZ4

This assembly is similar G22F2DZ3 the main difference being that the spatial discretization inside each cell has been refined (either explicitly using the `MESH` option or automatically using the `SPLIT` option). In fact each region G22F2DZ3 will generally contain more than region of G22F2DZ4 because of the presence of the split. One can find in Table 4 the location of each G22F2DZ4 region in G22F2DZ3.

3.2.10 Geometry G22F3D1, G22F3D2 and G22F3D3

As we have seen in Section 2.2.13 and Section 2.2.14, G22F3D1 and G22F3D2 are two different representations of the same geometry. This is confirmed by the fact that the TRACKING data structure for these two geometry are identical apart from the record `TITLE`. The geometry G22F3D3 is also similar G22F3D1 except from the use of internal symmetries. This is confirmed by the fact that the TRACKING data structure for G22F3D1 and G22F3D3 are identical except for the records `KEYMRG`, `BC-REFL+TRAN`, `MATCOD`, `VOLUME` and `KEYFLX`. From the record `KEYMRG` one can easily identify the various surfaces and regions in the cell which are formally affected by the symmetry (see Table 5). For G22F3D3, one can formally identifies regions 13 to 18 (located at $x > 35.575$) with regions 1 to 6 (located at $x < 21.575$).This illustrate the fact that the right, front and top surfaces of are identical to the left, back and bottom surfaces of G22F3D3 respectively because of the presence of the three symmetries in x, y and z.

Table 4: Association of G22F2DZ4 regions with G22F2DZ3 regions

G22F2DZ4	G22F2DZ3	G22F2DZ4	G22F2DZ3	G22F2DZ4	G22F2DZ3	G22F2DZ4	G22F2DZ3
6	6	12	6	18	6	24	6
25	1	26	2	27	3	28	4
29	5	30	6	31	1	32	2
33	3	34	4	35	5	36	6
42	6	43	1	44	2	45	3
46	4	47	5	48	6	49	1
50	2	51	3	52	4	53	5
54	6	60	6	66	6	72	6
73	7	74	7	75	7	76	7
77	7	78	7	79	7	80	7
86	13	92	13	98	13	104	13
105	8	106	9	107	10	108	11
109	12	110	13	111	8	112	9
113	10	114	11	115	12	116	13
122	13	123	8	124	9	125	10
126	11	127	12	128	13	129	8
130	9	131	10	132	11	133	12
134	13	140	13	146	13	152	13

Table 5: Comparison of surface numbers for G22F3D1 and G22F3D3

G22F3D1	G22F3D3	G22F3D1	G22F3D3	G22F3D1	G22F3D3	G22F3D1	G22F3D3
-44	-15	-43	-14	-42	-13	-41	-12
-40	-11	-39	-10	-38	-9	-37	-8
-36	-9	-35	-15	-34	-14	-33	-13
-32	-12	-31	-11	-30	-10	-29	-7
-28	-6	-27	-5	-26	-4	-25	-3
-24	-2	-23	-1	-22	-1	-21	-7
-20	-6	-19	-5	-18	-4	-17	-3
-16	-2	-15	-15	-14	-14	-13	-13
-12	-12	-11	-11	-10	-10	-9	-9
-8	-8	-7	-9	-6	-15	-5	-14
-4	-13	-3	-12	-2	-11	-1	-10

Table 6: Properties of selected integration lines for G22F3D5

Line number	Starting point x	y	z	Director cosine x	y	z
14	27.00	0.00	16.80	0.577	0.577	0.577
44	54.60	25.90	0.00	0.577	0.577	0.577
73	18.90	0.00	27.80	0.577	0.577	0.577
103	10.20	2.23	0.00	0.577	0.577	0.577
127	0.00	6.01	41.90	0.577	0.577	0.577
413	55.60	0.00	26.10	-0.577	0.577	0.577
443	57.20	22.10	47.00	-0.577	0.577	0.577
472	14.50	0.00	26.10	-0.577	0.577	0.577
502	36.00	2.23	0.00	-0.577	0.577	0.577
526	8.16	0.00	35.90	-0.577	0.577	0.577

3.2.11 Geometry G22F3D4

This assembly is similar G22F3D3 the main difference being that the spatial discretization inside each cell has been refined. As it was the case for the comparison of G22F2DZ3 and G22F2DZ4, each region G22F3D3 will generally contain more than region of G22F3D4 because of the presence of the split.

3.3 Verification of the Contents of the Binary Tracking File

We have verified the contents of the binary tracking file graphically for the two geometries G22F2DZ5 and G22F3D5 defined in Appendix B.13 and Appendix B.18. These geometries are illustrated in Figure 20 and 21 respectively. In fact by increasing the `EDIT` level to 1000000 in the `EXCELT:` module the explicit contents of the binary tracking file is copied to the output file. We then transferred this information to a Matlab program which can draw these lines on the reference geometry.`Matlab`

One will find in Figure 22 the result of processing the tracking file for G22F2DZ5. Here the top figure represent the complete geometry while the bottom figure is a zoomed version of the green region in G22F2DZ5. The 17 lines in red were those generated for the first tracking angle while the 17 lines in blue were generated for the second angle. Each intersection point along an integration line is indicated by a '+' sign. As we can see the tracking process of DRAGON has succeeded in identifying each intersection point correctly.

For the 3–D geometry G22F3D5 the process of illustrating the integration lines is somewhat more complex. Here we have selected arbitrarily 5 out 133 integration lines generated for 2 of the 4 directions requested in the `EXCELT:` options (`TRAK TISO 2 0.01`). The general properties of these integration lines are provided in Table 6.

One can see in Figure 23 the trajectory of these tracks. The top part of this figure represents a projection of the cell on the $x-y$ plane with the y directed cylinder at the center of the cell omitted. Similarly the bottom part of the figure represents a projection of the cell on the $x-z$ plane with the 2 z directed cylinders omitted. The red lines correspond to the first 5 tracks which are all associated with the first tracking direction while the blue tracks are associated with the second tracking direction. Again each intersection point along an integration line is indicated by a '+' sign. Note that the intersection points in the top part of Figure 23 that are not associated with a mesh point in the $x-y$ plane can be identified in the bottom part of this figure with an intersection in the $x-z$ plane (and vice-versa). A second comment is that some of the lines do not seem to cross the whole geometry as was the case in Figure 22. In fact, this means that such lines in the $x-y$ (or $x-z$) plane left the assembly by the top (front) or bottom (back) planes. Finally, the tracking process of DRAGON has again identified each region intersection successfully.

Table 7: Volume errors as a function of integration parameters

Geometry	Integration parameters		Errors (%)	
	Angular	Spatial	Maximum	Average
G22F2DZ5	2	0.3	> 100	0.01
	7	3.0	4.11	0.01
	15	30.0	0.03	0.00
G22F3D5	2	0.01	40.52	0.17
	4	0.1	13.83	0.02
	4	1.0	12.05	0.00
	4	10.0	0.81	0.00
	4	25.0	0.21	0.00

The integrations lines generated by DRAGON can also be used to evaluate approximately the volume of each region. As a result a comparison between the approximate volume computed in DRAGON using the integration line and the exact volume can also help to assess the efficiency of the tracking process. Such a comparison automatic in DRAGON and the result of the comparison provided on the DRAGON output file. The results we obtained for the maximum and average error in the individual regions volumes are presented in Table 7 for different sets of integration parameter for the two geometry described above.

As one can see the average error decreases very rapidly as the integration parameters are increased. This is expected since this is equivalent to comparing the numerical and analytical values obtained for the total volume of the cell. The maximum error on regional volumes on the other hand remains much higher because of the presence of regions of relatively small volumes in the cell. For example the maximum volume error in G22F2DZ5 generally arises in the smallest regions with total volume 0.5592 cm^2 representing 0.017 % of the total cell volume. Finally the approximate volumes converge monotonically to the exact volumes as the spatial mesh is refined which indicates that the integration lines are correctly generated in DRAGON.

4 VERIFICATION OF THE ASM: MODULE

This module is used to integrate the collision probability matrices using a binary tracking file, a TRACKING data structure and a MACRIOLIB. The only collision probability integration option that can be used for 3–D problems is the EXCELP and our verification will be limited to the set of routines required by this option.

The overall verification process we suggest here will be divided into three parts.

1. A line by line verification for the following routines:
   - the collision probabilities re-normalization routines PIJRDG, PIJRGL, PIJRHL and PIJRNL. These are documented in Part 1 of the Dragon theory manual and in various publications;[9, 12–14]
   - the routine PIJABC that takes into account the boundary conditions to build the complete collision probability matrix;[9, 10]
   - the routine PIJSMD that generates the scattering modified CP matrix from the reduced CP matrix stored in a symmetric format;
   - the routine PIJNOS that generates the standard CP matrix from the reduced CP matrix stored in a symmetric format;
   - the routine PIJCPL that generates the total leakage matrix.
2. A numerical verification for the collision probability matrices. Here we will consider the following analysis:
   - for selected integration lines we will evaluate independently the contribution of this line to the various components of the CP matrix and compare these contributions with those computed in the subroutine PIJI3D;
   - for selected simple geometry perform an independent evaluation of the CP matrix and compare with that generated by PIJI3D;
3. The use of the self-verification option already present in the PIJWPR subroutine. This subroutine is generally used for printing the collision probability matrix. However, it contains two features which are of interest for the verification process:
   - it verifies the conservation relations associated with the collision, leakage and escape probabilities;[9]
   - it is called both before and after the collision probability re-normalization procedure as a means to evaluate the efficiency of these procedures and to detect the presence of unwanted negative probabilities which may be generated by the subroutines PIJRDG and PIJRGL.

4.1 Line by Line Verification

Before going into the detailed line by line verification, let us discuss the general notation used in these subroutines. Here, we will follow the notation presented in Part 1 of the DRAGON theory manual where the reduced collision, leakage and escape probabilities are denoted by p_{ij}, $p_{i\beta}$ and $p_{\alpha\beta}$ respectively.[9] The neutron conservation relations satisfied by these CP matrices are:

$$\sum_{\alpha=1}^{N_\alpha} \frac{S_\alpha}{4} p_{\alpha\beta} + \sum_{i=1}^{N_i} \Sigma_i V_i p_{i\beta} = \frac{1}{4} S_\beta \tag{4.1}$$

$$\sum_{\alpha=1}^{N_\alpha} \frac{S_\alpha}{4} p_{\alpha j} + \sum_{i=1}^{N_i} \Sigma_i V_i p_{ij} = V_j \tag{4.2}$$

Similarly, from the symmetry of the optical path τ, we can derive directly the following reciprocity relations:

$$\begin{aligned} V_i p_{ij} &= V_j p_{ji} \\ V_i p_{i\alpha} &= \frac{S_\alpha}{4} p_{\alpha i} \\ \frac{S_\alpha}{4} p_{\alpha\beta} &= \frac{S_\beta}{4} p_{\beta\alpha} \end{aligned}$$

In the DRAGON subroutines that are called by the `ASM:` module, the element (i, j) of the collision probability matrix p_{ij} is stored in the array `PIJSCT(I,J)` at location `I=`i and `J=`j before being stored on the ASMPIJ data structure. There are two additional array, namely `PIJSYM` and `PROB` which are used in these subroutines and that contain different form of the CP matrices. In fact `PIJSYM` contains a symmetrize version of the p_{ij} matrix, that is:

$$\tilde{p}_{ij} = \frac{p_{ij}}{V_i}$$

where the element (i, j) of $\tilde{p}_{ij}$ can be located in the array `PIJSYM(K)` at a location given by:

$$\mathtt{K} = \frac{\max(i, j)(\max(i, j) - 1)}{2} + \min(i, j)$$

The information stored in the array `PROB` is much more complex since it contains a symmetrize version of the p_{ij}, $p_{i\beta}$ and $p_{\alpha\beta}$ matrices, namely $\tilde{P}_{ab}$, which is defined as:

$$\tilde{P}_{ab} = \frac{S_\alpha}{4} p_{\alpha\beta}$$

for surfaces $a = -\alpha$ and $b = -\beta$,

$$\tilde{P}_{ab} = \tilde{P}_{ba} = \Sigma_i V_i p_{i\beta} = \Sigma_i \frac{S_\beta}{4} p_{\beta i}$$

for region $a = i$ and surface $b = -\beta$ and

$$\tilde{P}_{ab} = \begin{cases} V_i p_{ij} & \text{for } \Sigma_j = \Sigma_i = 0 \\ \Sigma_j V_i p_{ij} & \text{for } \Sigma_j \neq 0 \text{ and } \Sigma_i = 0 \\ \Sigma_i V_i p_{ij} & \text{for } \Sigma_j = 0 \text{ and } \Sigma_i \neq 0 \\ \Sigma_j \Sigma_i V_i p_{ij} & \text{for } \Sigma_j \neq 0 \text{ and } \Sigma_i \neq 0 \end{cases}$$

for region $a = i$ and surface $b = j$. Finally we will also define

$$\tilde{P}_{0b} = \begin{cases} \frac{S_\beta}{4} & \text{for } b = -\beta < 0 \\ 0 & \text{for } b = 0 \\ \Sigma_j V_j & \text{for } b = j > 0 \end{cases}$$

The element (a, b) of the symmetrized CP matrix $\tilde{P}_{ab}$ will therefore be stored in array `PROB` at location `K` defined as:

$$\mathtt{K} = \frac{\max(I, J)(\max(I, J) - 1)}{2} + \min(I, J)$$

where

$$\begin{aligned} I &= N_s + a + 1 \\ J &= N_s + b + 1 \end{aligned}$$

and N_s is the number of surfaces. The general form of the matrix `PROB` is illustrated in Figure 24. Finally, the explicit form of the conservation relations can be written in terms of the matrix $\tilde{P}_{ab}$ as follows:

$$\sum_{a \neq 0} \tilde{P}_{ab} = \tilde{P}_{0b}$$

4.1.1 Subroutine PIJRDG

The listing of the subroutine `PIJRDG.f` is provided in Appendix A.3.4. This subroutine is used to renormalized the CP (leakage, escape and collision) matrix to ensure that global neutron balance is preserved. The renormalization scheme used here consists in correcting the diagonal elements of the CP matrix. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-29 Comments describing the use of the subroutine and the parameters of the subroutine. Here we will first compute the correction terms (`BILAN`):

$$\Delta_b = \sum_{\substack{a \neq 0 \\ a \neq b}} \tilde{P}_{ab}$$

and redefine the diagonal elements of the CP matrix using:

$$\tilde{P}^D_{bb} = \tilde{P}_{0b} - \Delta_b$$

L:30-33 Definition of parameters used in the subroutine.

L:34-36 Initialization of indices to locate the first element in a line (`IPRB`) or a column (`IUNK`) in the `PROB` matrix. The index `IVOL` is used to locate in the matrix `PROB` the location of the surface/volume elements.

L:37-71 Normalize the diagonal element of the probability matrix for each surface and volume.

- L:40-47 Add to `BILAN` the contributions along one line in the symmetrized `PROB` matrix. Do not consider the diagonal contribution to the CP matrix
- L:48-57 Add to `BILAN` the contributions along one column in the symmetrized `PROB` matrix. Do not consider the diagonal contribution to the CP matrix
- L:58-60 Normalize $P_{\alpha\beta}$
- L:61-68 Normalize P_{jj} for non-voided cases
- L:69-70 Skip normalization for term P_{00}.

L:72-73 Return control to the calling program.

L:74 End of subroutine

4.1.2 Subroutine PIJRGL

The listing of the subroutine `PIJRGL.f` is provided in Appendix A.3.5. This subroutine is used to renormalized the CP (leakage, escape and collision) matrix to ensure that global neutron balance is preserved. The

renormalization scheme used here consists in correcting the all the elements of the CP matrix based on an homogeneous approach defined by Gelbard.[13] Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-31 Comments describing the use of the subroutine and the parameters of the subroutine. Here we will first compute the correction terms (`RI(IPRB)` is R_β or R_j):

$$R_b = \tilde{P}_{0b} - \sum_{a \neq 0} \tilde{P}_{ab}$$

and define $\tilde{R}$ and $\tilde{\Sigma}$ as:

$$\tilde{\Sigma} = \sum_{a \neq 0} P_{0a}$$

$$\tilde{R} = \frac{1}{\tilde{\Sigma}} \sum_{a \neq 0} R_a$$

The collision probabilities are then normalized using:

$$\tilde{P}^G_{ab} = \tilde{P}_{ab} + \frac{1}{\tilde{\Sigma}} \left(\tilde{P}_{0b} R_a + \tilde{P}_{0a} R_b - \tilde{P}_{0a} \tilde{P}_{0a} \tilde{R} \right)$$

L:32-38 Definition of parameters used in the subroutine.

L:39-45 Initialization of indices to locate the first element in a line (`IPRB`) or a column (`IUNK`) in the `PROB` matrix. The index `IVOL` is used to locate in the matrix `PROB` the location of the surface/volume elements. The local variable `RBARRE` and `GBARRE` will contain $\tilde{R}$ and $\tilde{\Sigma}$ respectively.

L:46-82 Compute the vector `RI` that contains R_β and R_i. Also sum the elements of `RBARRE` and `GBARRE`.

- L:47-54 Add to `RI` the contributions along one line in the symmetrized `PROB` matrix.
- L:55-63 Add to `RI` the contributions along one column in the symmetrized `PROB` matrix.
- L:64-79 Store in `RI`, the contribution from $\tilde{P}_{0i}$ or $\tilde{P}_{0\alpha}$ and subtract the result from the sum performed in L:47-63. Also add the contribution of $\tilde{P}_{0i}$ or $\tilde{P}_{0\alpha}$ to $\tilde{\Sigma}$ (`GBARRE`) and to $\tilde{R}$ (`RBARRE`).
- L:83-110 Normalize the collision probability matrices
- L:111-138 If required (`IPRT`>4), send to the output file the surface and volume correction factors computed (`RI`).

L:139 Return control to the calling program.

L:140 End of subroutine

4.1.3 Subroutine PIJRHL

The listing of the subroutine `PIJRHL.f` is provided in Appendix A.3.6. This subroutine is used to renormalized the CP (leakage, escape and collision) matrix based on a simple multiplicative normalization scheme.[9,14] Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-38 Comments describing the use of the subroutine and the parameters of the subroutine. The CP normalization scheme we will consider is the following:

$$\tilde{P}^H_{ab} = (w_a + w_b)\tilde{P}_{ab}$$

The conservation laws can be ensured by requiring that:

$$w_b \left(\tilde{P}_{bb} + \sum_{a\neq 0} \tilde{P}_{ab} \right) = \tilde{P}_{0b} + w_b\tilde{P}_{bb} - \sum_{a\neq 0} w_a\tilde{P}_{ab} = \tilde{P}_{0b} - \sum_{\substack{a\neq 0\\ a\neq b}} w_a\tilde{P}_{ab}$$

This system is for w_b using an iterative process, namely, assuming that w^k_a at iteration k is known for $a \neq b$ we can write:

$$w^{k+1}_b = \left(\tilde{P}_{0b} - \sum_{\substack{a\neq 0\\ a\neq b}} w^k_a\tilde{P}_{ab} \right) / \left(\tilde{P}_{bb} + \sum_{a\neq 0} \tilde{P}_{ab} \right) \tag{4.3}$$

For $k = 1$, the weights $w^k_a = 0,5$ are all identical, corresponding to the case where the collision probabilities are already normalized. The solution for w^{k+1}_a is assumed converged when:

$$\max \left(\frac{w^{k+1}_a - w^k_a}{w^{k+1}_a} \right) \leq \epsilon$$

This iterative process is also accelerated by comparing the error in two successive iteration, namely, if one defines:

$$R^1_a = w^{k+1}_a - w^k_a$$
$$R^2_a = w^{k+2}_a - w^{k+1}_a$$

then we will try to evaluate μ such that:

$$\tilde{R}^2_a = R^1_a + \mu(R^2_a - R^1_a) = 0$$

Taking the scalar product of $\tilde{R}^2_a$ with $(R^2_a - R^1_a)$ yields:

$$\mu = -\frac{\sum_a R^1_a(R^2_a - R^1_a)}{\sum_a (R^2_a - R^1_a)(R^2_a - R^1_a)} \tag{4.4}$$

and we can obtain the following approximation for w^{k+2}_a and w^{k+1}_a:

$$\tilde{w}^{k+2}_a = w^{k+1}_a + \mu R^2_a$$
$$\tilde{w}^{k+1}_a = w^k_a + \mu R^1_a$$

L:39-56 Definition of parameters used in the subroutine including the intrinsic function `IND(I,J)` which is used to locate in the array `PROP` the elements associated with the CP matrix.

L:57-73 Initialization of weights w^k_a, of the acceleration parameters `CPTLB` and `CPTAC` giving the number of free (without acceleration) and accelerated iteration respectively. Initialization of the weights for the current and two previous iterations k, $k-1$ and $k-2$ (`WEIGHT(IR,3)`, `WEIGHT(IR,2)` and `WEIGHT(IR,1)` respectively). Also initialize the array `CHI(IR)` in such a way that the calculations are not performed for `IR`=0 or in the case where the region is voided.

L:74-78 If required (IPRT>2), send iteration information to output file.

L:79-137 Iterate a maximum number of NITMAX=20 times. If the convergence is reached at any time then the control is transferred to instruction 120 (L:137), otherwise an error message is sent to the output file (L:135-136) and the last result for the weights are used for the normalization process.

- L:81-90 Compute the numerator (WFSPAD) and denominator (WFSP) of Eq. (4.3) and compute the weight itself (L:89)
- L:91-118 If the acceleration is required (3 free followed by 3 accelerated iteration) compute the acceleration parameter μ using Eq. (4.4) and modify the weights as prescribed above.
- L:119-129 Compute the relative error in this iteration and send the iteration information to output file if required.
- L:130-133 When convergence is reached exit the iteration loop.

L:138-148 Normalize the CP matrix

L:149-173 Send to the output file the weight factors in the case where convergence is not reach or if IPRT≥10

L:174 Return control to the calling program.

L:175-178 Formats for output

L:179 End of subroutine

4.1.4 Subroutine PIJRNL

The listing of the subroutine PIJRNL.f is provided in Appendix A.3.7. This subroutine is used to renormalized the CP (leakage, escape and collision) matrix using multiplicative weighting factors.[9,12] Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-40 Comments describing the use of the subroutine and the parameters of the subroutine. The CP normalization scheme we will consider is the following:

$$\tilde{P}^N_{ab} = w_a w_b \tilde{P}_{ab}$$

This results in the following quadratic system

$$F_b(\vec{w}) = w_b \sum_{a\neq 0} \tilde{P}_{ab} w_a - \tilde{P}_{0b} = 0$$

This system can be solve iteratively for the weights using the modified Newton's method:

$$\vec{w}^{k+1} = \vec{w}^k - A^{-1}\vec{F}(\vec{w}^k)$$

where the matrix A is simply the derivative of $\vec{F}(\vec{w}^k)$ with respect to $\vec{w}$ evaluated at iteration $k = 0$ where all the components of $\vec{w}$ are identically 1. Here A can be defined as:

$$A_{ab} = \tilde{P}_{ab}$$

in the case where $a \neq b$ while for A_{aa} we can write

$$A_{aa} = \tilde{P}_{aa} + \sum_{b\neq 0} \tilde{P}_{ab}$$

Note that the matrix A is symmetric (because the matrix $\tilde{P}_{ab}$ is symmetric). Accordingly, instead of inverting the matrix A, we will first perform a LDL^T factorization of this matrix and use it to solve:

$$A\vec{x} = \vec{F}(\vec{w}^k)$$

for $\vec{x}$ such that

$$\vec{x} = A^{-1}\vec{F}(\vec{w}^k)$$

L:41-48 Definition of parameters used in the subroutine.

L:49-88 Built the matrix `CIJ` which will contain the same information as that available in `PROB` except for the contribution corresponding to $\tilde{P}_{0b}$ and $\tilde{P}_{b0}$ which all vanishes except for $\tilde{P}_{00} = 1$. Similarly if region c is voided we will store $\tilde{P}_{cb} = \tilde{P}_{bc} = 0$ for $b \neq c$ in `CIJ`.

L:89-122 Store the matrix A in `WSPACE` using the information available in the array `CIJ`. In fact all the off diagonal elements of `WSPACE` are identical to those of `CIJ`. The diagonal elements `CIJ` are added twice to `WSPACE`. If required (`IPRT`>100) print the contents of the `CIJ` and `WSPACE` arrays.

L:123-125 Perform the LDL^T factorization of `WSPACE` using subroutine `ALLDLF`. The result is returned in the array `WSPACE`.

L:126-131 Initialize the weights for the first iteration.

L:132-195 Iterate a maximum number of `NITMAX=10` times. If the convergence is reached at any time, then the control is transferred to instruction 120 (L:195), otherwise an error message is sent to the output file (L:194) and the last result for the weights are used for the normalization process.

- L:145-166 Compute $\vec{F}(\vec{w}^k)$ and store in vector `WFSP`.
- L:167-172 If required (`IPRT`>100) print the contents of the `WFSP` array.
- L:173 Solve $A\vec{x} = \vec{F}(\vec{w}^k)$ for $\vec{x}$ using the LDL^T factorization stored in `WSPACE`. The result is returned in the vector `WFSP`.
- L:174-181 Compute the square of the norm `TOTCON` of the vector `WFSP`, and update the weight vector `WEIG`.
- L:182-188 If required (`IPRT`>100) print the contents of the `WEIG` array.
- L:189–191 If convergence is reached exit from the iteration loop by transferring to instruction 120 (L:195)

L:196-225 Recompute weights for void regions

L:226-236 Normalize the CP array using the weight factors computed

L:237-260 If required (`IPRT`>100) print the contents of the `WEIG` array.

L:261-262 Return control to the calling program.

L:263-272 Print formats

L:273 End of subroutine

4.1.5 Subroutine PIJABC

The listing of the subroutine `PIJABC.f` is provided in Appendix A.3.1. This subroutine takes into account the boundary conditions to compute the complete CP matrix using the relation:[9]

$$\mathbf{P}^c_{vv} = \mathbf{P}_{vv} + \mathbf{P}_{vs}\mathbf{P}^c_{ss}\mathbf{P}_{sv}$$

where

$$\mathbf{P}^c_{ss} = (\mathbf{I} - \mathbf{A}\mathbf{P}_{ss})^{-1}\,\mathbf{A} = \left(\mathbf{A}^{-1} - \mathbf{P}_{ss}\right)^{-1} \tag{4.5}$$

and A is the reflection/transmission matrix. In the cases where void boundary conditions are applied on different surfaces S_α, a slightly modified expression must be used. If one assumes that void boundary conditions are applied to the first n surfaces while for the remaining surfaces reflection or periodic boundary conditions are considered, the matrix **A** and $\mathbf{P}_{ss}$ can be written in the form:

$$\mathbf{A} = \begin{bmatrix} \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{A}_{22} \end{bmatrix}$$
$$\mathbf{A} = \begin{bmatrix} \mathbf{P}_{11} & \mathbf{P}_{12} \\ \mathbf{P}_{21} & \mathbf{P}_{22} \end{bmatrix}$$

and Eq. (4.5) transformed to:

$$\mathbf{P}^c_{ss} = (\mathbf{I} - \mathbf{A}\mathbf{P}_{ss})^{-1}\,\mathbf{A} = \left(\begin{bmatrix} \mathbf{S} & \mathbf{0} \\ \mathbf{0} & \mathbf{A}_{22}^{-1} - \mathbf{P}_{22} \end{bmatrix}\right)^{-1} \begin{bmatrix} \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{I} \end{bmatrix}. \tag{4.6}$$

where **S** is a diagonal matrix containing the components of $\tilde{P}_{0\alpha}$ associated with the void surfaces.

Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-39 Comments describing the use of the subroutine and the parameters of the subroutine.

L:40-49 Definition of parameters used in the subroutine. Here `PROB` is the symmetric CP matrix defined in the previous section, `MATRT` is a vector identifying the coupling of the surface. In the case where the surface is reflective then `MATRT(IS)=IS`. Otherwise the surface `IS` is coupled to surface `JS` defined by `MATRT(IS)`. The reflection and transmission coefficient β at each surface `IS` is stored in array `SIGTAL(IS)`.

L:50-85 Evaluate the matrix $\mathbf{A}^{-1} - \mathbf{P}_{ss}$.

- L:61-72 Store in matrix `PSST` the elements of $-\mathbf{P}_{ss}$ for the case where both surfaces are associated with non-void boundary conditions. In the case where a surface has an albedo of $\beta = 0$ (`SIGTAL`=0), the elements of `PSST` associated with this surface are initialized to 0.
- L:73-84 Store in matrix `PSST` the elements of $\mathbf{A}^{-1}$. In the case where a void boundary condition is used (L:73-74) at surface `IS`=α, store in the diagonal element of `PSST` the contribution from $\tilde{P}_{0\alpha}$. For non-void reflective surfaces, store $1/\beta$ (with β=`SIGTAL`) in the corresponding diagonal element of `PSST` (L:77-78). For non void transmission surfaces (from `IS` to `JS`) store $1/\beta$ in the off diagonal elements of `PSST` corresponding to surfaces `IS` and `JS` (L:80-82).

L:86-94 Inverse in place the matrix `PSST` using the subroutine `ALINVD` and abort if the matrix is singular.

L:95-125 Evaluate the matrix $\mathbf{P}^c_{vv}$. This is a two step process. First one computes $\mathbf{P}^c_{sv}$ using:

$$\mathbf{P}^c_{sv} = \mathbf{P}^c_{ss}\mathbf{P}_{sv}$$

and stores it in the array `PSVT` (L:104-109). Then one computes

$$\mathbf{P}^c_{vv} = \mathbf{P}_{vv} + \mathbf{P}_{vs}\mathbf{P}^c_{sv}$$

and stores it back in `PROB`, the symmetric CP matrix (L:110-122).

L:126 Return control to the calling program.

L:127 End of subroutine

4.1.6 Subroutine PIJSMD

The listing of the subroutine `PIJSMD.f` is provided in Appendix A.3.8. This subroutine to evaluate the scattering modified collision probability matrix $\mathbf{w}$ defined as:

$$\mathbf{w}_{ij}^{g} = \left[I - \mathbf{p}_{ij}^{g} \Sigma_{s0}^{g \to g}\right]^{-1} \mathbf{p}_{ij}^{g}$$

Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-36 Comments describing the use of the subroutine and the parameters of the subroutine.

L:37-61 Definition of parameters used in the subroutine. Here `PIJSYM` is a symmetric matrix containing the components of `PROB` defined in the previous section associated with the collision probability. The arrays `XSSIGW` and `XSSIGT` contain the total and within group scattering cross sections associated with each mixture respectively and `MATCOD` is a vector to identify the mixture used in each region. The array `INDPOS(I,J)` is used to locate in array `PIJSYM` the position of the i=`I` and j-`J` element in the matrix $\mathbf{p}_{ij}^{g}$

L:62-72 Compute the augmented matrix $\mathbf{K}$ containing:

$$\mathbf{K} = \left[\mathbf{I} - \mathbf{p}_{ij}^{g} \Sigma \mid \mathbf{p}_{ij}^{g}\right]$$

corresponding to the series of linear system:

$$\left[\mathbf{I} - \mathbf{p}_{ij}^{g} \Sigma\right] \mathbf{w}_{i,j}^{g} = \mathbf{p}_{ij}^{g}$$

and store this information in array `PIJSCT`. The solution to these linear systems $\mathbf{w}_{i,j}^{g}$ is the required scattering modified CP matrix.

L:73-79 Solve the linear system using the augmented matrix $\mathbf{K}$ using subroutine `ALSBD`. The result is returned in the source term of $\mathbf{K}$. Abort in the case where the system is singular, otherwise transfer the source term of $\mathbf{K}$ to `PIJSCT`.

L:80-90 If required (`IMPX`$\geq$ 8) print the matrix $\mathbf{w}_{i,j}^{g}$.

L:91-122 If required (`IMPX`$\geq$ 10) verify if the matrix $\mathbf{w}_{i,j}^{g}$ satisfies the adequate symmetric and conservation relations.

L:123 Return control to the calling program.

L:124-136 Format for output

L:137 End of subroutine

4.1.7 Subroutine PIJNOS

The listing of the subroutine `PIJNOS.f` is provided in Appendix A.3.3. This subroutine is used to transfer the symmetric CP matrix $\mathbf{p}_{ij}^{g}$ to a full matrix form. It is called only when the scattering modified CP matrix is not

required in the calculations. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-25 Comments describing the use of the subroutine and the parameters of the subroutine.

L:26-40 Definition of parameters used in the subroutine. For the contents of the variable see Section 4.1.6.

L:41-50 Transfer to `PIJSCT(I,J)` the elements of `PIJSYM(I,J)` divided by the region (`I`) volume.

L:51 Return control to the calling program.

L:52 End of subroutine

4.1.8 Subroutine PIJCPL

The listing of the subroutine `PIJCPL.f` is provided in Appendix A.3.2. This subroutine is used to generate leakage vector associated with the complete collision probability matrix. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-28 Comments describing the use of the subroutine and the parameters of the subroutine. Here we will compute for each region the out of cell leakage probability $P_{i,L}$ given by:

$$P_{i,L} = 1 - \frac{1}{V_i} \sum_{j=1}^{N_j} \Sigma_j \tilde{p}_{ij}$$

L:29-42 Definition of parameters used in the subroutine.

L:43-50 Compute $P_{i,L}$ using relation presented above.

L:51 Return control to the calling program.

L:52 End of subroutine

4.2 A Numerical Verification for the Collision Probability Matrices

In this section we will verify the consistency of the various CP matrices produced during a DRAGON execution. For simplicity we will consider the 2–D problem called T2D described in Appendix B.19 and the 3–D problem T3D described in Appendix B.20. The two groups cross section we have used in these calculations are presented in Appendix B.21 in the form of a MACROLIB data structure. Note that in DRAGON the CP matrices for a 2–D problem are computed using a two dimensional integration of Bickley-Nayler functions while the evaluation of the CP matrices for a 3–D problem requires a three dimensional integration of exponential functions.[9]

Because the collision, escape and transmission probabilities associated with each problem are computed independently in DRAGON, the consistency of the integration problem and of the integration lines with the regional

Table 8: Computed errors on the CP matrices

Parameter	T2D	T3D
ϵ_β^B	0.23	4.36
ϵ_β^A	0.00004	0.00002
ϵ_j^B	0.000003	0.000008
ϵ_j^A	0.00003	0.00003
ϵ_c	0.0001	0.0001
ϵ_s	0.0001	0.0003

volume can be assessed by verifying the validity of the conservation relations described in Eqs. (4.1) and (4.2). When the `EDIT` level in the `ASM:` module is sufficiently large, DRAGON provides the following information:

$$\frac{4}{S_\beta}\left(\sum_{\alpha=1}^{N_\alpha}\frac{S_\alpha}{4}p_{\alpha\beta}+\sum_{i=1}^{N_i}\Sigma_i V_i p_{i\beta}\right)=R_\beta$$

$$\frac{1}{V_j}\left(\sum_{\alpha=1}^{N_\alpha}\frac{S_\alpha}{4}p_{\alpha j}+\sum_{i=1}^{N_i}\Sigma_i V_i p_{ij}\right)=R_j$$

where in principle $R_\beta = R_j = 1$ for all β and j. For both the 2–D and 3–D problems, the second relation is always satisfied to within $1.0 \times 10^{-7}\%$. In fact, for the 2–D and 3–D problems we obtained the results presented in Table 8 where:

$$\epsilon_\beta^{B/A} = 100 \times \left(\frac{||1-R_\beta||}{||R_\beta||}\right)$$

$$\epsilon_j^{B/A} = 100 \times \left(\frac{||1-R_j||}{||R_j||}\right)$$

and the index B represents the results before renormalization while the index A denotes the results after CP renormalization has been performed.

Note that the relatively large errors on R_β is expected because of the relatively large error on the surface evaluation using the integration lines as compared with the exact values (0.4 and 5.3 % for T2D and T3D respectively).

Using the collision, leakage and escape probabilities we have also evaluated explicitly the complete CP matrix which takes into account the effect of the boundary conditions using Matlab ($P_{c,M}$). This can be compared with the results ($P_{c,D}$) provided in the PIJASM data structure called `PIJMATSTD` (case where the `SKIP` option is used in the `ASM:` module). We can also evaluated explicitly the scattering modified CP matrix which takes into account the within group scattering cross section using Matlab ($P_{s,M}$). This can be compared with the results ($P_{s,D}$) provided in the PIJASM data structure called `PIJMATSMD` (here the `SKIP` option is not used in the `ASM:` module). The results we obtained are again presented in Table 8 where

$$\epsilon_c = 100 \times \left(\frac{||P_{c,M}-P_{c,D}||}{||P_{c,M}||}\right)$$

$$\epsilon_s = 100 \times \left(\frac{||P_{s,M}-P_{c,D}||}{||P_{s,M}||}\right)$$

These results confirm that the `ASM:` module performs as expected, at least for the series of test cases we have considered here. Since these problems are very general in nature, one can expect that `ASM:` will behave in the same fashion for other geometries and cross sections sets.

5 VERIFICATION OF THE FLU: MODULE

This module is used to solve the multigroup CP equations for the flux and eigenvalue. The first observation here is that instead of using the generic flux solution and residual calculation external function names (FMODUL and SMODUL respectively), we will insert directly in the above structure the explicit subroutine names used for the solution of all collision probability problems, namely the TRFICF and TRFICS subroutines respectively. In fact the only other options that is available in DRAGON involves a response matrix solution to the JPM transport problem that is not pertinent to the current discussion.

The overall verification process has been divided into 3 parts.

1. A line by line verification for the following routines:
   - FLUGET and FLUGPI that are used to read the `FLU:` processing options;
   - TRFICF that is used to compute the one group flux ϕ^g associated with a fixed source S^g using:

     $$\phi_i^g = \sum_j p_{ij}^g S_j^g;$$

   - TRFICS that is used to compute the one group residual $\Delta\phi^g$ associated with a fixed source S^g and a reference flux ϕ^g using:

     $$\Delta\phi_i^g = \phi_i^g - \sum_j p_{ij}^g S_j^g;$$

   - FLUQFX and FLUQFS that add to the current source the contribution from fission and an external fixed source respectively;
   - FLUGFL and FLUSFL that read and write the flux to or from the FLUXUNK data structure.
2. A global numerical verification for the following routines:
   - TRFICF and TRFICS that are used to compute the one group flux ϕ^g and residual $\Delta\phi^g$ as described above;
   - FLUQFX and FLUQFS that add to the current source the contribution from fission and an external fixed source respectively;
   - the B1DIFF set of subroutines that computes homogeneous B_0 and B_1 diffusion coefficients and the corresponding buckling;
3. A self-verification process for the following routines:
   - for FLUDB2 and B1DIFF by comparing the case where convergence on buckling is considered with that where a k_{eff} convergence is used with imposed leakage.

5.1 Line by Line Verification

5.1.1 Subroutine FLUGET

The listing of the subroutine `FLUGET.f` is provided in Appendix A.4.1. This subroutine is used to read the calculation options for the flux solution module. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-5 Main entry point to the subroutine.

L:6-96 Comments describing the use and the contents of the variables and arrays transfer to the subroutine.

L:97-119 Definition of parameters used in the subroutine.

L:120-137 Initialize the default value for the module and local parameters that will be used to validate the input options.

L:138-159 Read processing options using subroutine `FLUGPI` until `;`, `INIT` or an invalid keyword is reached. If `;` is found then transfer to instruction 2000 (L:159) to validate the options selected in the flux calculation. In the case where `INIT` is found call subroutine `FLURFL` to read the flux from the input stream. Once completed, continue to read the remaining keywords in the input stream by returning to instruction 1000 (L141). Finally abort if an invalid keyword is detected on the input stream.

L:160-167 Assume a `TYPE K` (no leakage) calculation with reference k_{eff}^{p}rovided. By default the reference $k_{eff}^{=}$1 (L:134).

L:168-183 In the case where the flux calculations are performed with leakage, read if possible from the FLUXUNK data structure the buckling vector. One first verifies in a set of heterogeneous bucklings are available, in which case they are read. Otherwise, one one verifies is homogeneous bucklings are provided and reads them. In the case where no buckling information is provided the defaults values will be used (L:164-167).

L:184-197 In the case where the non-leakage probability option (`PNL` or `PNLR`) is selected as a leakage option, verify if it is compatible with the type of collision probability. If the scattering reduced collision probability are selected the option `PNL` is replaced by `PNLR`, otherwise, the option `PNLR` is replaced with `PNL`.

L:198-221 For a direct fission problem with k_{eff} calculation and imposed buckling, verify if the buckling is initialized both for the heterogeneous (L:200-204) and homogeneous case (L:205-206). In the buckling is not initialized a buckling search is required with imposed k_{eff}. For all the other types of calculations verify if a specific buckling direction is selected and save this direction in `ISDIR`. By default `ISDIR`=0 (L:198).

L:222-260 For the case where an heterogeneous leakage method is considered, test for consistency in buckling. If a global buckling search is requested, verify that there are not x, y and z directional buckling provided, and initialize the buckling B_i^2 in directions $i = x, y, z$ to $B^2/3$. If a radial buckling search is requested, verify that there are not x and y directional buckling provided, and initialize the buckling B_i^2 in directions $i = x, y$ to $B^2/2$. Otherwise, abort if directional bucklings are provided (L:253-260).

L:261-266 For simulated leakage calculations, verify that there is no physical leakage from the cell.

L:267-278 Define the precision parameters. The minimum precision permitted for the inner and outer iteration is specified by `EPSCUT`. Moreover, the precision on k_{eff}^{m}ust be smaller or equal to the precision on the unknowns. In the case where a buckling search is requested and the maximum number of outer iterations is not specified, a default value of `10*NREGIO+1` is selected where `NREGIO` is the number of regions at which flux solutions is required. Otherwise, a default value of `2*NREGIO+1` is specified.

L:279-300 For generalized adjoint solution, direct problems with fixed or leakage sources are forbidden. All the leakage options are bypassed and replaced by the `SIGS` option. For the adjoint solution, all the leakage options are bypassed and replaced by the `SIGS` option.

L:301-303 For a k_{eff} calculation without leakage, restore `ILEAK`=0.

L:304 Return control to the calling program.

L:305 End of subroutine

5.1.2 Subroutine FLUGPI

The listing of the subroutine `FLUGPI.f` is provided in Appendix A.4.3. This subroutine is used to read the input stream for the options requested in the flux solution module. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-88 Comments

L:89-124 Definition of parameters used in the subroutine.

L:125-133 Initialize direction option `ISDIR`=0 and transfer the last keyword read (if not blank) in variable `CARLIR` before transferring control to the keyword analysis part of the subroutine (instruction 1010 on L:136).

L:134-366 Read input stream and validate information. This implicit loop is terminated (transfer to instruction 2000 on L:366) if the input stream is empty (L:139), if the keyword `;` is encountered (L:144), if the keyword `INIT ON` is read (L:232) or if the keyword in not valid (L:363). The keywords are processed as follows:

- L:137-140 The input stream is empty: terminate the analysis by returning to instruction 2000 (L:366)
- L:141-142 Abort if the last record read on the input stream is not a keyword.
- L:143-144 The keyword `;` is encountered: terminate the analysis by returning to instruction 2000 (L:366)
- L:145-149 The keyword `EDIT` is encountered: read the integer edit option and store in `IPRINT`
- L:150-210 The keyword `TYPE` is encountered: read the next keyword and initialize `ITYPEC` depending on this keyword (L154-172). In the case where the type is `K`, `B` or `L`, try to read on the input stream the type of leakage type considered. If the keyword read does not correspond to a leakage model assume a new keyword is available in `CARLIR` and return to instruction 1010 (L:136) for further processing. In the case where a `TYPE K` calculation is requested with leakage, `ITYPEC` now becomes 2. Then, read the next keyword which should represent the leakage model to be used. In the case where an heterogeneous buckling search is to be considered, read the direction for this search.
- L:211-222 The keyword `REBA` is encountered: set the rebalancing parameter to `ON` or `OFF` as required. By default the rebalancing option is assumed to be `ON`.
- L:223-233 The keyword `INIT` is encountered: initialize the flux from the input stream if required.
- L:234-244 The keyword `THER` is encountered: initialize the maximum number of thermal iterations and the precision required on the flux in these iterations.
- L:245-255 The keyword `EXTE` is encountered: initialize the maximum number of power iterations and the precision required on k_{eff} in these iterations.
- L:256-260 The keyword `UNKT` is encountered: initialize the precision required on unknowns in the outer iterations.
- L:261-265 The keyword `EGPA` is encountered: initialize the convergence criterion for the generalized adjoint calculation.

L:266-270 The keyword CGPA is encountered: initialize the decontamination factor for the generalized adjoint calculation.

L:271-282 The keyword DECO is encountered: select the decontamination option. This option is either ON or OFF. By default the option ON is selected.

L:283-289 The keyword ACCE is encountered: read the 2 integer variational acceleration parameters.

L:290-301 The keyword KEFF is encountered: read the k_{eff} from the input stream.

L:302-339 The keyword BUCK is encountered: read the homogeneous or heterogeneous buckling B^2 from the input stream.

L:340-351 The keyword IDEN is encountered: specify that the homogeneous or heterogeneous buckling B^2 will be extracted from the reference FLUXUNK data structure.

L:352-363 One of the keywords FLX, PAF, AF, GPA or GA is encountered: the type of flux calculation required. The keywords FLX, PAF, AF, GPA or GA represent a direct flux, a pseudo-adjoint, an adjoint, a generalized pseudo-adjoint and a generalized adjoint calculation respectively.

L:367-369 If a directional leakage calculation is specified, store in the array IRSDIR at location ISDIR a value of -1 to indicate that the buckling in this direction is only a first approximation.

L:370 Transfer the contents of the last keyword read in the variable CARLST

L:371 Return control to the calling program.

L:372 End of subroutine

5.1.3 Subroutine TRFICF

The listing of the subroutine TRFICF.f is provided in Appendix A.4.7. This subroutine is used to obtain the flux $\vec{\phi}^g = \phi_i^g$ from the sources $\vec{S}^g = S_i^g$ using the following relation:

$$\vec{\phi}^g = \mathbf{K}^g \vec{S}^g \tag{5.1}$$

for a single group g. In the case where the scattering modified CP matrix is used, the matrix $\mathbf{K}^g = \mathbf{w}_{ij}^g$ as defined in Section 4.1.6 and the source vector does not contain the the within group scattering sources. Otherwise, the matrix $\mathbf{K}_{ij}^g = \mathbf{p}_{ij}^g$ as defined in Section 4.1.7 and the source vector does contain the the within group scattering sources. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-4 Main entry point to the subroutine.

L:5-34 Comments

L:35-72 Definition of parameters used in the subroutine.

L:73-87 Verify if the asmpij data structure contains the CP matrix $\mathbf{K}^g$. If the record is present, allocate the memory (if necessary) and read the information in the vector array RBASE with the first element starting at location ICPMAT. These elements are store by groups of NREGIO elements corresponding to with $\mathbf{K}_{i,j}^g$ with j=1,NREGIO, i=NREGIO such sets being present in the vector RBASE.

L:88-95 If required, print the contents of the source vector $\vec{S}^g$.

L:96-102 Initialize the flux vector to 0.0 before performing the matrix product.

L:103-110 Compute the flux using the matrix product of Eq. (5.1).

L:111-118 If required, print the contents of the flux vector $\vec{\phi}^g$.

L:119 Release memory allocated to store the matrix $\mathbf{K}^g$ (if necessary).

L:120 Return control to the calling program.

L:121-125 Formats for printing

L:126 End of subroutine

5.1.4 Subroutine TRFICS

The listing of the subroutine `TRFICS.f` is provided in Appendix A.4.8. This subroutine is used to obtain the residual vector $\vec{R}^g = R_i^g$ corresponding to a CP flux calculation by subroutine `TRFICF` (see Section 5.1.3). Here $\vec{R}^g$ is computed using:

$$\vec{R}^g = \vec{\Phi}^g - \vec{\phi}^g \tag{5.2}$$

where $\vec{\phi}^g$ is the solution of the transport equation associated with the current source vector $\vec{S}^g$ (see Eq. (5.1)) while $\vec{\Phi}^g$ is a reference solution provided by the user of this subroutine. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-4 Main entry point to the subroutine.

L:5-34 Comments

L:35-60 Definition of parameters used in the subroutine.

L:58-64 Allocate memory to store $\vec{\phi}^g$ and compute it using the subroutine `TRFICF` (see Eq. (5.1) and Section 5.1.3)

L:65-71 Compute the residual vector $\vec{R}^g$ using Eq. (5.2) and then release memory allocated to store $\vec{\phi}^g$.

L:72-79 If required, print the contents of the residual vector $\vec{R}^g$.

L:80 Return control to the calling program.

L:81-85 Formats for printing

L:86 End of subroutine

5.1.5 Subroutine FLUQFX

The listing of the subroutine `FLUQFX.f` is provided in Appendix A.4.5. This subroutine is used to store in the current total source $\vec{S}^g$ the fixed (flux independent) contribution available on the MACROLIB data structure $\vec{q}^g$.

$$\vec{S}^g \leftarrow \vec{q}^g$$

Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-36 Comments

L:36-52 Definition of parameters used in the subroutine.

L:53-76 For each group g, first locate the adequate directory on the MACROLIB data structure where the fixed source $\vec{q}^g$ (L:57-58). Verify if the fixed source record has the required number of elements is read it (L:59-61). Transfer the information from $\vec{q}^g$ to $\vec{S}^g$ (L:62-65) and print it on the output file if required (L:66-70).The program will abort (L71-74) in the case where the number of elements in the fixed source record `ILCMLN` is invalid (`ILCMLN`$\neq$`NBMIX`). Finally return the MACROLIB data structure to its original position.

L:77 Return control to the calling program.

L:78-82 Formats for printing

L:83 End of subroutine

5.1.6 Subroutine FLUQFS

The listing of the subroutine `FLUQFS.f` is provided in Appendix A.4.4. This subroutine is used to store in the current total source $\vec{S}^g$ the fission source (flux dependent) contribution Here $\vec{q}^g$ contains the total fission source:

$$\vec{q}^g = \nu\Sigma_f^g \vec{\phi}^g$$

where $\nu\Sigma_f$ is the matrix containing the product of the fission cross section and the average number of neutron emitted per fission. Accordingly

$$\vec{S}^g \leftarrow \vec{q}^g + \lambda\chi^g\vec{q}^g$$

where χ is the fission spectrum and λ is a known flux normalization factor. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-4 Main entry point to the subroutine.

L:5-41 Comments

L:42-60 Definition of parameters used in the subroutine.

L:61-84 For each group g, first locate the adequate directory on the MACROLIB data structure where the fission spectrum χ^g and read it (L:65-67). Add to the current source $\vec{S}^g$ the contribution from fission (L:72-75) and print it on the final source if required (L:76-80). Finally return the MACROLIB data structure to its original position.

L:85 Return control to the calling program.

L:86-91 Formats for printing

L:92 End of subroutine

5.1.7 Subroutine FLUGFL

The listing of the subroutine `FLUGFL.f` is provided in Appendix A.4.2. This subroutine is used to extract form a FLUXUNK data structure the flux information. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-20 Comments

L:21-33 Definition of parameters used in the subroutine.

L:34-43 For each group g, first verify if the flux record record is present and has dimensions which are compatible with those provided by the calling routine (`NUNKNO`). If the flux record has the adequate dimensions, read it and store the information in the array `FUNKNO`.

L:44 Return control to the calling program.

L:45 End of subroutine

5.1.8 Subroutine FLUSFL

The listing of the subroutine `FLUSFL.f` is provided in Appendix A.4.6. This subroutine is used to store on the FLUXUNK data structure the flux information. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2 Main entry point to the subroutine.

L:3-21 Comments

L:22-34 Definition of parameters used in the subroutine.

L:35-41 For each group g, transfer the flux information present in the array `FUNKNO` on the FLUXUNK data structure.

L:42 Return control to the calling program.

L:43 End of subroutine

5.2 Numerical Verification

In this section, two types of verification will be considered. First, we will verify that some of the routines called during the execution of the `FLU:` module perform adequately. In the second part of this section we will deal with self consistency analysis: for example a flux calculation with buckling search should yields results identical to those obtained using a k_{eff} search provided the imposed buckling is identical to the critical buckling. For simplicity we will again consider the 2–D and 3–D problems described in Appendix B.19 and Appendix B.20 for which the flux calculations are performed using the files `T2DF.did` and `T3DF.did` respectively. The two groups cross section we have used in these calculations are presented in Appendix B.21 in the form of a MACROLIB data structure.

5.2.1 Global

Here we will mainly evaluate the performance of the `FLUINR`, `TRFICF` and `FLUBAL` subroutines. Two cases will be considered, namely the case where the scattering modified collision probability matrix is used and that where the standard CP matrix is considered. Assuming that the external sources are denoted by F_i^g, then the source total source term computed in the `FLUINR` subroutine should be given by:

$$Q_{m,i,k}^{g} = F_i^g + \sum_{h=1,h\neq g}^{G} \Sigma_{s,i}^{h\to g} \tilde{\phi}_{i,k-1}^{h}$$

Table 9: Errors on the source and fluxes

Model	Iteration	Group	Scattering Modified CP			Standard CP		
	k	g	ϵ_s	ϵ_1	ϵ_2	ϵ_s	ϵ_1	ϵ_2
	1	1	1.0634	1.9772	3.8882	1.2227	1.8209	3.8308
T2D	1	2	1.5408	1.6926	1.7661	0.9405	1.9796	3.4300
	2	1	1.3069	2.9109	3.3660	1.2545	2.6740	3.8613
	2	2	0.9555	1.7644	2.2121	1.1288	2.8659	0.6017
	1	1	1.0636	2.4653	19.0556	1.3045	2.5521	19.6887
T3D	1	2	1.6990	2.1748	2.8039	1.1978	2.4511	2.8578
	2	1	1.0934	2.9636	18.1880	1.1608	2.8644	19.4770
	2	2	1.3440	2.1592	5.7258	1.1831	3.4981	3.9370

where $\tilde{\phi}^h_{i,k-1}$ is the rebalanced flux from the last thermal iteration. Here $Q^g_{m,i,k}$ denotes the sources for thermal iteration k in region i for group g in the case where the within group scattering contribution is automatically taken into account in the CP matrix (scattering modified CP). In the case where the direct CP matrix is used the total source will be given by:

$$Q^g_{d,i,k} = Q^g_{m,i,k} + \Sigma^{g\to g}_{s,i}\tilde{\phi}^h_{i,k-1}$$

The `TRFICF` subroutine is just used to multiply the sources and the collision probability matrix (see Section 5.1.3), namely:

$$\phi^g_{i,k} = \sum_{j=1}^{N} P^g_{ij} Q^g_{j,k}$$

where $Q^g_{j,k}$ can represent the direct $Q^g_{d,i,k}$ or scattering modified $Q^g_{m,i,k}$ source depending on the technique used. The rebalancing process, which is performed by the routine `FLUBAL`, is used to accelerate the thermal iteration. The rebalancing equation is:

$$\tilde{\phi}^g_{i,k} = \alpha^g \phi^g_{i,k}$$

where α^g satisfies:

$$\sum_{h=1}^{G}\left(\sum_{i=1}^{N} V_i(\delta_{gh}\Sigma^h_{s,i} - \Sigma^{h\to g}_{s,i})\phi^h_{i,k}\right)\alpha^g = \sum_{i=1}^{N} V_i F^g_i$$

When the editing level used in the `FLU:` module is sufficiently large, DRAGON produces on the output file the results for $Q^g_{i,k}$ and $\phi^g_{i,k}$ at each thermal iteration k. Similarly the external sources F^g_i and the initial flux approximation $\phi^g_{i,0}$ are also provided. We can therefore verify numerically if the sources and fluxes computed within DRAGON are compatible with those obtained using the above relations. Here we wrote a Matlab program that performed such a comparison. The regional cross sections were taken explicitly from the file `MAC2G` while the CP matrices were taken from the files `PIJMACSTD` (for standard CP matrix) and `PIJMACSMD` (for scattering modified CP matrix) which were generated by the `ASM:` module. The norm of the errors on the source, the direct

Table 10: Errors on the diffusion coefficients, eigenvalues and fluxes for global comparison

Properties	T2D	T3D
$\epsilon_{S,k_{\mathit{eff}}}$	-0.35	-0.13
ϵ_{S,ϕ^1}	20.5	17.7
ϵ_{S,ϕ^2}	9.2	6.4
ϵ_{K,D^1}	0.0	0.0
ϵ_{K,D^1}	0.0	0.0
$\epsilon_{K,B}$	-0.10	-0.14
$\epsilon_{K,k_{\mathit{eff}}}$	0.01	0.01
ϵ_{K,ϕ^1}	0.06	0.03
ϵ_{K,ϕ^2}	0.04	0.22
ϵ_{I,D^1}	0.0	0.0
ϵ_{I,D^1}	0.0	0.0
$\epsilon_{I,B}$	0.0	0.0
$\epsilon_{I,k_{\mathit{eff}}}$	0.17	-0.17
ϵ_{I,ϕ^1}	0.02	0.001
ϵ_{I,ϕ^2}	1.32	1.60

and the rebalanced flux for the first 2 thermal iterations are presented in Table 9 where we have used

$$\epsilon_s(k,g) = 10^7 \times \frac{||Q^g_{i,k} - Q^{g,D}_{i,k}||}{||Q^g_{i,k}||}$$
$$\epsilon_1(k,g) = 10^7 \times \frac{||\phi^g_{i,k} - \phi^{g,D}_{i,k}||}{||\phi^g_{i,k}||}$$
$$\epsilon_2(k,g) = 10^7 \times \frac{||\tilde{\phi}^g_{i,k} - \tilde{\phi}^{g,D}_{i,k}||}{||\tilde{\phi}^g_{i,k}||}$$

Here the index D denotes a result available on the DRAGON output file. Note that the relative errors are all lower than 2.0×10^{-6} which is consistent with the single precision nature of the calculations performed in DRAGON.

5.2.2 Self-Consistency Analysis

Two types of global comparison were performed to verify that the **FLU:** module is self consistent. The first case consists in k_{eff} eigenvalue problem where one uses respectively the scattering modified and the standard CP matrices. Using the information available in the FLXUNK data structure we have computed the following differences:

$$\epsilon_{S,k_{\mathit{eff}}} = 1.0 \times 10^5 \left(\frac{k^S_{\mathit{eff}} - k^D_{\mathit{eff}}}{k^S_{\mathit{eff}}} \right)$$
$$\epsilon_{S,\phi^g} = 1.0 \times 10^5 \left(\frac{||\phi^g_S - \phi^g_D||}{||\phi^g_S||} \right)$$

where the index S refers to the results obtained using the scattering modified CP and the index D to the result obtained using the standard CP matrices. As one can see in Table 10, the two solutions are identical within the convergence criterion required for the fluxes and the eigenvalue.

The second case refers to flux calculations with leakage. Here the reference calculation (index B) is for an homogeneous B_1 buckling search. We then performed two successive k_{eff} calculations, the first one (K) for the case where an homogeneous B_1 buckling identical to that computed for the reference calculation is imposed manually while for the second problem (denoted by the index I) the homogeneous dB_1^2 leakage term is taken directly from the results of the reference calculation. The following differences were then computed:

$$\epsilon_{T,D^g} = 1.0 \times 10^5 \left(\frac{D_B^g - D_T^g}{D_B^g} \right)$$

$$\epsilon_{T,B} = 1.0 \times 10^5 \left(\frac{B_B - B_T}{B_B} \right)$$

$$\epsilon_{T,k_{\mathit{eff}}} = 1.0 \times 10^5 \left(\frac{k_{\mathit{eff}}^B - k_{\mathit{eff}}^T}{k_{\mathit{eff}}^B} \right)$$

$$\epsilon_{T,\phi^g} = 1.0 \times 10^5 \left(\frac{||\phi_B^g - \phi_T^g||}{||\phi_B^g||} \right)$$

where $T = K$ or I. As one can see from the errors presented in Table 10 the results we obtained using these three different methods are again identical within the convergence criterion used for the fluxes and the eigenvalue.

Since the problems we have considered here are very general in nature, one can expect that **`FLU:`** will behave in the same fashion for other geometries and cross sections sets.

6 VERIFICATION OF THE EDI: MODULE

This module is used to edit the homogenized and condensed reaction rates and cross sections. The main observations here is that a large number of these routines, namely EDIMIC, EDITXS, EDITIS, EDIISO are related to microscopic cross sections condensation and homogenization. Since the information that will be transferred from WIMS–AECL to DRAGON involves only macroscopic cross sections, these subroutine are of no interest in the current verification process. A second observation is that we will only consider a direct flux/volume homogenization. In that case the SPH factors are all be imposed to 1.0 and the SPHDRV subroutine is never called. Here the EDIHFC subroutine is used to compute the H-factors. Unless the information provided on the MACROLIB that will be generated from WIMS–AECL contains the required information these H-factors will not be produced. Moreover, a more convenient method to generate the same information as that stored in the H-factors is to use an additional macroscopic cross section $\kappa\Sigma_f$ (κ is the energy produced by fission) which can be condensed and homogenized like any other vector cross sections. Accordingly, the EDIHFC subroutine will not be used in typical DRAGON executions at AECL. Finally, the EDILBD subroutine can only be used if a B_1 current consistent homogenization of the linearly anisotropic scattering cross section is required. In AECL application, this will not be the case and the subroutine EDILBD will never be called.

The overall verification process has been divided into three parts.

1. A line by line verification for the following routines:
   - EDIGET and EDIENE that are used respectively to read the `EDI:` processing options and to select the condensation group limit associated with a specific energy;
   - EDIRAT that is used to evaluate the reaction rates associated with various type of vector reactions;
   - EDISCT that is used to evaluate the scattering rates.
2. A global numerical verification for the following routines:
   - EDIDTX and EDIPRR and EDIPXS that are used to compute the reaction rates to print them and to print the associated macroscopic homogenized and condensed cross section;
   - EDIDTS, EDISTA and EDIDEL that are used to compare reaction rates and to evaluate incremental cross sections.
3. A self-verification process:
   - for EDIDTX using EDIDTS by comparing the homogenized and condensed cross sections generated by DRAGON with reference values generated manually.

6.1 Line by Line Verification

6.1.1 Subroutine EDIENE

The listing of the subroutine `EDIENE.f` is provided in Appendix A.5.1. This subroutine is used to analyze the energy condensation specifications provided on the input stream (`COND`). In the case where the energy structure of the MACROLIB is known, it also generates the condensed energy limits and lethargy width.

Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-26 Comments

L:27-40 Definition of parameters used in the subroutine.

L:41-80 For the case where an energy condensation is requested in the input stream (`COND` is present) verify if this condensation is compatible with the information available on the MACROLIB.

L:46-68 If the condensation is specified using energy limit E_L, one first verify if the energy group limits are available on the MACROLIB. The program aborts if this is not the case (L:48-49), otherwise, the program tries to identify the upper group number g such that:

$$E^g \geq E_L \geq E^{g+1}$$

Note that if $E_L \leq E^{G+1}$ then $g = G$. Similarly, if two energy limits are located inside the same group, there are replaced by a single condensation group.

L:69-80 If the condensation is specified using group number, one verifies if these group numbers are monotonically increasing.

L:81-98 In the case where the energy structure of the MACROLIB is known, find the energy structure and compute the group lethargy width of the MACROLIB that will be generated using the condensation specifications.

L:99 Return control to the calling program.

L:100 End of subroutine

6.1.2 Subroutine EDIGET

The listing of the subroutine `EDIGET.f` is provided in Appendix A.5.2. This subroutine is used to read the input stream to acquire the editing options. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-7 Main entry point to the subroutine.

L:8-91 Comments

L:92-118 Definition of parameters used in the subroutine.

L:119-127 Initialize the vector for homogenization. By default, are regions are treated independently and the MACROLIB data base that will be generated will be such that a mixture will be associated with each region.

L:128 Control instruction for infinite do-loop associated with the extraction of the DRAGON keywords from the input stream. Transfer to this instruction is required if no keyword is present in the variable `CARLIR`.

L:129 Read next record on the input stream and return the type of record read as well as the information read.

L:130 Alternate control instruction for infinite do-loop associated with the extraction of the DRAGON keywords from the input stream. Transfer to this instruction is required if a keyword is present in the variable `CARLIR`.

L:131-133 Validate the type of information extracted during the last call to `REDGET`. In the case where `INTLIR=10`, the input stream is empty and the control of the program is transferred to instruction 250 (L:584). In the case where `INTLIR`$\neq$3, the input stream does not contain a keyword and the program aborts.

L:134-135 If keyword `;` is found the processing of the input stream is complete, transfer control to instruction 250 (L:584)

L:136-141 The `EDIT` keyword is to be processed. Read the integer print level `IPRINT` from the input stream.

L:142-143 The `UPS` keyword is to be processed. Initialize the integer variable `ILUPS=1`.

L:144-159 The `P1SCAT` keyword is to be processed. This is to specify the weighting used for the P_1 scattering matrix. By default, a current weighting is used when homogenized currents are available, a coherent weighting is used when directional currents are available and a flux weighting is used otherwise. Here, one can specify a specific weighting for the P_1 scattering matrix different from the default value.

L:160-183 The `MICR` keyword is to be processed. This keyword is required when microscopic cross sections properties associated with different isotopes are to be produced on the EDITION data structure or on binary files in the `ISOTXS` format (L:162-165). The cross sections for a given isotope will be generated only if the mixture containing this isotope is present in the homogenization regions specified by `MERG` or `TAKE`. One can select each isotope independently (L:171-179), all the isotopes (L:166-167) or no isotopes (L:168-169).

L:184-207 The `FLIB` keyword is to be processed. This keyword is required when a MICROLIB is to be generated on the EDITION data structure or on binary files in the `ISOTXS` format (L:186-189). Note that this keyword is similar to `MICR` with the following exceptions: in addition to the microscopic cross section, the decay chain will also be saved if available. The cross sections for a given isotope will be generated only if the mixture containing this isotope is present in the homogenization regions specified by `MERG` or `TAKE`. Again, one can select each isotope independently (L:195-203), all the isotopes (L:190-1191) or no isotopes (L:192-193).

L:208-232 The `ACTI` keyword is to be processed. This keyword is required when the microscopic cross sections associated with isotopes not present in any mixture a located in the homogenization regions specified by `MERG` or `TAKE` are to be generated. Here the isotopes are selected by mixture (L:217-231), namely, the cross sections associated with all the isotopes defined for a specific mixture will be condensed and homogenized and properties will be generated for each homogenization region. For multi-region condensation, one assume that the isotope is present in each region with a constant concentration of 1 isotope per cubic centimeter.

L:233-298 The `SPH` keyword is to be processed. This keyword is used to activate the SPH homogenization procedure. An infinite do-loop, controlled by instruction 103 (L:239) can be used the read successively from the input stream the following set of options

- `SELE` for Selengut normalization (L:243-246).
- `ALSB` in the case where the cell albedo are to be taken into account in the cell homogenization procedure (L:247-250).
- `MGEO` to specify the geometry used for the homogenization (L:251-257)

The presence of the remaining keywords will terminate the execution of the infinite do-loop controlled by instruction 103 (L:239):

- `OFF` to disconnect the use of the SPH homogenization procedure (L:258-262).
- `SPRD` to use SPH factors already stored on the EDITION data structure (L:263-266).
- `HOME` to specify that the SPH factors will be derived from an homogeneous macro calculation (L:267-270).
- `:::` to specify that the type of calculation that will be used for the evaluation of the SPH factors (L:272-295). Note that in this case control will be returned (L: 295) to instruction 250 (L:584). As a result the, the remaining information on the input stream is assumed to belong to the specific tracking module specified following the keyword `:::` (namely `JPMT`, `SYBILT`, `EXCELT` or `BIVACT`).

L:299-342 The `COND` keyword is to be processed. In this case three options can be considered:

- If the keyword `NONE` follows `COND` (L:307-313), no condensation is considered, the next keyword is read and the control is returned to instruction 103 (L:130). The condensation vector is initialized in such a way that to each MACROLIB group is associated a condensed group.
- One assume that each integer variables following `COND` (L:320-330) identifies the upper group number associated with a specific condensed group. These upper group number must be increasing in value. If this is not the case the standard action is to identify the next value for the upper group limit to the previous value plus 1. This loop is terminated in the case where a keyword is encountered or if the maximum number of condensed group limits is larger that available on the MACROLIB data structure.
- One assume that each real variables following `COND` (L:331-341) identifies the lower energy limit associated with a specific condensed group. These energies must be decreasing in value. If this is not the case the standard action is to identify the next value for lower energy limit to the previous value. This loop is terminated in the case where a keyword is encountered or if the maximum number of condensed group limits is larger that available on the MACROLIB data structure.

L:343-432 The `MERG` keyword is to be processed. In this case four options are available:

- If the keyword `COMP` follows `MERG` (L:353-351) a full cell homogenization is to be considered.
- If the keyword `MIX` follows `MERG` (L:353-351) then an homogenization per mixture is assumed. In this case, one either specify for each mixture the condensation region to which it will be associated (L:373-394) or if the no mixture number is specified (initialization of the `IMERGE` on L:366-371) that each mixture will be associated with a condensation region.
- If the keyword `REGI` follows `MERG` (L:414-419) then an homogenization per region is assumed. In this case, one must specify for each region the condensation region to which it will be associated.
- If the keyword `NONE` follows `MERG` (L:420-420) then no homogenization will take place.

L:433-489 The `TAKE` keyword is to be processed. In this case two options are available:

- If the keyword `MIX` follows `TAKE` (L:440-467) then an homogenization per mixture is assumed. In this case, one must specify which mixture will be associated with each condensation region.
- If the keyword `REGI` follows `TAKE` (L:414-419) then an homogenization per region is assumed. In this case, one must specify which original region will be associated with each condensation region. In fact in this case no condensation will take place since there is a one to one correspondence between the original and condensed regions. This option is mainly used to reduce the number for which information will be sent to the output file (namely to select regions of interest).

L:490-511 The `SAVE` keyword is to be processed. This keyword is used to identify the directory on the `edition` data structure where condensed and homogenized cross sections (in the form of MACROLIB and MICROLIB) will be stored. If the keyword `ON` follows `SAVE`, a user define directory name can be used otherwise the default directory name will be used.

L:512-533 The `PERT` keyword is to be processed. This keyword is used to specify that time dependent perturbation cross section will be saved on the `edition` data structure. If the keyword `REFE` follows `PERT`, the reference cross section must be taken from the directory name provided by the user, otherwise the default reference directory name will be used.

L:534-568 The `STAT` keyword is to be processed. This keyword is used to control the type of information transfer to the output file when comparing the current DRAGON calculations with the information already store in a `edition` data structure from a previous call to the `EDI:` module (L:556-568).

L:569-572 The NBAL keyword is to be processed. The neutron balance is to be provided in the output stream. This is indicated by initializing IFFAC=1000. In this case the next record is also read from the input stream before transferring control to instruction 101 (L:130).

L:573-576 The MAXR keyword is to be processed. Read from the input stream the maximum number of final regions MAXPTS.

L:577-578 The keyword is invalid, abort.

L:594 Return control to the calling program.

L:595-602 Formats for printing

L:603 End of subroutine

6.1.3 Subroutine EDIRAT

The listing of the subroutine EDIRAT.f is provided in Appendix A.5.3. This subroutine is used to compute the contribution from all the homogenization regions to various "reaction rates". Here the term reaction rates includes: integrated flux, and explicit reaction rates. Similarly the so-called cross section vector can represent cross sections, reaction rates or volume, depending on its use. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-3 Main entry point to the subroutine.

L:4-32 Comments

L:33-47 Definition of parameters used in the subroutine.

L:48-58 Add a new contribution to the current integrated flux for each homogenization regions:

$$\tilde{\Phi}_I = \Phi_I + \sum_{i \in I} \Phi_i$$

where $\Phi_i = V_i \phi_i$ is the region integrated flux.

L:59-68 Add a new contribution to the current reaction rates for each homogenization regions:

$$\tilde{R}_{X,I} = R_{X,I} + \sum_{i \in I} \Phi_i \Sigma_{X,i}$$

where $\Sigma_{X,i}$ is the macroscopic cross section of type X in region i.

L:69-78 Remove a new contribution from the current reaction rates for each homogenization regions:

$$\tilde{R}_{X,I} = R_{X,I} - \sum_{i \in I} \Phi_i \Sigma_{X,i}$$

L:79-87 Add a new contribution to the current cross section for each homogenization regions (the cross sections vector in this case represents a reaction rate):

$$\tilde{\Sigma}_{X,I} = \Sigma_{X,I} + \sum_{i \in I} \Sigma_{X,i}$$

L:89 Return control to the calling program.

L:90 End of subroutine

6.1.4 Subroutine EDISCT

The listing of the subroutine `EDISCT.f` is provided in Appendix A.5.4. This subroutine is used to evaluated homogenized and condensed scattering rates. Here follows a description of the subroutine that was generated while performing the line by line verification.

L:1 Deck identification Card.

L:2-6 Main entry point to the subroutine.

L:7-79 Comments. Here the parameters `NWGTH` and `ILEAKS` should be defined.

L:80-99 Definition of parameters used in the subroutine.

L:101-129 In the case where a coherent or directional P_1 current weighting is required, compute the group dependent weighting factor Λ^g using:[15]

$$\Lambda^g = 3\left(\frac{\Sigma_H^g}{B^2}\right)^2\left(\frac{\frac{B^2}{\Sigma_H^g} - \arctan(\frac{B^2}{\Sigma_H^g})}{\arctan(\frac{B^2}{\Sigma_H^g})}\right)$$

L:130-289 Compute condensed and homogenized scattering reaction rates

L:154-248 Compute linearly anisotropic scattering reaction rates. The relations we will use for direction k, homogenization region I and condensed groups $G \to H$ is:[15]

$$R_{s1,I,k}^{G\to H} = \sum_{g\in G}\sum_{h\in H}\sum_{i\in I} B_k^2 \frac{1}{V_I J_{Ik}^g} V_i \left(\Sigma_{s1,i}^{g\to h} + \delta^{gh}(\Sigma_H^g - \Sigma_{s0,i}^g)\right) J_{ik}^g \mu_I^g$$

L:249-275 Compute isotropic scattering reaction rates using:

$$R_{s0,I}^{G\to H} = \sum_{g\in G}\sum_{h\in H}\sum_{i\in I} V_i \phi_i^g \Sigma_{s0,i}^{g\to h}$$

L:281 Return control to the calling program.

L:282 End of subroutine

6.2 Numerical Verification

In this section, two types of verification will be again be considered. First, we will verify explicitly the homogenization and condensation process performed by the `EDI:` module of DRAGON. Then, we will verify if the macroscopic cross section information transferred to the EDITION data structure is in a MACROLIB format by re-executing a transport calculation using the information stored on the EDITION generated in the first step of the validation. For simplicity we will again consider the 2–D and 3–D problems described in Appendix B.19 and Appendix B.20. The two groups cross section we have used in these calculations are presented in Appendix B.21 in the form of a MACROLIB data structure.

Table 11: Full homogenization with no condensation

	T2D	T3D
$\delta\Sigma^1$	0.1548	0.0401
$\delta\Sigma^2$	-0.2142	-0.2713
$\delta\nu\Sigma_f^1$	0.4466	0.1501
$\delta\nu\Sigma_f^2$	-0.4537	-0.1957
$\delta\chi^1$	0.0	0.0
$\delta\chi^2$	0.0	0.0
$\delta\Sigma_s^{2\to 1}$	-0.5027	-0.2232
$\delta\Sigma_s^{1\to 1}$	0.0780	0.0311
$\delta\Sigma_s^{2\to 2}$	-0.0145	-0.6877
$\delta\Sigma_s^{1\to 2}$	-0.2514	0.1251

Table 12: Full condensation with no homogenization

	T2D		T3D	
	error	region	error	region
$\delta\Sigma$	-0.4180	13	-0.5698	8
$\delta\Sigma_s$	-0.5145	3	-0.4730	7

Table 13: Full condensation and homogenization

	T2D	T3D
$\delta\Sigma$	-0.1759	-0.1446
$\delta\Sigma_s$	-0.4616	-0.0075

6.2.1 Global

Here three condensation and homogenization options have been considered. We first studied the case where a full cell homogenization takes place without energy condensation (saved on directory `MAC4` in the EDITION data structure). Then we considered successively the case with no homogenization and condensation to a one group structure (`MAC5`) and the combined case where one group average cell cross sections are generated (`MAC8`).

The results we obtained after comparing the information stored on the EDITION data structure `EDIRES` with an explicit homogenization in a Matlab procedure a direct flux/volume homogenization procedure are presented in Table 11, Table 12 and Table 13 respectively. Note that here δG where G is a specific property is computed using:

$$\delta G = 10^7 \left(\frac{G^E - G^M}{G^E} \right)$$

where G^E is the value available on `EDIRES` while G^M is that computed using Matlab. Also note that in Table 12 the maximum difference and the region number where this difference arises are presented. As one can see, the homogenization and condensation process in the module `EDI:` is entirely coherent with the results generated using out Matlab procedure where the fluxes, volume and cross sections were extracted respectively from the files `VOLTRK`, `FLUXB1` and `MAC2G` used by the `EDI:` module.

6.2.2 Self-Consistency Analysis

Here the self-consistency analysis is based on the fact that directory `MAC1`, `MAC2` and `MAC3` produced on the `EDIRES` data structure should each include a MACROLIB which contains information identical to that appearing in the `MAC2G` file. In fact, the directory `MAC1` generated by `T2DE.did` (`T3DE.did`) contains a table of 2 groups cross section for 13 (15) independent mixtures, each mixture being associated with a specific region in the original geometry defined in `T2DT.did` (`T3DT.did`). For `MAC2` and `MAC3`, the 2 groups cross sections generated for mixtures 1, 2 and 3 should be identical to those of mixtures 1, 5 and 11 of `MAC2G` since the homogenization per region or by mixtures specified in the files `T2DE.did` and `T3DE.did` should be equivalent in this case. Accordingly, performing a new flux calculation using these MACROLIB with a similar geometry (except for the mixture identification) should yield results similar to those obtained using `T2DF.did` and `T3DF.did`. By examining the output file generated after running `T2DG.did` and `T3DG.did`, one immediately realizes that this observation is indeed true.

In addition, after a full cell homogenization and one group condensation of the cell properties obtained after calculations involving `MAC1`, `MAC2` and `MAC3` respectively we should obtain results identical to those stored in `MAC8` of `EDIRES`. This can be confirmed by examining the output files associated with `T2DG.did` and `T3DG.did` where the editing module provides statistics resulting from a comparison of various calculation options with the contents of `MAC8`. As one can observe after running these test cases using DRAGON, the differences vanish identically for all the cases.

Again the problems we have considered being very general in nature, one can expect that `EDI:` will behave in the same fashion for other geometries and cross sections sets.

7 CONCLUSION

The verification procedure that we used has not been able to identify any major problems in the code DRAGON. In fact the main observations that can be drawn from this exercise are:

1. Line by line verification:
   - Most of the errors we observed appeared in the comments describing the parameters of the routines.
   - In a few instances, useless instructions were found in some sub-routines. However, these instructions had no effect on the overall behavior of the code.
2. Verification of the data structures:
   - In general the contents of each data structure is compatible with the information provided in report IGN-232.[?]
   - However, the description of the TRACKING data structure is not complete. In fact, the contents of the `EXCELL` directory cannot be found. Moreover an additional subroutine should be included in the `EXCELT:` module to compress the information stored in this directory by removing useless information from the vectors `VOLSUR`, `INDEX`, etc.
3. Global verification process:
   - This part of the verification process was completed with success, even if it was not always automated.
   - The main problem in this case is to determine the expected precision of the calculations since some evaluation in DRAGON are performed using single precision arithmetics while other were performed in double precision.
4. Self-verification process:
   - For the tests we performed that rely on the DRAGON self-verification process, we generally obtained results that confirm that the code was performing as expected.

Overall, the verification process we used tends to confirm that DRAGON performs as expected for the modules we tested. However, there could still be some errors in the code that our verification plan failed to identify. In the next few years, we intend to extend this verification to other modules of DRAGON.

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Figures

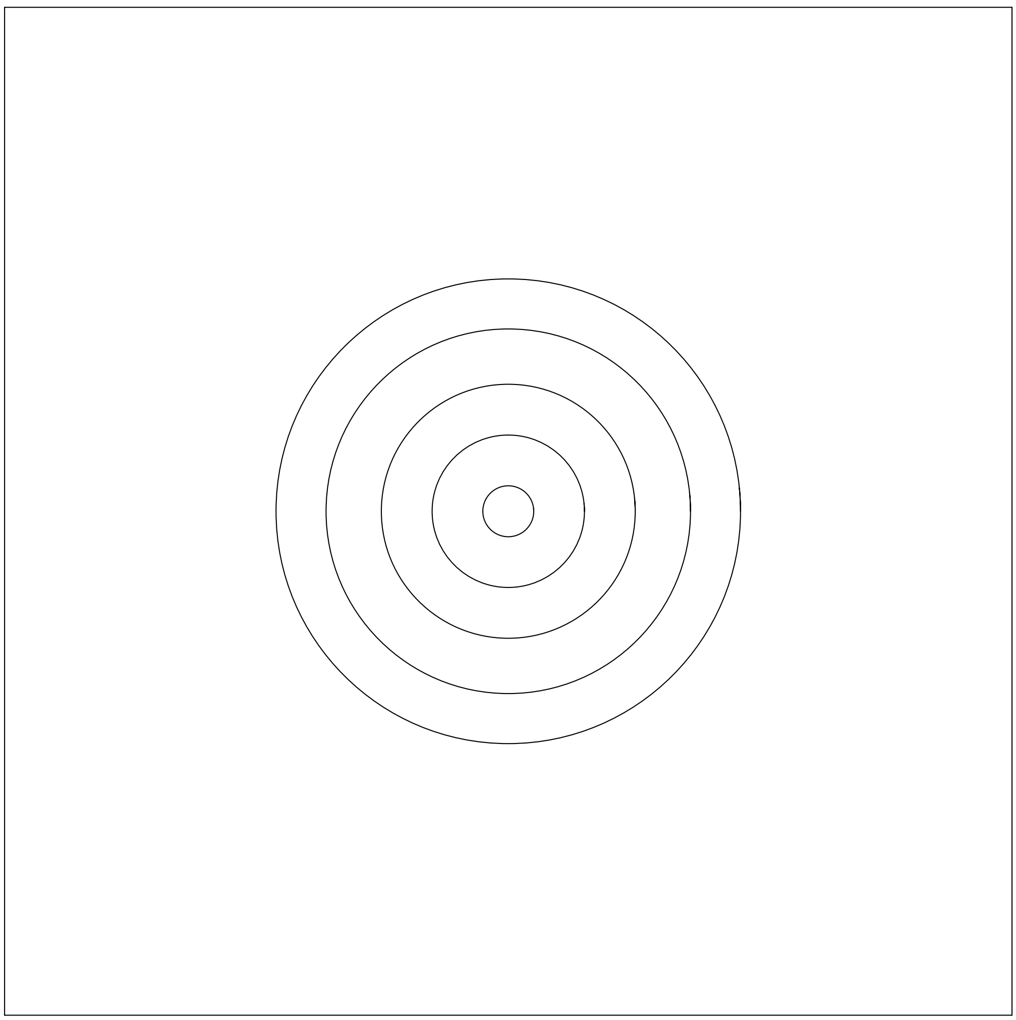

Figure 1: Model 1 for 2–D Gentilly-2 Cell

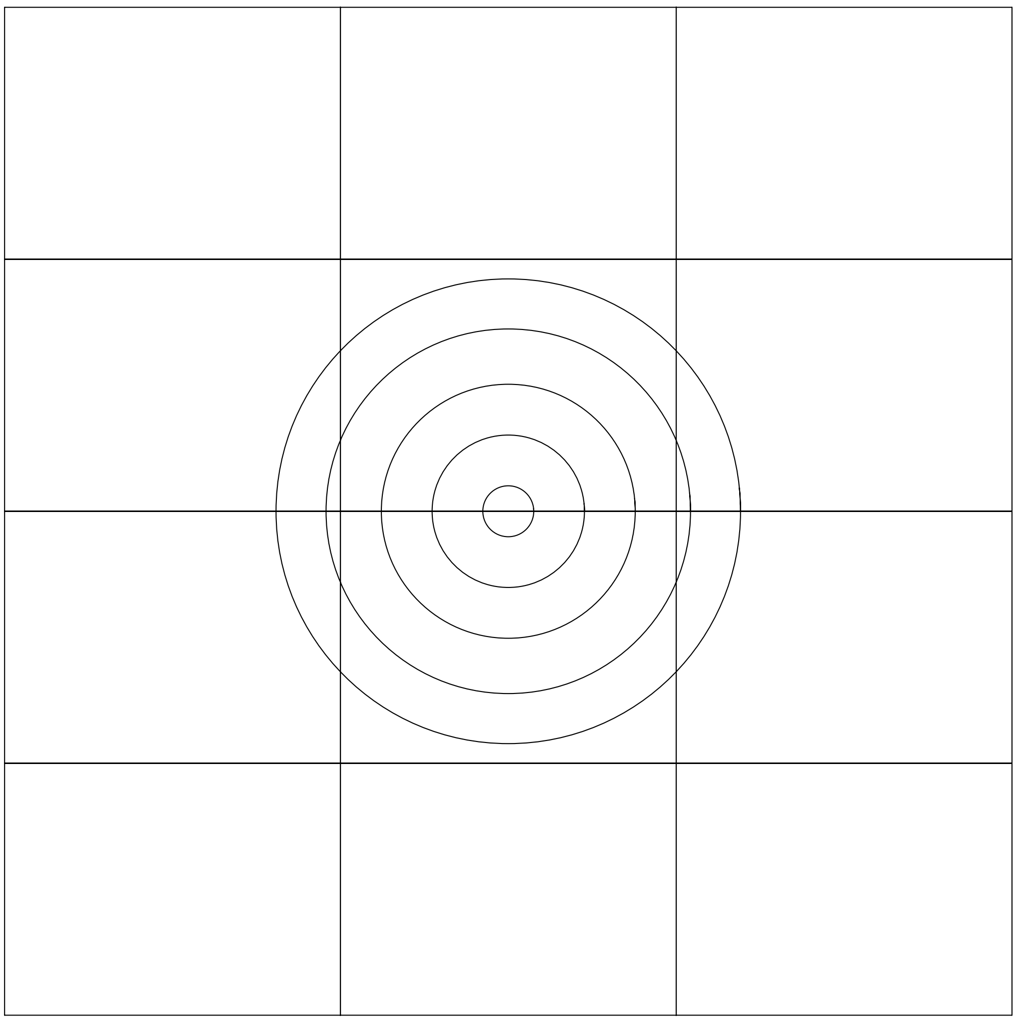

Figure 2: Model 2 for 2–D Gentilly-2 Cell

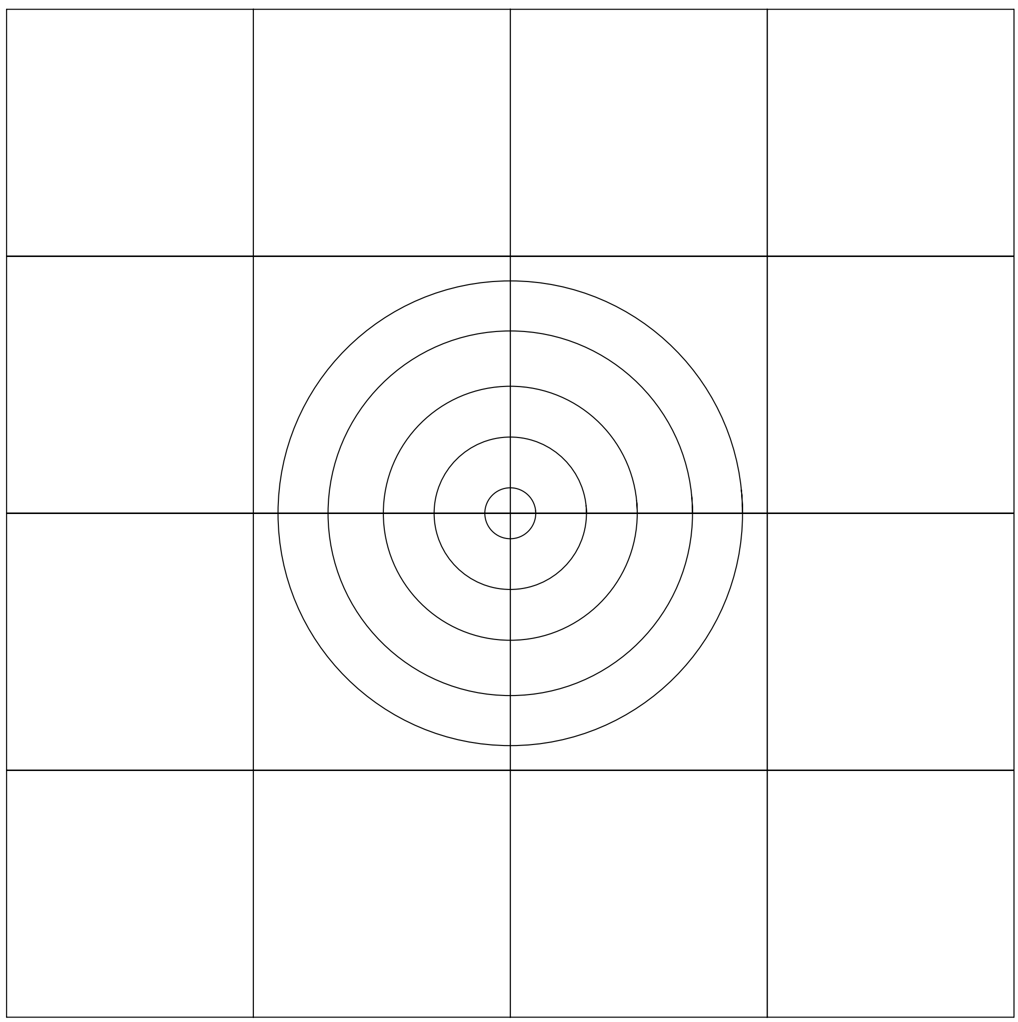

Figure 3: Model 3 for 2–D Gentilly-2 Cell

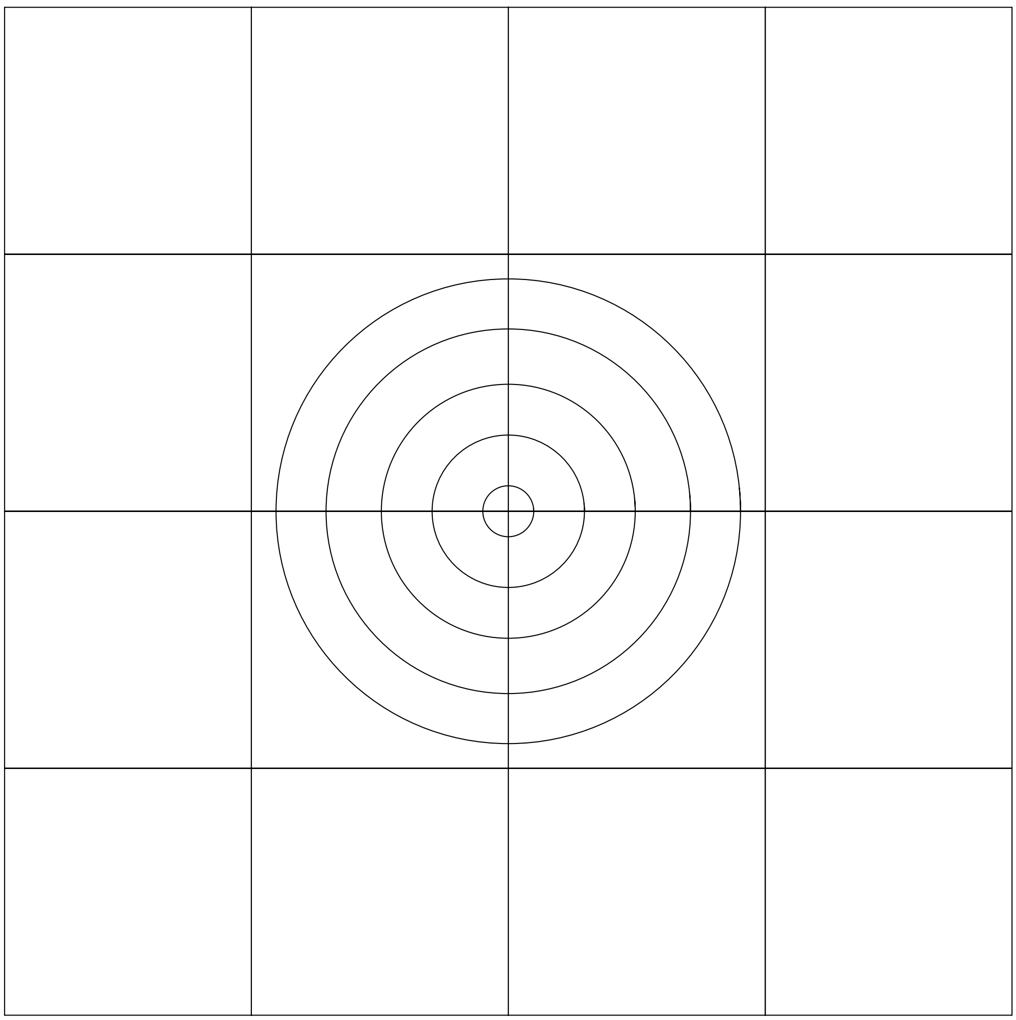

Figure 4: Model 4 for 2–D Gentilly-2 Cell

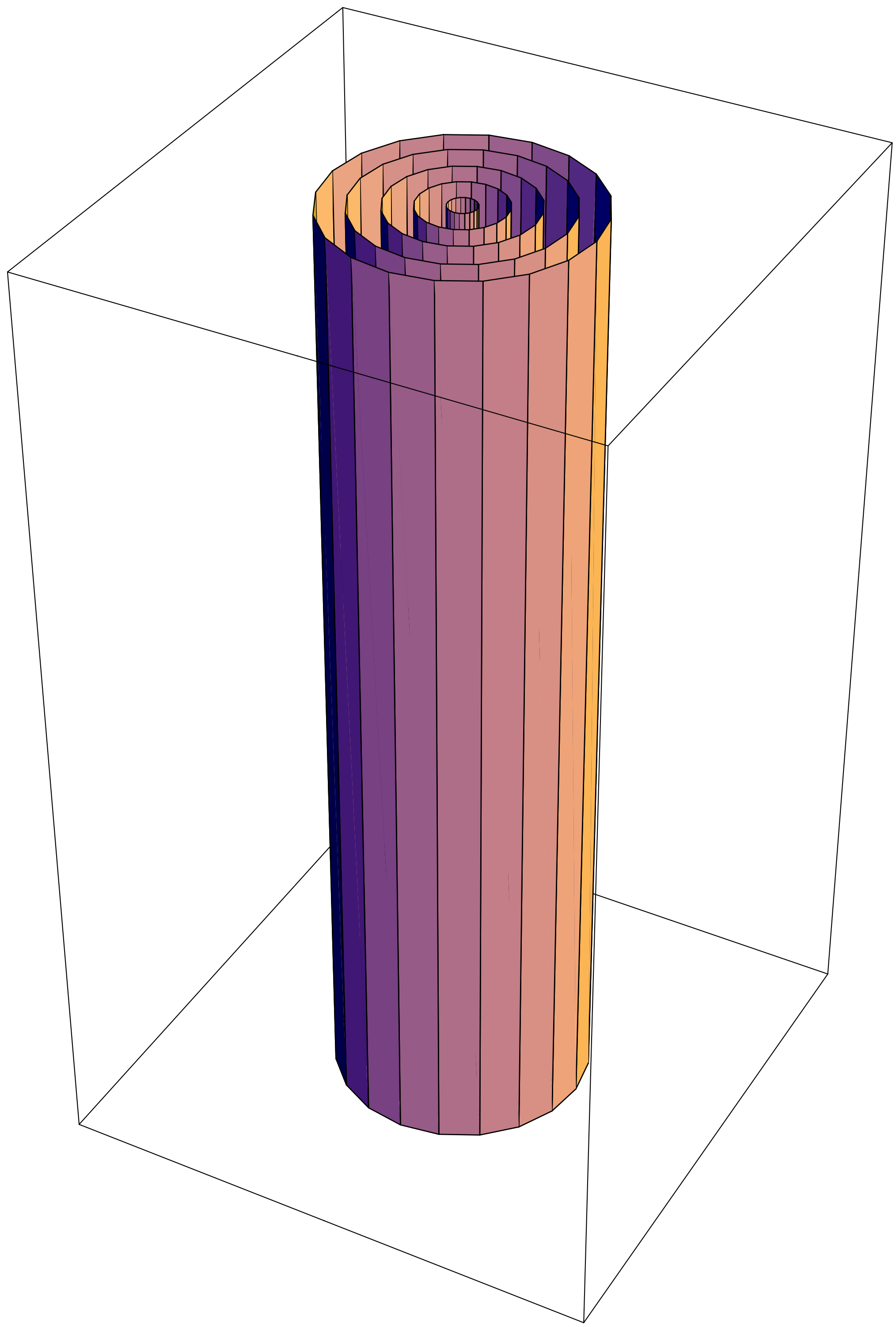

Figure 5: Model 1 for 3–D Gentilly-2 Cell

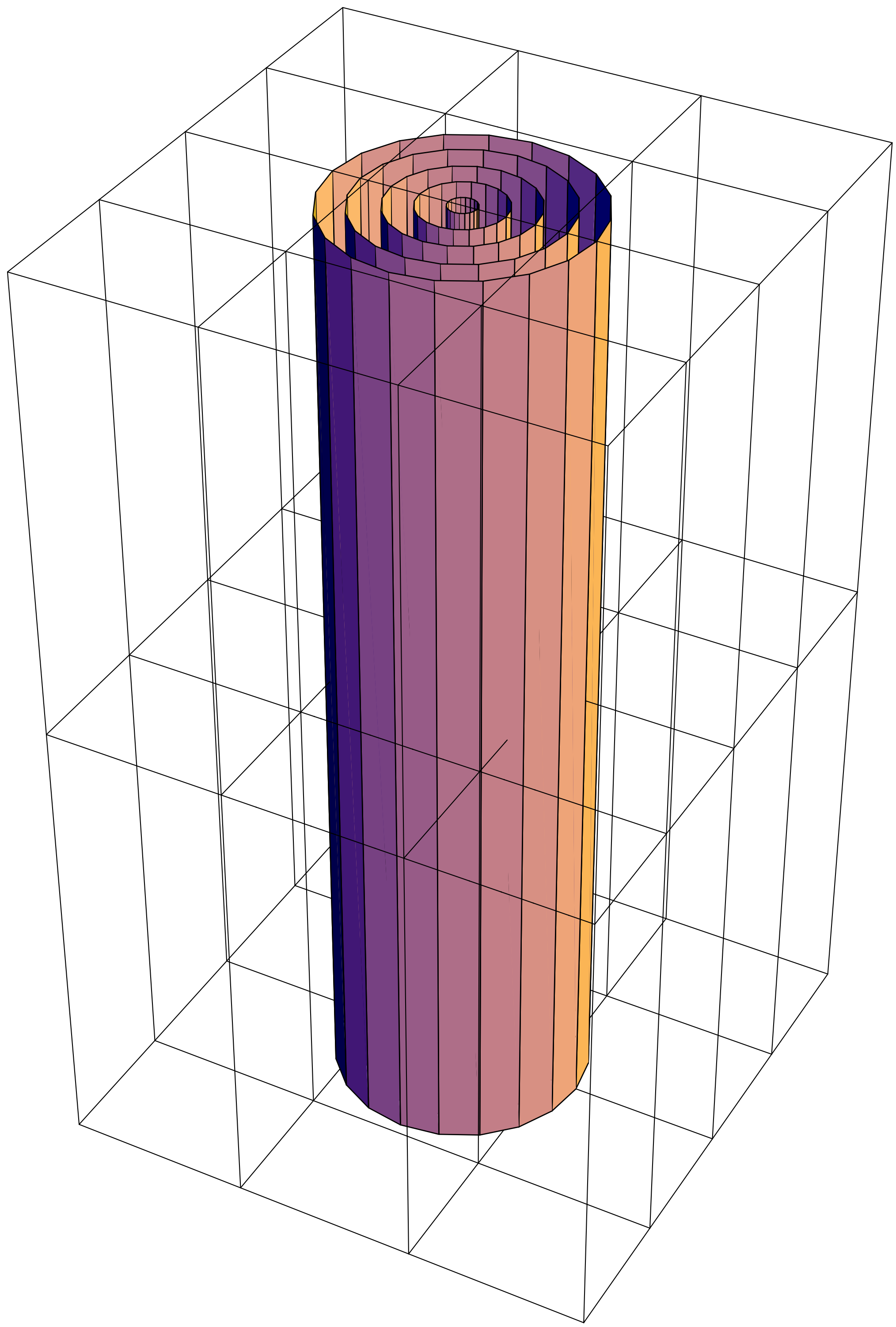

Figure 6: Model 2 for 3–D Gentilly-2 Cell

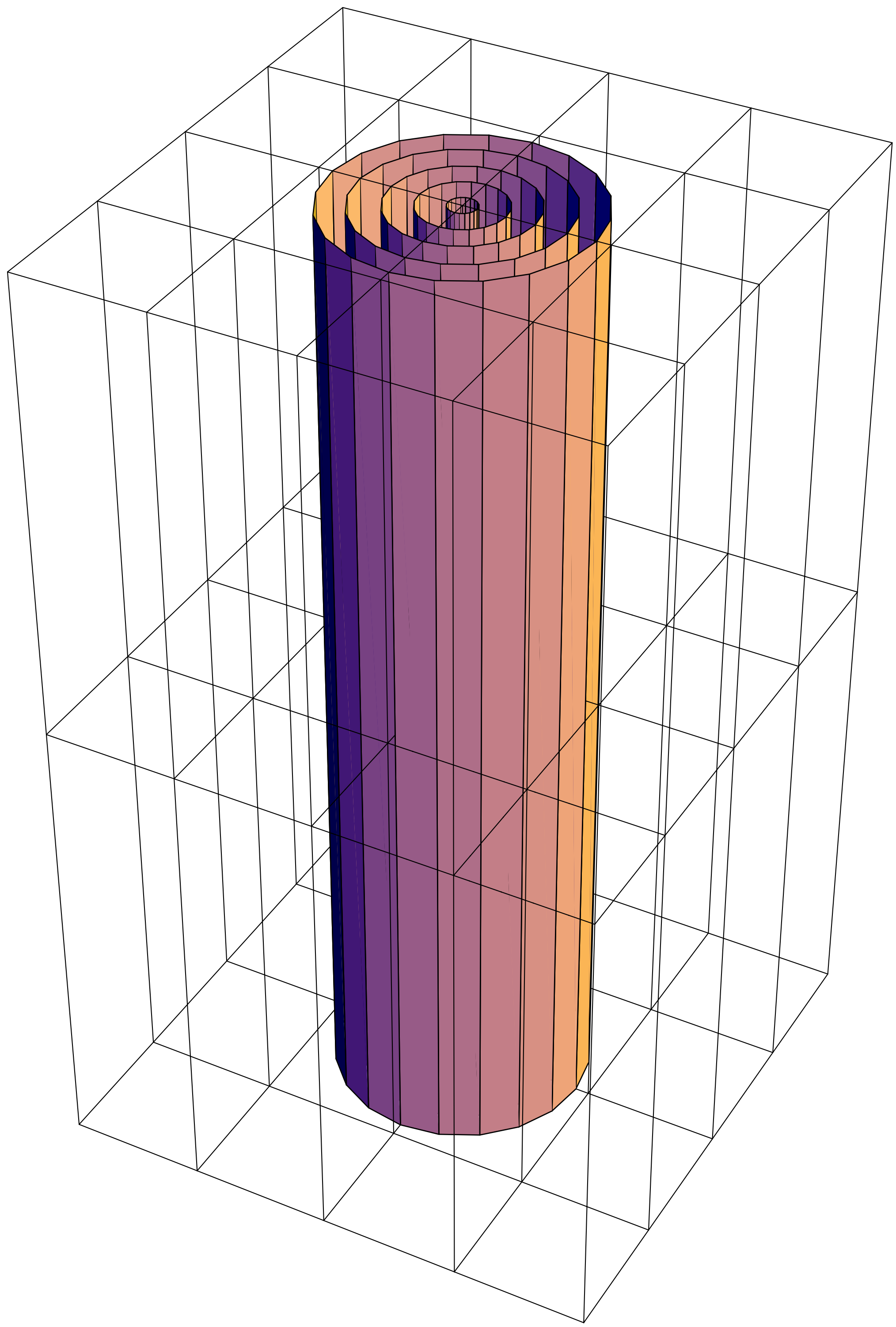

Figure 7: Model 3 for 3–D Gentilly-2 Cell

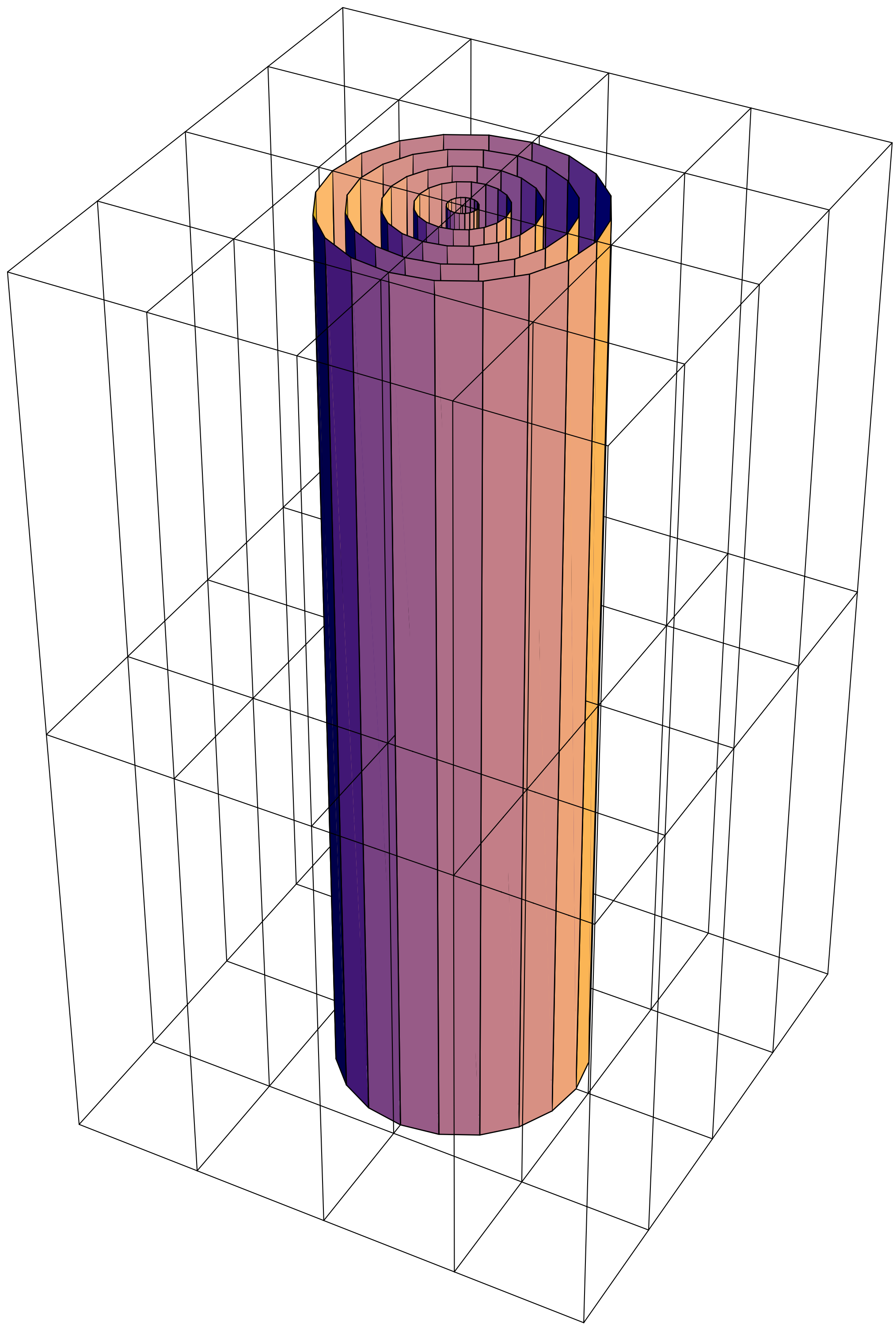

Figure 8: Model 4 for 3–D Gentilly-2 Cell

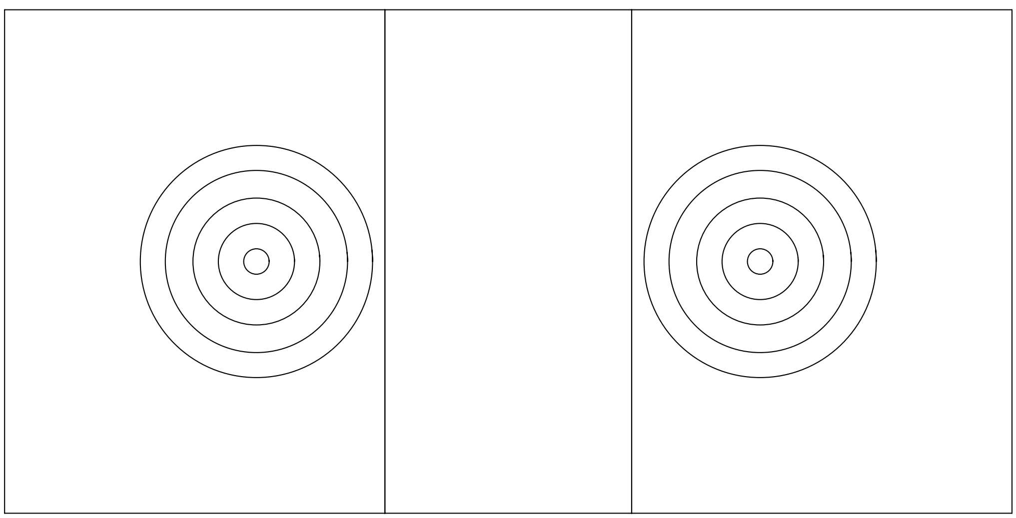

Figure 9: Model 1 for 2–D Gentilly-2 Supercell

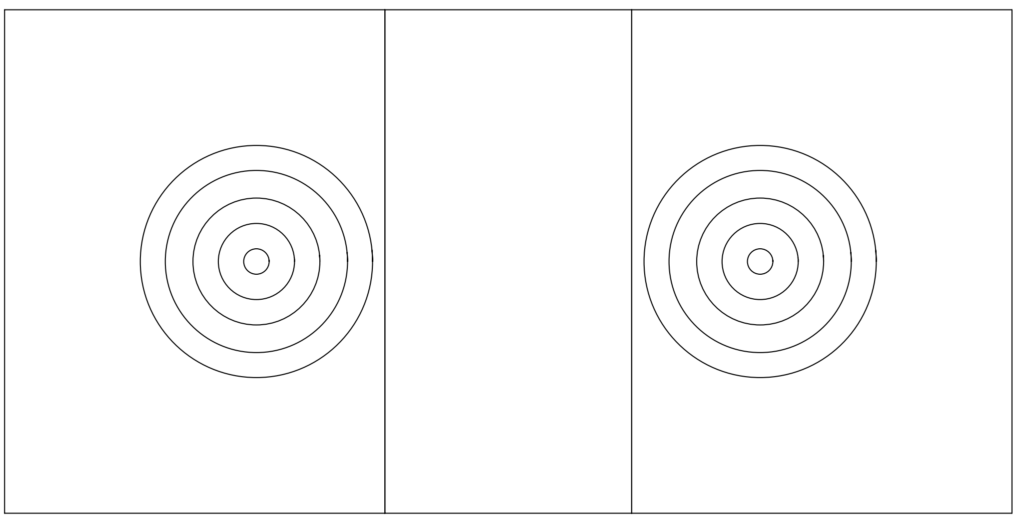

Figure 10: Model 2 for 2–D Gentilly-2 Supercell

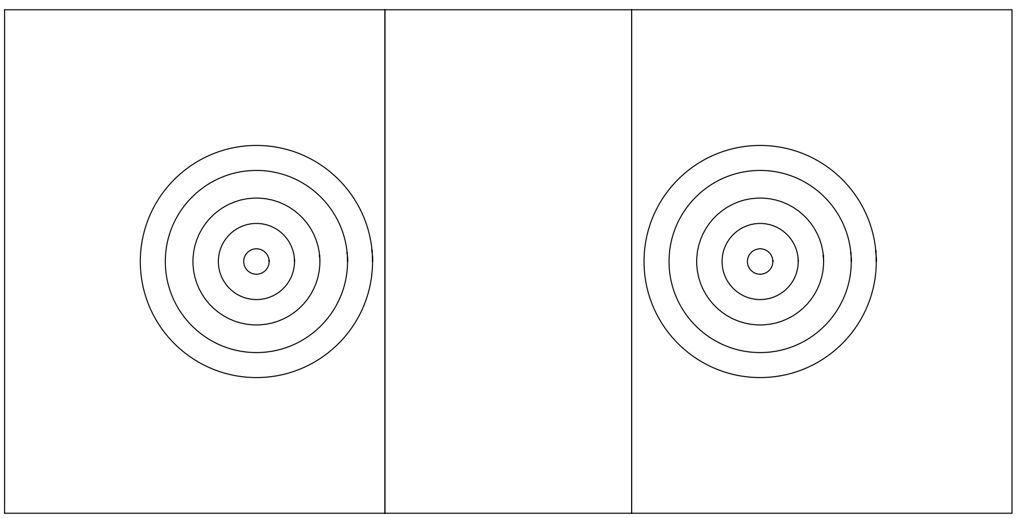

Figure 11: Model 4 for 2–D Gentilly-2 Supercell

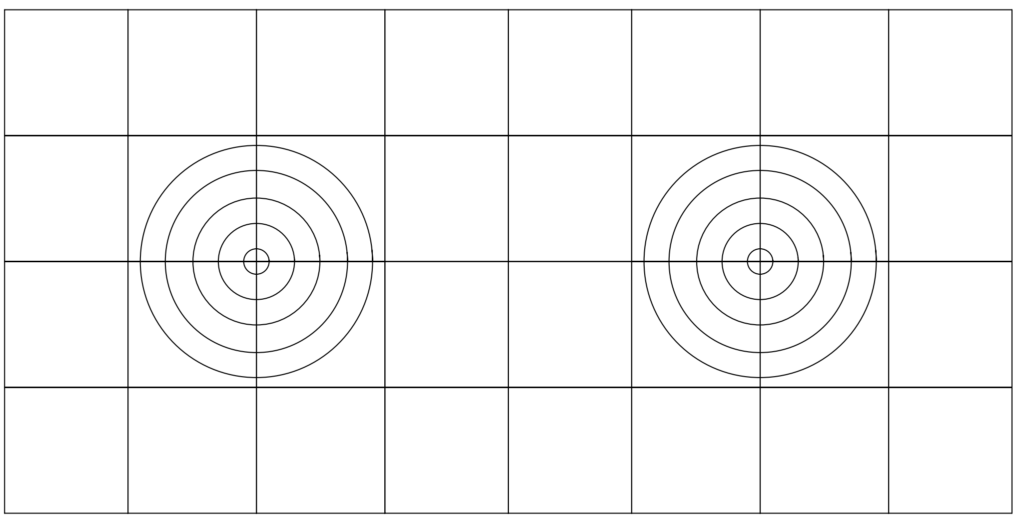

Figure 12: Model 4 for 2–D Gentilly-2 Supercell

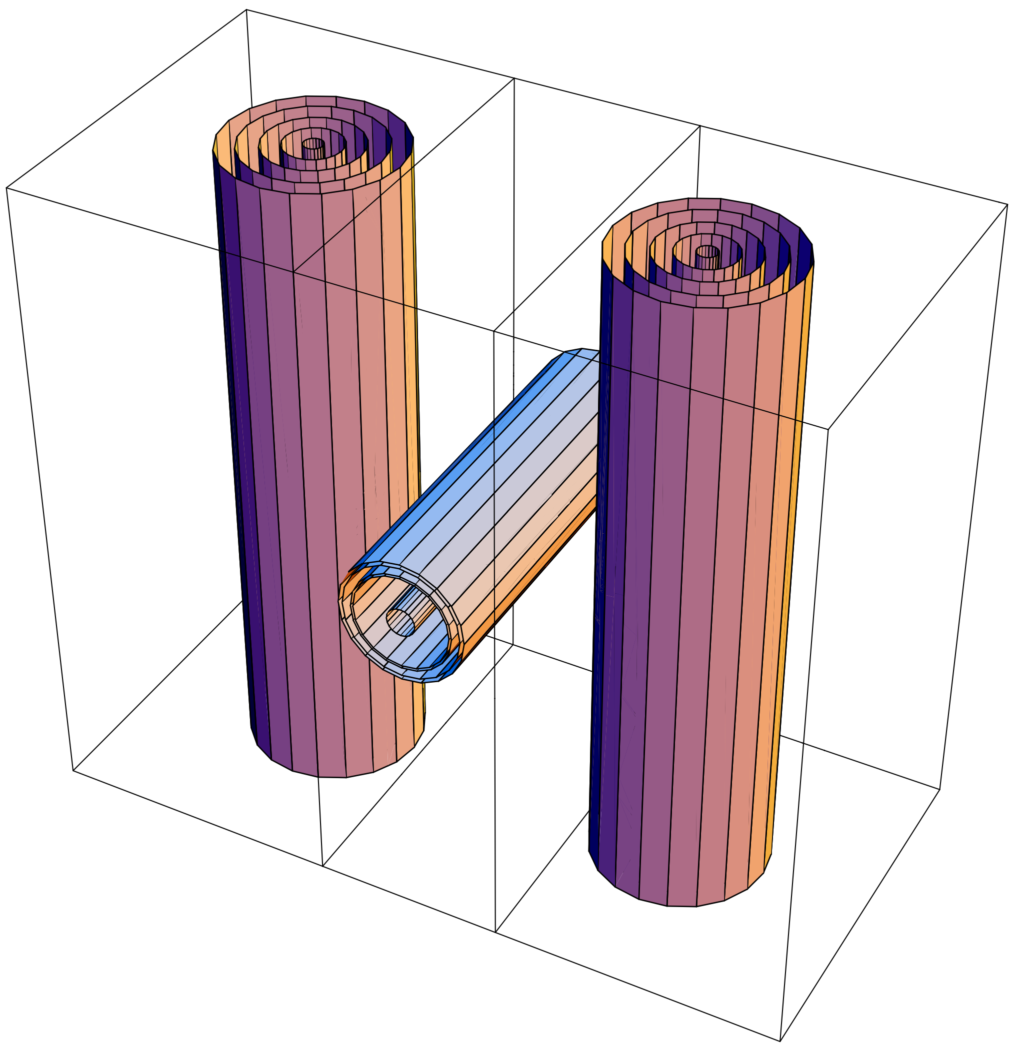

Figure 13: Model 1 for 3–D Gentilly-2 Supercell

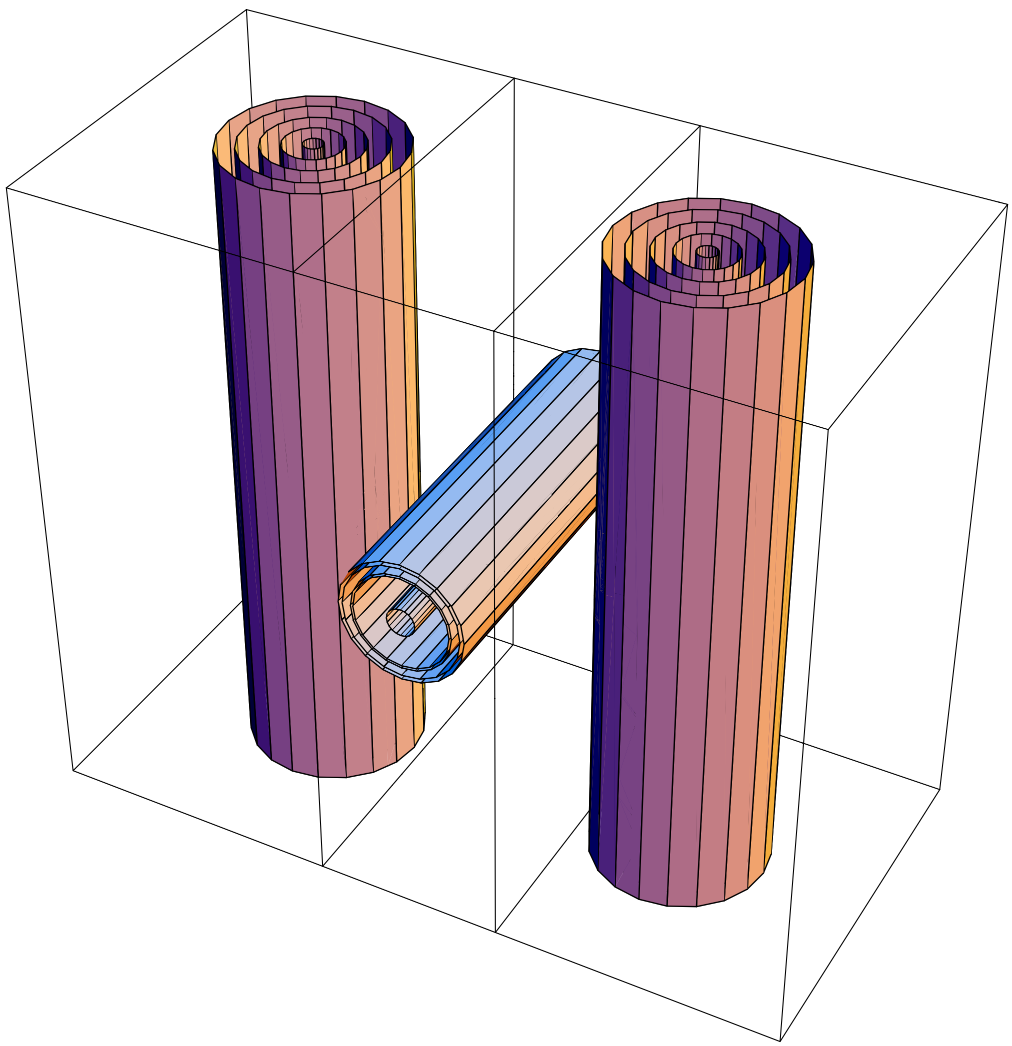

Figure 14: Model 2 for 3–D Gentilly-2 Supercell

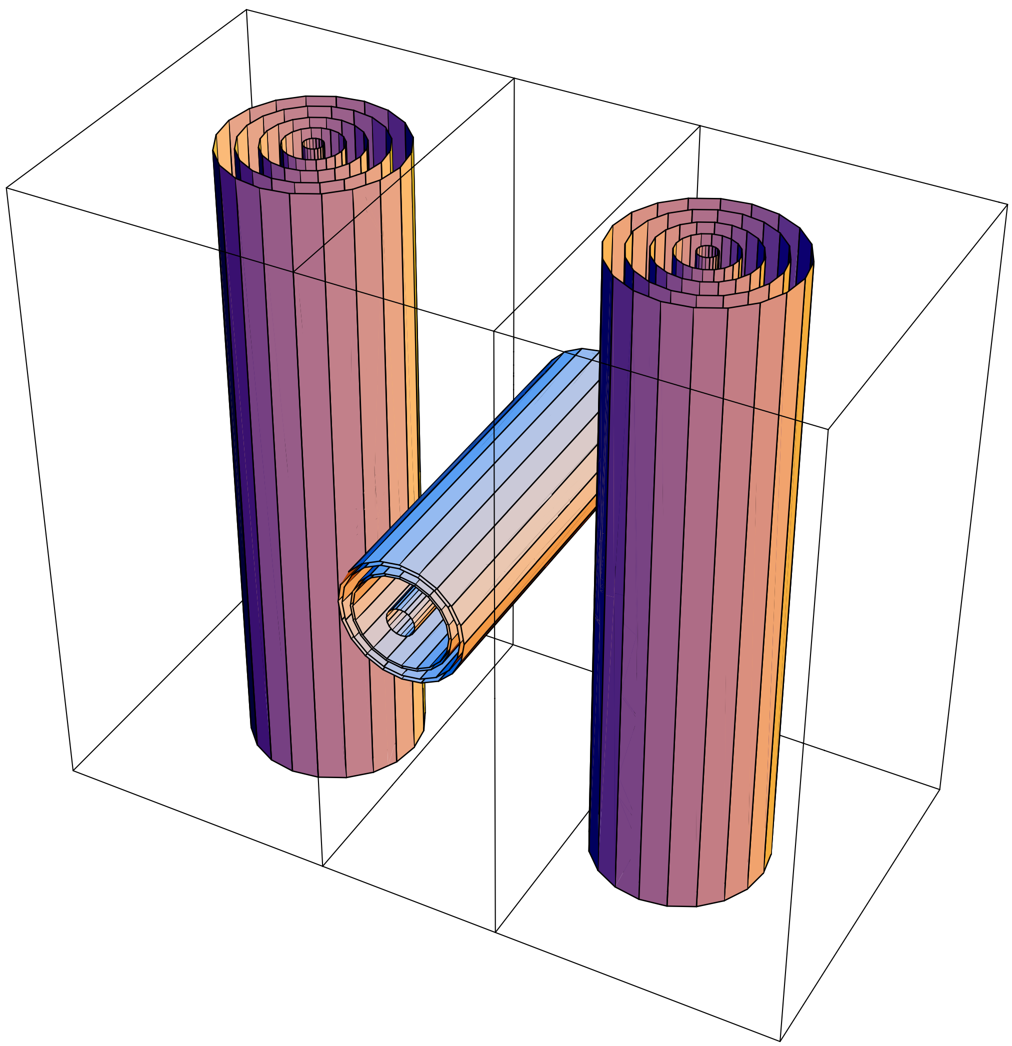

Figure 15: Model 3 for 3–D Gentilly-2 Supercell

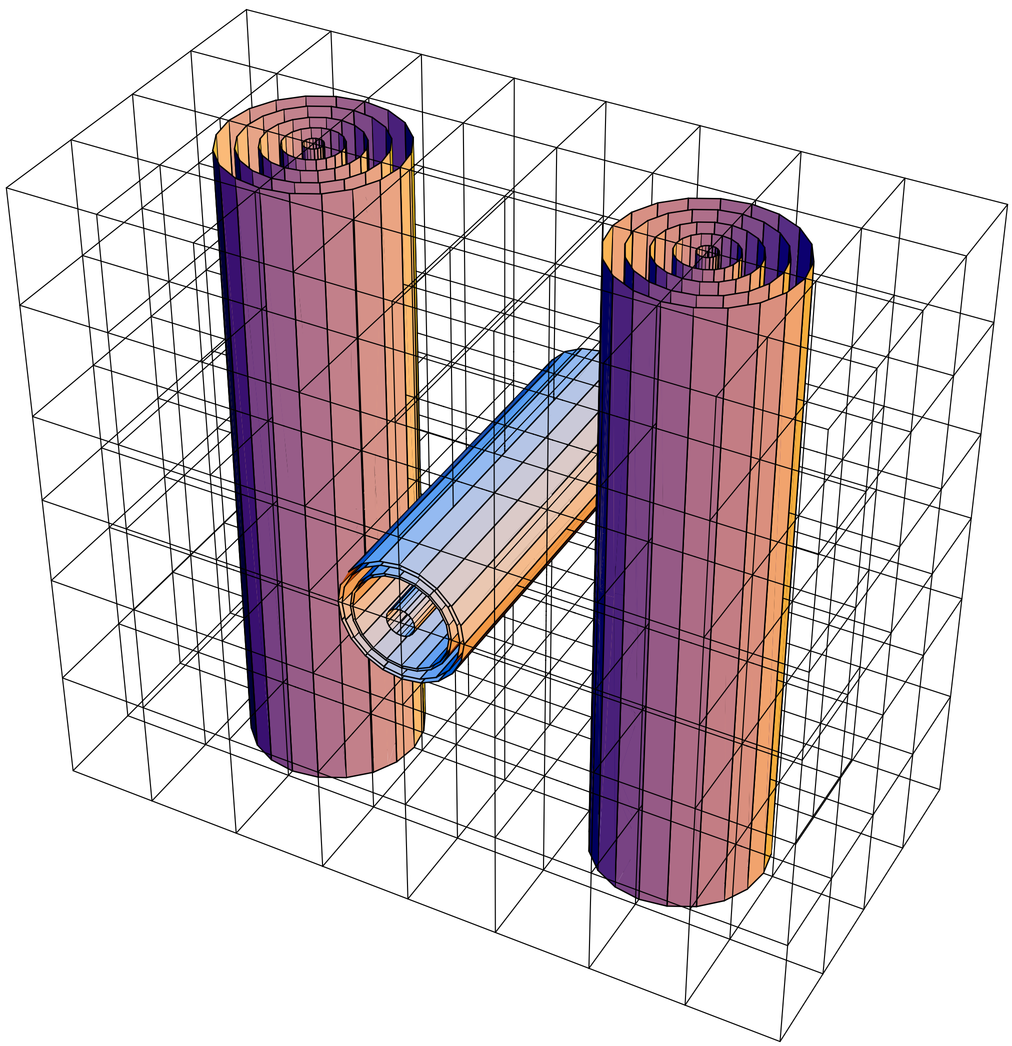

Figure 16: Model 4 for 3–D Gentilly-2 Supercell

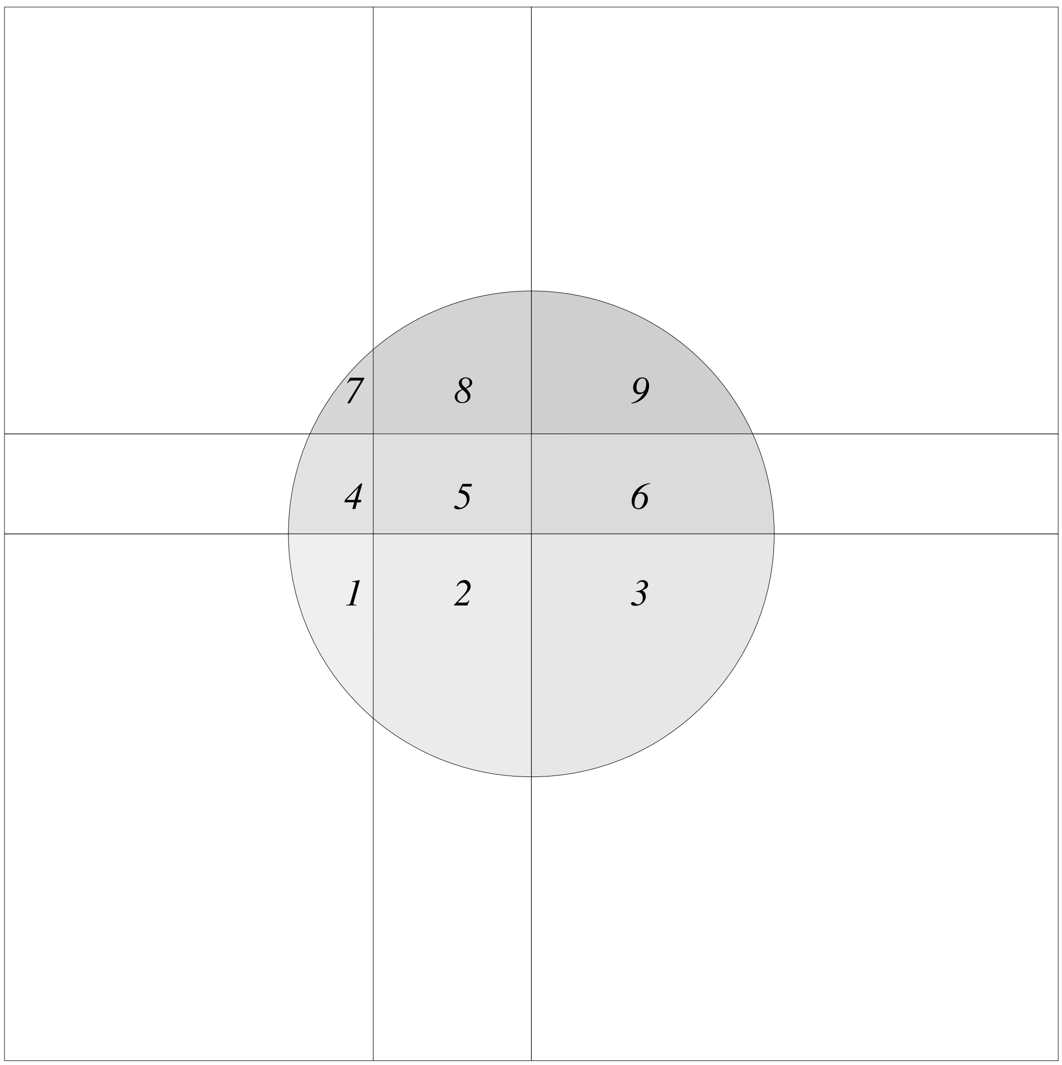

Figure 17: Intersection between a uniform Cartesian mesh and an annular region

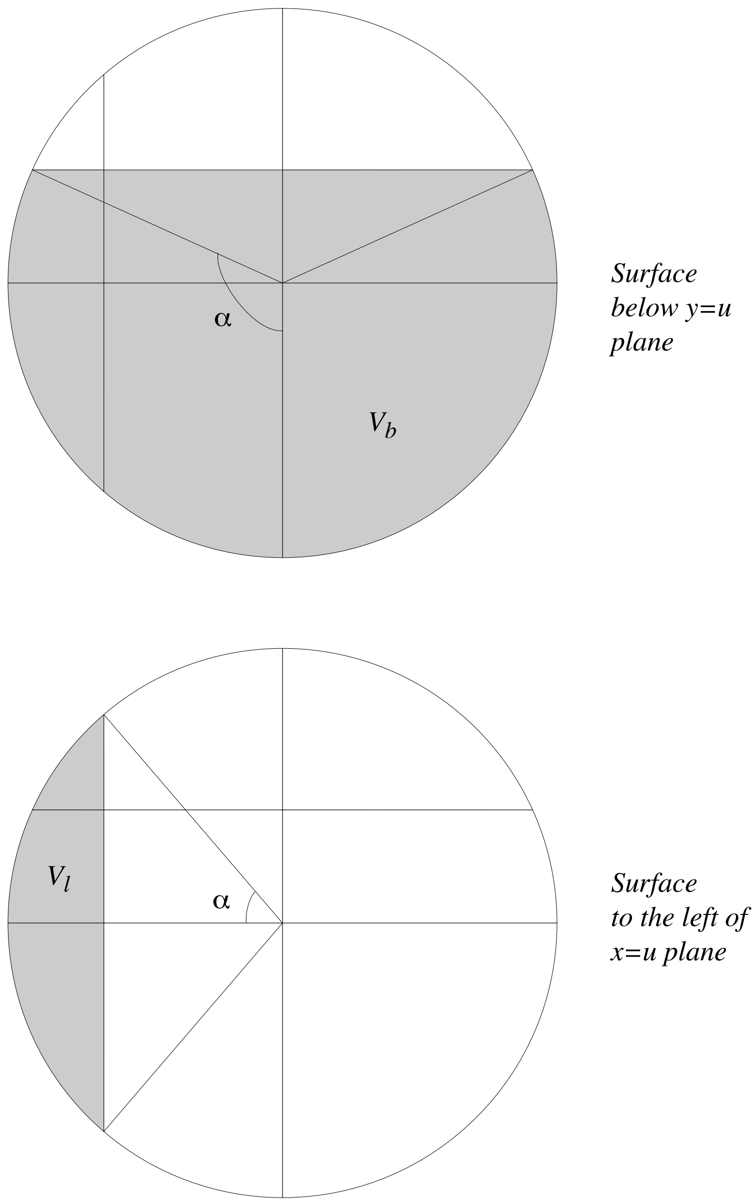

Figure 18: Intersection between one half-plane and annular region

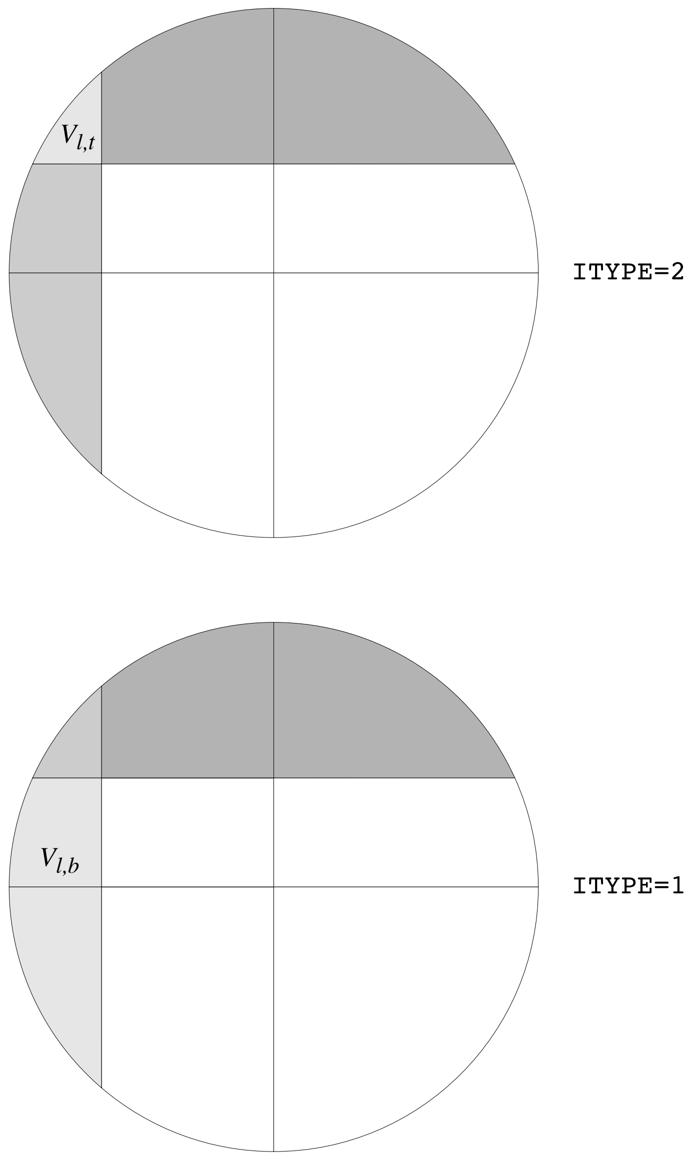

Figure 19: Intersection between two half-planes and annular region

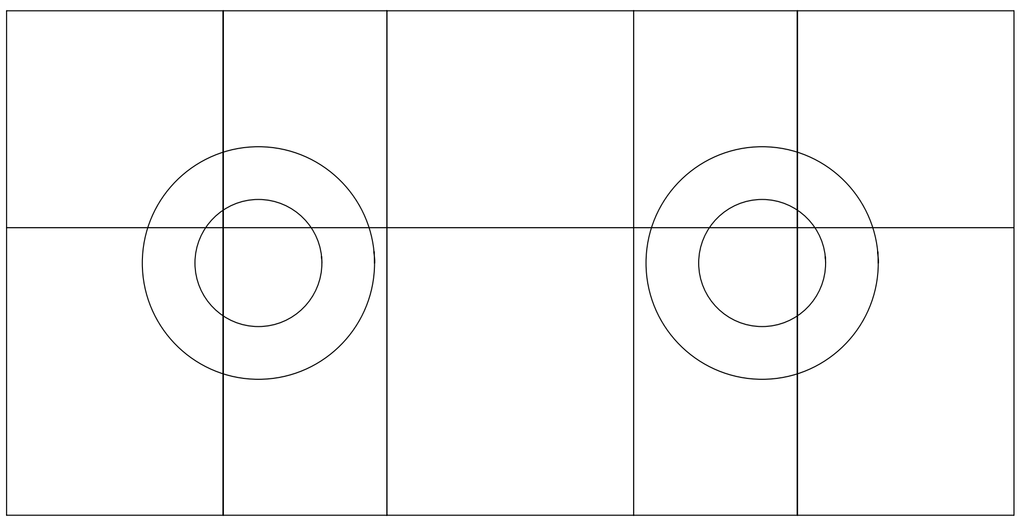

Figure 20: Model 5 for 2–D Gentilly-2 Supercell

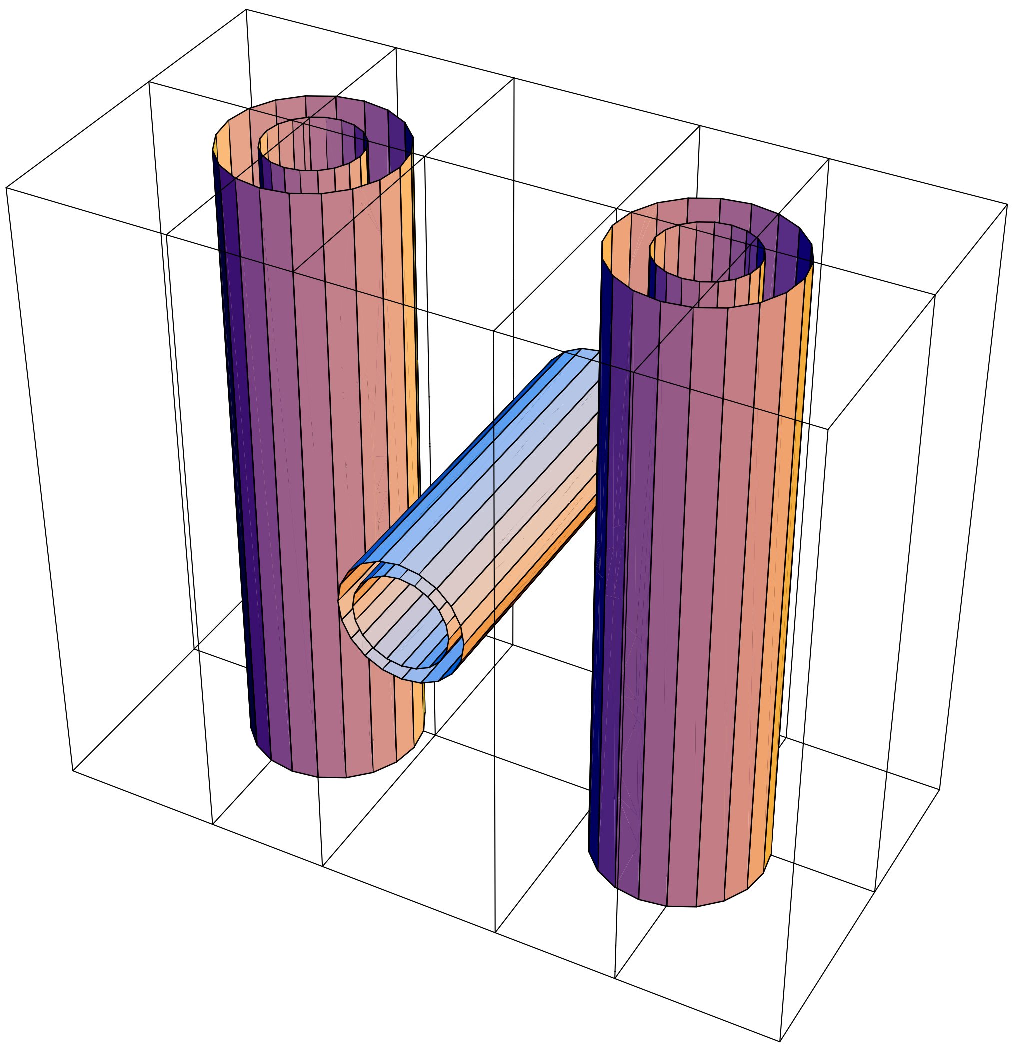

Figure 21: Model 5 for 3–D Gentilly-2 Supercell

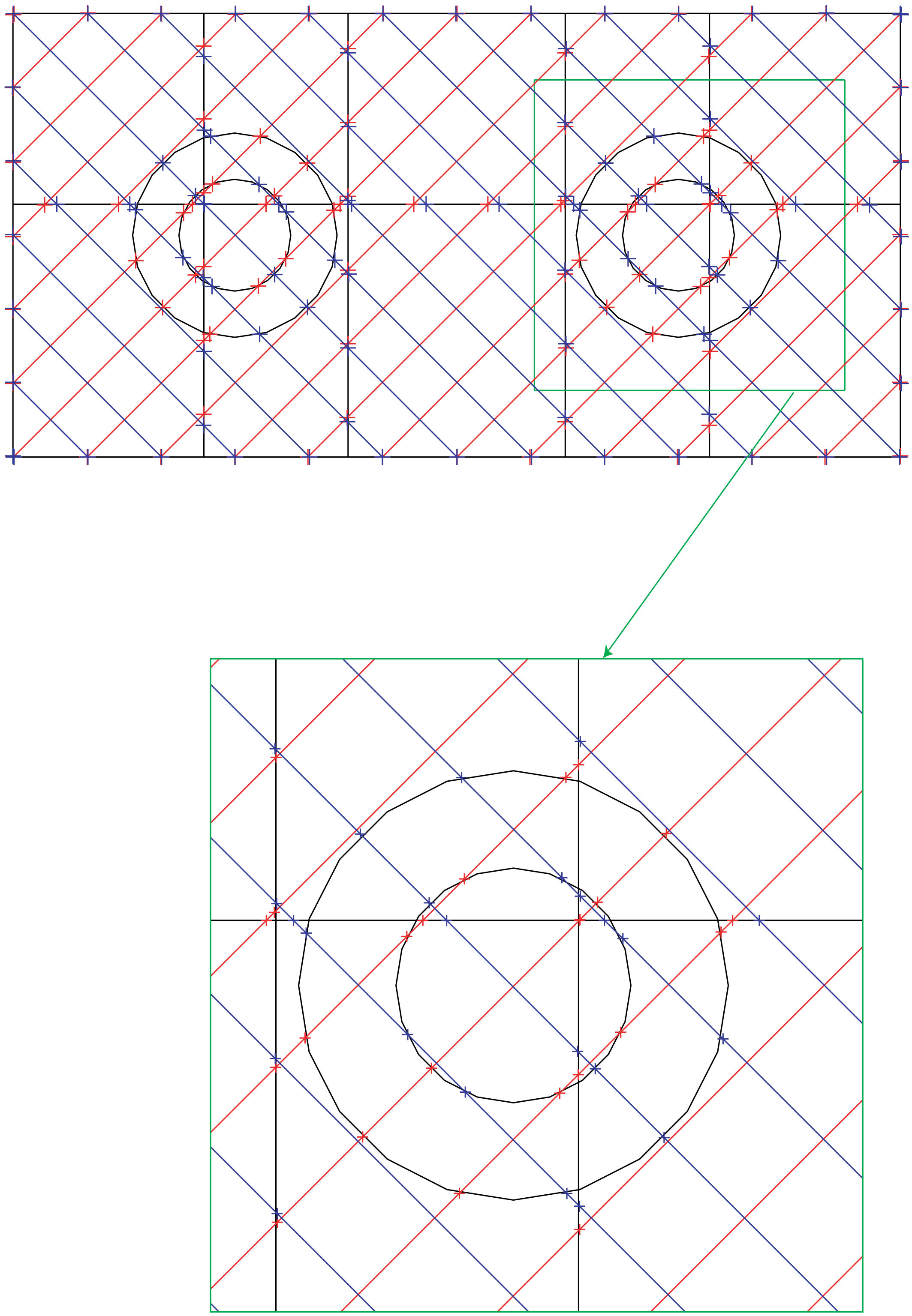

Figure 22: Integration lines for G22F2DZ5 Model

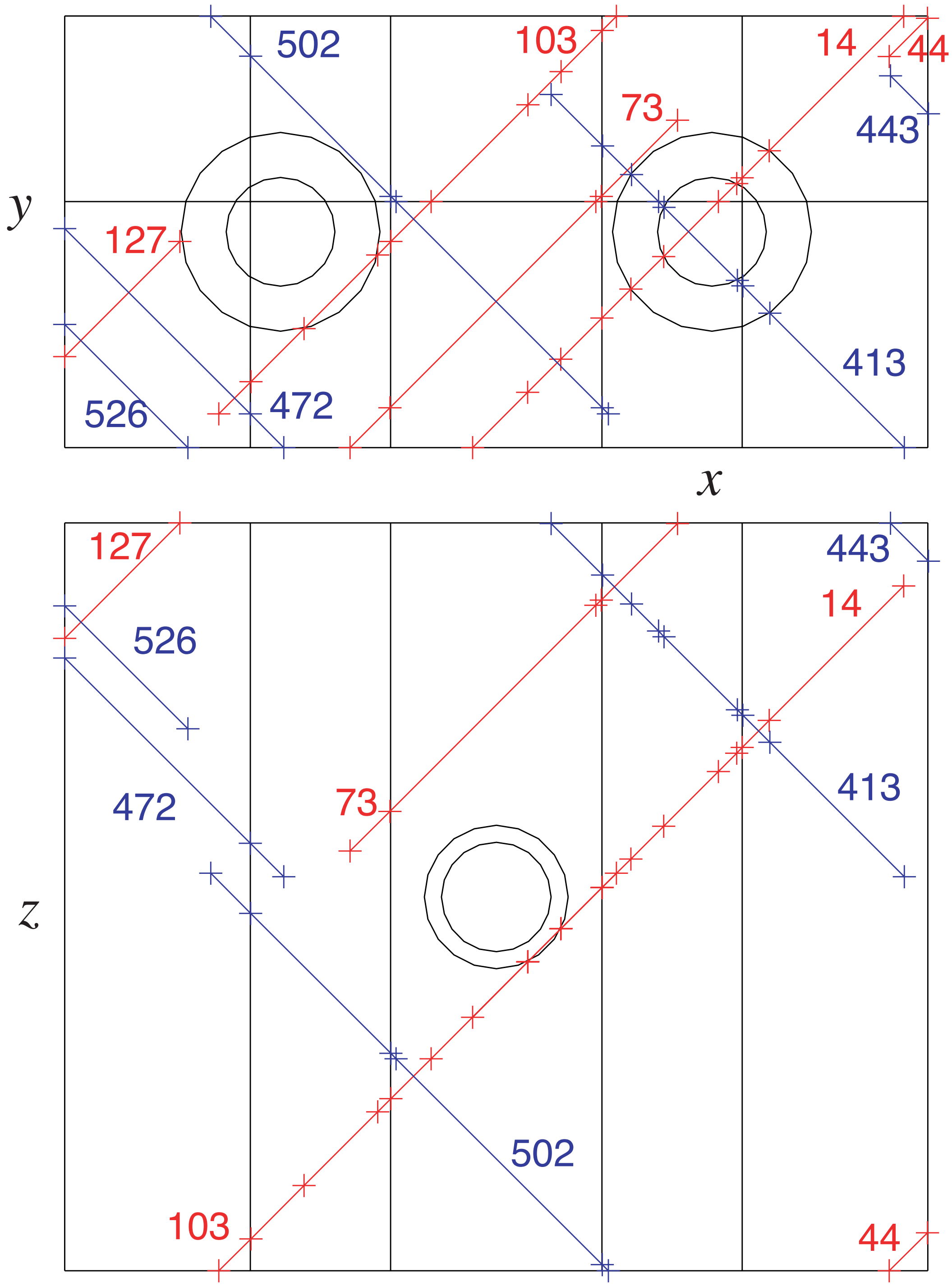

Figure 23: Integration lines for G22F3D5 Model

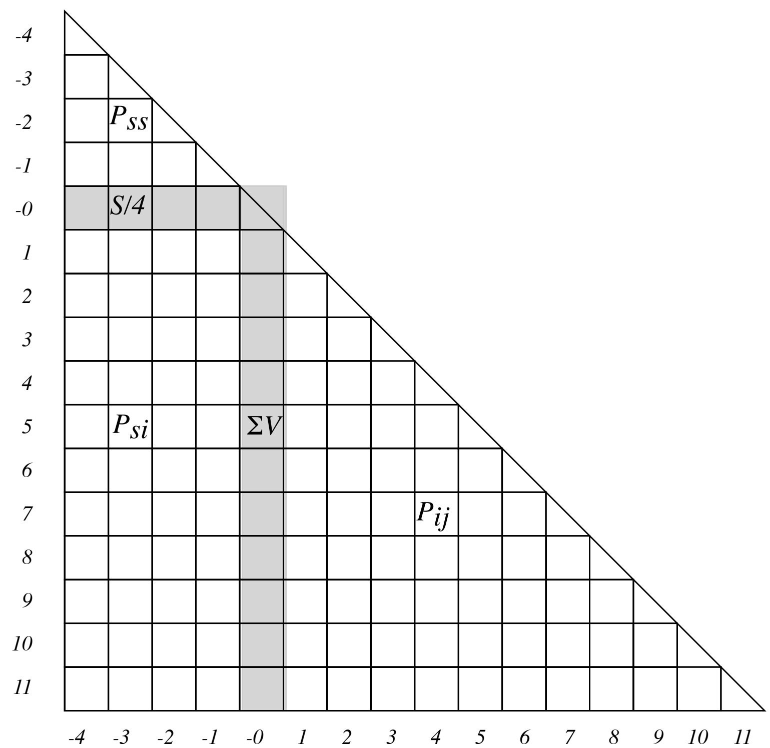

Figure 24: Contents of the symmetric CP matrix

Appendices

Appendix A

Listing of selected DRAGON subroutines

A.1 The GEO: Module

A.1.1 Subroutine GEO.f

```
*DECK GEO
      SUBROUTINE GEO(NENTRY,HENTRY,IENTRY,JENTRY,KENTRY)
C-----------------------------------------------------------------------
C
C GEOMETRY DEFINITION MODULE FOR DRAGON-2.
C
C INPUT/OUTPUT PARAMETERS:
C  NENTRY : NUMBER OF LINKED LISTS OR FILES USED BY THE MODULE.
C  HENTRY : CHARACTER*12 NAME OF EACH LINKED LIST OR FILE.
C  IENTRY : =1 LINKED LIST; =2 XSM FILE; =3 SEQUENTIAL BINARY FILE;
C           =4 SEQUENTIAL ASCII FILE.
C  JENTRY : =0 THE LINKED LIST OR FILE IS CREATED.
C           =1 THE LINKED LIST OR FILE IS OPEN FOR MODIFICATIONS;
C           =2 THE LINKED LIST OR FILE IS OPEN IN READ-ONLY MODE.
C  KENTRY : =FILE UNIT NUMBER; =LINKED LIST ADDRESS OTHERWISE.
C           DIMENSION HENTRY(NENTRY),IENTRY(NENTRY),JENTRY(NENTRY),
C           KENTRY(NENTRY)
C
C LINKED LISTS / XSM FILES:
C  HENTRY(1) : CREATE OR MODIFICATION TYPE(L_GEOM).
C  HENTRY(2) : READ-ONLY OPTIONAL TYPE(L_GEOM).
C
C--------------------------------------- AUTHOR: A. HEBERT ; 22/09/94 ---
      IMPLICIT NONE
C----
C  SUBROUTINE PARAMETERS
C----
      INTEGER      IOUT
      CHARACTER    NAMMOD*12
      PARAMETER   (IOUT=6,NAMMOD='GEO:        ')
      INTEGER      NENTRY
      CHARACTER    HENTRY(NENTRY)*12
      INTEGER      IENTRY(NENTRY),JENTRY(NENTRY),KENTRY(NENTRY)
C----
C  LOCAL VARIABLES
C----
      INTEGER      KCHAR(3),ITYPE,IPGEOM,IMPX,IPGEO2,I1,MAXMIX
      CHARACTER    TEXT12*12,TEXT13*12
C----
C  PRINT CREDITS
C----
      WRITE(IOUT,6900) NAMMOD
      WRITE(IOUT,6910)
C
```

```
C PARAMETER VALIDATION.
C
      IF(NENTRY.LT.1) CALL XABORT
     > ('GEO: AT LEAST ONE DATA STRUCTURE REQUIRED')
      IF(IENTRY(1).NE.1.AND.IENTRY(1).NE.2) CALL XABORT
     >  ('GEO: FIRST DATA STRUCTURE NOT A LINKED LIST OR XSM FILE')
      IF(JENTRY(1).NE.0.AND.JENTRY(1).NE.1) CALL XABORT
     >  ('GEO: FIRST DATA STRUCTURE NOT IN CREATE OR MODIFY MODE')
      ITYPE=JENTRY(1)
      IPGEOM=KENTRY(1)
*
      IMPX=1
      IF((ITYPE.EQ.0).AND.(NENTRY.GT.1)) THEN
*----
*  CREATE A NEW GEOMETRY BASED ON AN EXISTING ONE.
*----
        IF(IENTRY(2).NE.1.AND.IENTRY(2).NE.2) CALL XABORT
     >  ('GEO: SECOND DATA STRUCTURE NOT A LINKED LIST OR XSM FILE')
        IF(JENTRY(2).NE.2) CALL XABORT
     >  ('GEO: SECOND DATA STRUCTURE NOT IN READ-ONLY MODE')
         IPGEO2=KENTRY(2)
         CALL LCMGET(IPGEO2,'SIGNATURE',KCHAR)
         WRITE(TEXT12,'(3A4)') (KCHAR(I1),I1=1,3)
         IF(TEXT12.NE.'L_GEOM') THEN
            TEXT13=HENTRY(2)
            CALL XABORT('GEO: SIGNATURE OF '//TEXT13//' IS '//TEXT12//
     1      '. L_GEOM EXPECTED(1).')
         ENDIF
         CALL LCMEQU(IPGEO2,IPGEOM)
      ELSE IF(ITYPE.EQ.1) THEN
*        MODIFY AN EXISTING GEOMETRY USING THE SAME NAME.
         CALL LCMGET(IPGEOM,'SIGNATURE',KCHAR)
         WRITE(TEXT12,'(3A4)') (KCHAR(I1),I1=1,3)
         IF(TEXT12.NE.'L_GEOM') THEN
            TEXT13=HENTRY(1)
            CALL XABORT('GEO: SIGNATURE OF '//TEXT13//' IS '//TEXT12//
     1      '. L_GEOM EXPECTED(2).')
         ENDIF
      ENDIF
*
      TEXT12='/'
      CALL GEOIN1 (TEXT12,IPGEOM,1,IMPX,MAXMIX)
      WRITE(IOUT,6901) NAMMOD
      RETURN
 6900 FORMAT('->@BEGIN MODULE : ',A12)
 6901 FORMAT('->@END MODULE   : ',A12)
 6910 FORMAT('->@DESCRIPTION  : GEOMETRY DEFINITION'/
     >       '->@CREDITS      : A. HEBERT'/
     >       '->@COPYRIGHTS   : ECOLE POLYTECHNIQUE DE MONTREAL ')
      END
```

A.1.2 Subroutine GEOIN1.f

```
*DECK GEOIN1
      SUBROUTINE GEOIN1(GEONAM,IPLIST,LEVEL,IMPX,MAXMIX)
C
C-----------------------------------------------------------------------
C
C READ AND/OR MODIFY AN OBJECT ORIENTED GEOMETRY.
C
C INPUT PARAMETERS:
C   GEONAM : CHARACTER*12 NAME OF THE DIRECTORY WHERE THE GEOMETRY IS
C            STORED.
C   IPLIST : POINTER TO THE GEOMETRY (L_GEOM SIGNATURE).
C   LEVEL  : HIERARCHICAL LEVEL OF THE GEOMETRY.
C   IMPX   : PRINT FLAG. IMPX=0 FOR NO PRINT.
C
C OUTPUT PARAMETER:
C   MAXMIX : MAXIMUM NUMBER OF MIXTURES, CONSIDERING ALL SUB GEOMETRIES.
C
C-------------------------------------- AUTHOR: A. HEBERT ; 10/11/89 ---
C
      IMPLICIT NONE
C----
C  PARAMETERS
C----
      INTEGER      MAXCOD,MAXHEX,MAXTUR,MAXTYP,MXCL,NSTATE,IOUT
      PARAMETER   (MAXCOD=7,MAXHEX=9,MAXTUR=12,MAXTYP=30,MXCL=500,
     >             NSTATE=20,IOUT=6)
C----
C  MEMORY ALLOCATION
C----
      INTEGER      IBASE(1)
      REAL         BASE
      COMMON       BASE(1)
      EQUIVALENCE (BASE(1),IBASE(1))
      INTEGER      IMIX,IMESH,ICYL,ICENT,ICELL,IIGEN,IMERGE,ITURN,INS,
     &             IRS,IMIXDL,IMIXGR,IMILIE,IFRACT,IPOURC,IPROCE
C----
C  LOCAL VARIABLES
C----
      REAL         ZCODE(6),FLOTT,SIDE,PIN
      INTEGER      ISTATE(NSTATE),NCODE(6),ICODE(6),KCHAR(3),
     &             LR,LX,LY,LZ,LREG,MINMIX,MINICO,IPLIST,ILONG,
     &             ITYX,I,J,K,I1,LEVEL,INDC,NITMA,IRLXY,IRLYZ,IFILE,
     &             IRC,IMPX,LMESH,LCYL,IKG,JKG,NPIN,MICRO,NG,
     &             IOFJ,IOFK,NMILG,NSMAX,ISURF,IHEX,IMPX2,MAXMI2,
     &             MAXMIX
      CHARACTER    GEONAM*12,COND(MAXCOD)*4,CHEX(MAXHEX)*8,
     &             CTUR(MAXTUR)*1,TYPE(0:MAXTYP)*16,TEXT4*4,
     &             TEXT12*12,TEXT13*12,NAMT*12,DIR*1,NAMSBR*6
      LOGICAL      LHEX,LCM
      DOUBLE PRECISION DBLINP
C----
C  EXTERNALS
C----
      INTEGER      KDROPN,KDRCLS
C----
C  DATA
```

```
C----
      SAVE         COND,CHEX,CTUR,TYPE
      EQUIVALENCE (LR,ISTATE(2)),(LX,ISTATE(3)),(LY,ISTATE(4)),
     1 (LZ,ISTATE(5)),(LREG,ISTATE(6))
      DATA     COND/'VOID','REFL','DIAG','TRAN','SYME','ALBE','ZERO'/
      DATA     CHEX/'S30','SA60','SB60','S90','R120','R180','SA180',
     1              'SB180','COMPLETE'/
      DATA     CTUR/'A','B','C','D','E','F','G','H','I','J','K','L'/
      DATA     TYPE/'VIRTUAL','HOMOGENEOUS','CARTESIAN 1-D','TUBE 1-D',
     1         'SPHERE 1-D','CARTESIAN 2-D','TUBE 2-D','CARTESIAN 3-D',
     2         'HEXAGONAL 2-D','HEXAGONAL 3-D',10*' ','2-D RECT. CELL',
     3       3*'3-D RECT. CELL','2-D HEX. CELL','3-D HEX. CELL',4*' ',
     4         'DO-IT-YOURSELF'/
*
      NAMSBR='GEOIN1'
      MINMIX=0
      MINICO=1
      CALL LCMLEN(IPLIST,'SIGNATURE',ILONG,ITYX)
      IF(ILONG.EQ.0) THEN
*        INPUT A NEW GEOMETRY.
         CALL XDRSET(ISTATE,NSTATE,0)
         LHEX=.FALSE.
         DO 20 I=1,6
         NCODE(I)=0
         ZCODE(I)=0.0
   20    ICODE(I)=0
      ELSE
*        MODIFY AN EXISTING GEOMETRY.
         CALL LCMGET(IPLIST,'SIGNATURE',KCHAR)
         WRITE(TEXT12,'(3A4)') (KCHAR(I1),I1=1,3)
         IF(TEXT12.NE.'L_GEOM') THEN
            CALL XABORT(NAMSBR//': SIGNATURE OF '//GEONAM//' IS '
     1      //TEXT12//'. L_GEOM EXPECTED.')
         ENDIF
         CALL XDRSET(ISTATE,NSTATE,0)
         CALL LCMGET(IPLIST,'STATE-VECTOR',ISTATE)
         LHEX=(ISTATE(1).EQ.8).OR.(ISTATE(1).EQ.9).OR.(ISTATE(1).EQ.24)
     1   .OR.(ISTATE(1).EQ.25)
         CALL LCMGET(IPLIST,'NCODE',NCODE)
         CALL LCMGET(IPLIST,'ZCODE',ZCODE)
         CALL LCMGET(IPLIST,'ICODE',ICODE)
         IF(LEVEL.EQ.1) GO TO 30
      ENDIF
*
      CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
      IF(INDC.NE.3) CALL XABORT
     >  (NAMSBR//': CHARACTER DATA EXPECTED(1).')
      IF(TEXT12.EQ.'VIRTUAL') THEN
         ISTATE(1)=0
      ELSE IF(TEXT12.EQ.'HOMOGE') THEN
         ISTATE(1)=1
         LREG=1
      ELSE IF(TEXT12.EQ.'CAR1D') THEN
         ISTATE(1)=2
         CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
```

```
            LREG=LX
         ELSE IF(TEXT12.EQ.'TUBE') THEN
            ISTATE(1)=3
            CALL REDGET(INDC,LR,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=LR
         ELSE IF(TEXT12.EQ.'SPHERE') THEN
            ISTATE(1)=4
            CALL REDGET(INDC,LR,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=LR
         ELSE IF(TEXT12.EQ.'CAR2D') THEN
            ISTATE(1)=5
            CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            CALL REDGET(INDC,LY,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=LX*LY
         ELSE IF(TEXT12.EQ.'TUBEZ') THEN
            ISTATE(1)=6
            CALL REDGET(INDC,LR,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            CALL REDGET(INDC,LZ,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=LR*LZ
         ELSE IF(TEXT12.EQ.'CAR3D') THEN
            ISTATE(1)=7
            CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            CALL REDGET(INDC,LY,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            CALL REDGET(INDC,LZ,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=LX*LY*LZ
         ELSE IF(TEXT12.EQ.'HEX') THEN
            ISTATE(1)=8
            LHEX=.TRUE.
            CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=LX
         ELSE IF(TEXT12.EQ.'HEXZ') THEN
            ISTATE(1)=9
            LHEX=.TRUE.
            CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            CALL REDGET(INDC,LZ,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=LX*LZ
         ELSE IF(TEXT12(1:6).EQ.'CARCEL') THEN
            CALL REDGET(INDC,LR,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
            DIR=TEXT12(7:7)
            IF(DIR .EQ. ' ') THEN
              ISTATE(1)=20
              LX=1
              LY=1
```

```
           IRLXY=1
           CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
           IF(INDC .EQ. 3) THEN
             IRLXY=0
           ELSE IF(INDC.EQ. 2) THEN
             CALL XABORT(NAMSBR//': INVALID REAL DATA.')
           ELSE
             CALL REDGET(INDC,LY,FLOTT,TEXT12,DBLINP)
             IF(INDC.NE.1) CALL XABORT
     >         (NAMSBR//': INTEGER DATA EXPECTED.')
           ENDIF
           LREG=(LR+1)*LY*LX
           IF(IRLXY .EQ. 0 ) GO TO 35
         ELSE
           LX=1
           LY=1
           LZ=1
           CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
           IF(INDC.NE.1) CALL XABORT
     >       (NAMSBR//': INTEGER DATA EXPECTED.')
           CALL REDGET(INDC,LY,FLOTT,TEXT12,DBLINP)
           IF(INDC .EQ. 3) THEN
             IRLYZ=0
           ELSE IF(INDC.EQ. 2) THEN
             CALL XABORT(NAMSBR//': INVALID REAL DATA.')
           ELSE
             IRLYZ=1
             CALL REDGET(INDC,LZ,FLOTT,TEXT12,DBLINP)
             IF(INDC.NE.1) CALL XABORT
     >         (NAMSBR//': INTEGER DATA EXPECTED.')
           ENDIF
           LREG=(LR+1)*LY*LZ*LX
           IF(DIR .EQ. 'X') THEN
             ISTATE(1)=21
           ELSE IF(DIR .EQ. 'Y') THEN
             ISTATE(1)=22
             IF(IRLYZ .EQ.0 ) THEN
               LY=LX
               LX=1
               GO TO 35
             ENDIF
           ELSE IF(DIR .EQ. 'Z') THEN
             ISTATE(1)=23
             IF(IRLYZ .EQ.0 ) THEN
               LZ=LX
               LX=1
               GO TO 35
             ENDIF
           ELSE
             GO TO 500
           ENDIF
         ENDIF
      ELSE IF(TEXT12(1:6).EQ.'HEXCEL') THEN
         LHEX=.TRUE.
         CALL REDGET(INDC,LR,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
```

```
         LX=1
         IF(TEXT12(7:7).EQ.' ') THEN
            ISTATE(1)=24
            LREG=LR+1
         ELSE IF(TEXT12(7:7).EQ.'Z') THEN
            ISTATE(1)=25
            CALL REDGET(INDC,LZ,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT
     >        (NAMSBR//': INTEGER DATA EXPECTED.')
            LREG=(LR+1)*LZ
         ELSE
            GO TO 500
         ENDIF
      ELSE IF(TEXT12.EQ.'GROUP') THEN
*        DO-IT-YOURSELF OPTION.
         ISTATE(1)=30
         CALL REDGET(INDC,LX,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
         LREG=LX
      ELSE IF(TEXT12.NE.GEONAM) THEN
*        COPY ATTRIBUTES FROM AN EXISTING GEOMETRY LOCATED ON A PARALLEL
*        DIRECTORY OF THE LINKED LIST POINTED BY IPLIST.
         IF(LEVEL.EQ.1) CALL XABORT
     >     (NAMSBR//': THE GEOMETRY NAME SHOULD APPEARS BEFORE THE ::')
         CALL LCMSIX(IPLIST,' ',2)
         CALL LCMLEN(IPLIST,TEXT12,ILONG,ITYX)
         IF(ILONG.EQ.0) CALL XABORT(NAMSBR//': UNKNOWN GEOMETRY.')
         CALL LCMSIX(IPLIST,TEXT12,1)
         IFILE=KDROPN('DUMMYSQ',0,2,0,0)
         IF(IFILE.LE.0) CALL XABORT(NAMSBR//': KDROPN FAILURE.')
         CALL LCMEXP(IPLIST,0,IFILE,1,1)
         REWIND(IFILE)
         CALL LCMSIX(IPLIST,' ',2)
         CALL LCMSIX(IPLIST,GEONAM,1)
         CALL LCMEXP(IPLIST,0,IFILE,1,2)
         IRC=KDRCLS(IFILE,2)
         IF(IRC.LT.0) CALL XABORT(NAMSBR//': KDRCLS FAILURE.')
         CALL LCMGET(IPLIST,'STATE-VECTOR',ISTATE)
         LHEX=(ISTATE(1).EQ.8).OR.(ISTATE(1).EQ.9).OR.(ISTATE(1).EQ.24)
     1   .OR.(ISTATE(1).EQ.25)
         CALL LCMGET(IPLIST,'NCODE',NCODE)
         CALL LCMGET(IPLIST,'ZCODE',ZCODE)
         CALL LCMGET(IPLIST,'ICODE',ICODE)
      ENDIF
*
   30 CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
      IF(INDC.NE.3) CALL XABORT(NAMSBR//': CHARACTER DATA EXPECTED(2).')
   35 IF(TEXT12.EQ.'EDIT') THEN
         CALL REDGET(INDC,IMPX,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
      ELSE IF(TEXT12.EQ.'MIX') THEN
*        INPUT MIXTURE NUMBERS.
         CALL SETARA(IBASE,LREG,IMIX)
         CALL XDRSET(IBASE(IMIX),LREG,0)
         I=0
   40    I=I+1
```

```
         CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
         IF(INDC.EQ.3) GO TO 50
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
         IF(I.GT.LREG) GO TO 500
         IBASE(IMIX+I-1)=NITMA
         ISTATE(7)=MAX(ISTATE(7),IBASE(IMIX+I-1))
         MINMIX=MIN(MINMIX,IBASE(IMIX+I-1))
         GO TO 40
   50    LREG=I-1
         CALL LCMPUT(IPLIST,'MIX',LREG,1,IBASE(IMIX))
         CALL RLSARA(IBASE(IMIX))
         GO TO 35
      ELSE IF(TEXT12(1:4).EQ.'MESH') THEN
*        INPUT CARTESIAN COORDINATES.
         IF(TEXT12(5:5).EQ.'X') THEN
            IF(LX.EQ.0) GO TO 500
            LMESH=LX+1
         ELSE IF(TEXT12(5:5).EQ.'Y') THEN
            IF(LY.EQ.0) GO TO 500
            LMESH=LY+1
         ELSE IF(TEXT12(5:5).EQ.'Z') THEN
            IF(LZ.EQ.0) GO TO 500
            LMESH=LZ+1
         ELSE
            GO TO 500
         ENDIF
         CALL SETARA(BASE,LMESH,IMESH)
         DO 60 I=1,LMESH
         CALL REDGET(INDC,NITMA,BASE(IMESH+I-1),TEXT13,DBLINP)
         IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
         IF(I.GT.1) THEN
            IF(BASE(IMESH+I-1).LE.BASE(IMESH+I-2)) GO TO 500
         ENDIF
   60    CONTINUE
         CALL LCMPUT(IPLIST,TEXT12,LMESH,2,BASE(IMESH))
         CALL RLSARA(BASE(IMESH))
      ELSE IF(TEXT12.EQ.'RADIUS') THEN
*        INPUT TUBE RADIUS.
         IF(LR.EQ.0) GO TO 500
         LCYL=LR+1
         CALL SETARA(BASE,LCYL,ICYL)
         DO 70 I=1,LCYL
         CALL REDGET(INDC,NITMA,BASE(ICYL+I-1),TEXT12,DBLINP)
         IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
         IF(I.GT.1) THEN
            IF(BASE(ICYL+I-1).LE.BASE(ICYL+I-2)) GO TO 500
         ENDIF
   70    CONTINUE
         IF(BASE(ICYL).NE.0.0) GO TO 500
         CALL LCMPUT(IPLIST,'RADIUS',LCYL,2,BASE(ICYL))
         CALL RLSARA(BASE(ICYL))
      ELSE IF(TEXT12.EQ.'OFFCENTER') THEN
*        INPUT TUBE CENTER LOCATION (USE FOR CARCEL* ONLY).
         IF(LR.EQ.0) GO TO 500
         CALL SETARA(BASE,3,ICENT)
         CALL XDRSET(BASE(ICENT),3,0.0)
```

```
          DO 71 I=1,3
            CALL REDGET(INDC,NITMA,BASE(ICENT+I-1),TEXT12,DBLINP)
            IF(INDC.NE.2) GO TO 72
 71       CONTINUE
          CALL REDGET(INDC,NITMA,BASE(ICENT+I-1),TEXT12,DBLINP)
 72       CONTINUE
          CALL LCMPUT(IPLIST,'OFFCENTER',3,2,BASE(ICENT))
          CALL RLSARA(BASE(ICENT))
          GO TO 35
       ELSE IF(TEXT12.EQ.'SIDE') THEN
*         INPUT THE SIDE LENGTH IN HEXAGONAL GEOMETRY.
          IF(.NOT.LHEX) CALL XABORT(NAMSBR//': SIDE PROHIBITED.')
          CALL REDGET(INDC,NITMA,SIDE,TEXT12,DBLINP)
          IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
          CALL LCMPUT(IPLIST,'SIDE',1,2,SIDE)
       ELSE IF(TEXT12(1:5).EQ.'SPLIT') THEN
*         INPUT MESH SPLITTING FACTORS.
          ISTATE(11)=1
          IF(TEXT12(6:6).EQ.'X') THEN
             IF(LX.EQ.0) GO TO 500
             LMESH=LX
          ELSE IF(TEXT12(6:6).EQ.'Y') THEN
             IF(LY.EQ.0) GO TO 500
             LMESH=LY
          ELSE IF(TEXT12(6:6).EQ.'Z') THEN
             IF(LZ.EQ.0) GO TO 500
             LMESH=LZ
          ELSE IF(TEXT12(6:6).EQ.'R') THEN
             IF(LR.EQ.0) GO TO 500
             LMESH=LR
          ELSE
             GO TO 500
          ENDIF
          CALL SETARA(IBASE,LMESH,IMESH)
          DO 80 I=1,LMESH
          CALL REDGET(INDC,IBASE(IMESH+I-1),FLOTT,TEXT13,DBLINP)
          IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
          IF(((IBASE(IMESH+I-1).LE.0).AND.(TEXT12.NE.'SPLITR')).OR.
     >        (IBASE(IMESH+I-1).EQ.0)) CALL XABORT
     >    (NAMSBR//': INVALID MESH-SPLITTING INDEX.')
   80     CONTINUE
          CALL LCMPUT(IPLIST,TEXT12,LMESH,1,IBASE(IMESH))
          CALL RLSARA(IBASE(IMESH))
       ELSE IF(TEXT12.EQ.'CELL') THEN
*         FORCE SUB GEOMETRIES AT SPECIFIC LOCATIONS.
          ISTATE(8)=1
          CALL SETARA(BASE,3*LREG,ICELL)
          CALL SETARA(IBASE,LREG,IIGEN)
          I=0
          IKG=0
  110     I=I+1
          CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
          IF(INDC.NE.3) CALL XABORT(NAMSBR//': CHARACTER DATA EXPECTED.')
          IF((TEXT12(2:2).EQ.'-').OR.(TEXT12(2:2).EQ.'+').OR.
     1    (TEXT12.EQ.'HBC').OR.(TEXT12(1:4).EQ.'MESH').OR.
     2    (TEXT12(1:5).EQ.'SPLIT').OR.(TEXT12.EQ.'SIDE').OR.
```

```
     3   (TEXT12.EQ.'MERGE').OR.(TEXT12.EQ.'TURN').OR.(TEXT12.EQ.
     4   'CLUSTER').OR.(TEXT12(2:4).EQ.'PIN').OR.(TEXT12.EQ.'BIHET')
     5   .OR.(TEXT12.EQ.'POURCE').OR.(TEXT12.EQ.'PROCEL').OR.(TEXT12.EQ.
     6   ';').OR.(TEXT12.EQ.':::')) GO TO 120
         IF(I.GT.LREG) GO TO 500
         DO 115 J=1,I-1
         JKG=IBASE(IIGEN+J-1)
         WRITE(TEXT13(:4),'(A4)') BASE(ICELL+3*(JKG-1))
         WRITE(TEXT13(5:8),'(A4)') BASE(ICELL+3*(JKG-1)+1)
         WRITE(TEXT13(9:),'(A4)') BASE(ICELL+3*(JKG-1)+2)
         IF(TEXT12.EQ.TEXT13) THEN
            IBASE(IIGEN+I-1)=JKG
            GO TO 110
         ENDIF
  115    CONTINUE
         IKG=IKG+1
         IBASE(IIGEN+I-1)=IKG
         READ (TEXT12(:4),'(A4)') BASE(ICELL+3*(IKG-1))
         READ (TEXT12(5:8),'(A4)') BASE(ICELL+3*(IKG-1)+1)
         READ (TEXT12(9:),'(A4)') BASE(ICELL+3*(IKG-1)+2)
         GO TO 110
  120    LREG=I-1
         CALL LCMPUT(IPLIST,'CELL',3*IKG,3,BASE(ICELL))
         CALL LCMPUT(IPLIST,'GENERATING',LREG,1,IBASE(IIGEN))
         CALL RLSARA(IBASE(IIGEN))
         CALL RLSARA(BASE(ICELL))
         GO TO 35
      ELSE IF(TEXT12.EQ.'MERGE') THEN
*        INPUT CELL-MERGING INDCES.
         ISTATE(10)=1
         CALL SETARA(IBASE,LREG,IMERGE)
         I=0
  130    I=I+1
         CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
         IF(INDC.EQ.3) GO TO 140
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
         IF(I.GT.LREG) GO TO 500
         IBASE(IMERGE+I-1)=NITMA
         GO TO 130
  140    LREG=I-1
         CALL LCMPUT(IPLIST,'MERGE',LREG,1,IBASE(IMERGE))
         CALL RLSARA(IBASE(IMERGE))
         GO TO 35
      ELSE IF(TEXT12.EQ.'TURN') THEN
*        INPUT ORIENTATION INFORMATION.
         CALL SETARA(IBASE,LREG,ITURN)
         I=0
  150    I=I+1
         CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.3) CALL XABORT(NAMSBR//': CHARACTER DATA EXPECTED.')
         DO 160 J=1,MAXTUR
         IF(TEXT12.EQ.CTUR(J)) THEN
            IF(I.GT.LREG) GO TO 500
            IBASE(ITURN+I-1)=J
            GO TO 150
         ELSE IF(TEXT12.EQ.'-'//CTUR(J)) THEN
```

```
            IF(I.GT.LREG) GO TO 500
            IBASE(ITURN+I-1)=MAXTUR+J
            GO TO 150
         ENDIF
  160    CONTINUE
         LREG=I-1
         CALL LCMPUT(IPLIST,'TURN',LREG,1,IBASE(ITURN))
         CALL RLSARA(IBASE(ITURN))
         GO TO 35
      ELSE IF(TEXT12.EQ.'CLUSTER') THEN
*        DEFINE CLUSTER SUB GEOMETRIES.
         IF(LR.EQ.0) GO TO 500
         CALL SETARA(BASE,3*MXCL,ICELL)
         I=0
  180    I=I+1
         CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.3) CALL XABORT(NAMSBR//': CHARACTER DATA EXPECTED.')
         IF((TEXT12(2:2).EQ.'-').OR.(TEXT12(2:2).EQ.'+').OR.
     1   (TEXT12.EQ.'HBC').OR.(TEXT12(1:4).EQ.'MESH').OR.(TEXT12(1:5)
     2   .EQ.'SPLIT').OR.(TEXT12.EQ.'SIDE').OR.(TEXT12.EQ.'MIX').OR.
     3   (TEXT12.EQ.'CELL').OR.(TEXT12.EQ.'MERGE').OR.(TEXT12.EQ.'TURN')
     4   .OR.(TEXT12(2:4).EQ.'PIN').OR.(TEXT12.EQ.'BIHET').OR.
     5   (TEXT12.EQ.'POURCE').OR.(TEXT12.EQ.'PROCEL').OR.(TEXT12.EQ.
     6   ';').OR.(TEXT12.EQ.':::')) GO TO 190
         IF(I.GT.MXCL) GO TO 500
         READ (TEXT12(:4),'(A4)') BASE(ICELL+3*(I-1))
         READ (TEXT12(5:8),'(A4)') BASE(ICELL+3*(I-1)+1)
         READ (TEXT12(9:),'(A4)') BASE(ICELL+3*(I-1)+2)
         GO TO 180
  190    CALL LCMPUT(IPLIST,'CLUSTER',3*(I-1),3,BASE(ICELL))
         ISTATE(13)=I-1
         CALL RLSARA(BASE(ICELL))
         GO TO 35
      ELSE IF(TEXT12.EQ.'NPIN') THEN
*        INPUT NUMBER OF PINS IN CLUSTER RING.
         IF((ISTATE(1).NE.3).AND.(ISTATE(1).NE.6)) GO TO 500
         CALL REDGET(INDC,NPIN,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
         CALL LCMPUT(IPLIST,'NPIN',1,1,NPIN)
      ELSE IF((TEXT12.EQ.'RPIN').OR.(TEXT12.EQ.'APIN')) THEN
*        INPUT RADIUS/ANGLE OF CLUSTER RING.
         IF((ISTATE(1).NE.3).AND.(ISTATE(1).NE.6)) GO TO 500
         CALL REDGET(INDC,NITMA,PIN,TEXT12,DBLINP)
         IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
         CALL LCMPUT(IPLIST,TEXT12,1,2,PIN)
      ELSE IF(TEXT12.EQ.'BIHET') THEN
*        DOUBLE HETEROGENEITY OPTION.
         ISTATE(12)=1
         IF(LEVEL.NE.1) CALL XABORT
     >    (NAMSBR//': BIHET DATA SHOULD BE WRITTEN ON FIRST '//
     >             'DIRECTORY LEVEL.')
         CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.3) CALL XABORT(NAMSBR//': CHARACTER DATA EXPECTED.')
         IF(TEXT12.EQ.'TUBE') THEN
            MICRO=3
         ELSE IF(TEXT12.EQ.'SPHE') THEN
```

```
            MICRO=4
         ELSE
            CALL XABORT(NAMSBR//': PROHIBITED TYPE OF MICRO GEOMETRY.')
         ENDIF
         CALL LCMPUT(IPLIST,'MICRO',1,1,MICRO)
         CALL REDGET(INDC,NG,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
         CALL REDGET(INDC,NMILG,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
*
         CALL SETARA(IBASE,NG,INS)
         NSMAX=0
         DO 200 I=1,NG
         CALL REDGET(INDC,IBASE(INS+I-1),FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
  200    NSMAX=MAX(NSMAX,IBASE(INS+I-1))
         CALL LCMPUT(IPLIST,'NS',NG,1,IBASE(INS))
*
         CALL SETARA(BASE,(NSMAX+1)*NG,IRS)
         DO 205 IOFJ=1,(NSMAX+1)*NG
  205    BASE(IRS+IOFJ-1)=0.0
         DO 210 I=1,NG
         DO 210 J=1,IBASE(INS+I-1)+1
         IOFJ=(I-1)*(NSMAX+1)+J
         CALL REDGET(INDC,NITMA,BASE(IRS+IOFJ-1),TEXT12,DBLINP)
         IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
  210    CONTINUE
         CALL LCMPUT(IPLIST,'RS',(NSMAX+1)*NG,2,BASE(IRS))
         CALL RLSARA(BASE(IRS))
*
         CALL SETARA(IBASE,NMILG,IMILIE)
         DO 220 I=1,NMILG
         CALL REDGET(INDC,IBASE(IMILIE+I-1),FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
  220    CONTINUE
         CALL LCMPUT(IPLIST,'MILIE',NMILG,1,IBASE(IMILIE))
         CALL RLSARA(IBASE(IMILIE))
*
         CALL SETARA(IBASE,NMILG,IMIXDL)
         DO 230 I=1,NMILG
         CALL REDGET(INDC,IBASE(IMIXDL+I-1),FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.1) CALL XABORT(NAMSBR//': INTEGER DATA EXPECTED.')
  230    CONTINUE
         CALL LCMPUT(IPLIST,'MIXDIL',NMILG,1,IBASE(IMIXDL))
         CALL RLSARA(IBASE(IMIXDL))
*
         CALL SETARA(IBASE,NSMAX*NG*NMILG,IMIXGR)
         DO 235 IOFK=1,NSMAX*NG*NMILG
  235    IBASE(IMIXGR+IOFK-1)=0
         CALL SETARA(BASE,NG*NMILG,IFRACT)
         DO 250 I=1,NMILG
         DO 240 J=1,NG
         IOFJ=(I-1)*NG+J
         CALL REDGET(INDC,NITMA,BASE(IFRACT+IOFJ-1),TEXT12,DBLINP)
         IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
  240    CONTINUE
```

```
         DO 250 J=1,NG
         IOFJ=(I-1)*NG+J
         IF(BASE(IFRACT+IOFJ-1).GT.0.0) THEN
            DO 245 K=1,IBASE(INS+J-1)
            IOFK=((I-1)*NG+(J-1))*NSMAX+K
            CALL REDGET(INDC,IBASE(IMIXGR+IOFK-1),FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.1) CALL XABORT
     >        (NAMSBR//': INTEGER DATA EXPECTED.')
  245       CONTINUE
         ENDIF
  250    CONTINUE
         CALL LCMPUT(IPLIST,'FRACT',NG*NMILG,2,BASE(IFRACT))
         CALL RLSARA(BASE(IFRACT))
         CALL LCMPUT(IPLIST,'MIXGR',NSMAX*NG*NMILG,1,IBASE(IMIXGR))
         CALL RLSARA(IBASE(IMIXGR))
*
         CALL RLSARA(IBASE(INS))
      ELSE IF(TEXT12.EQ.'POURCE') THEN
*        CELL PROPORTIONS FOR DO-IT-YOURSELF OPTION.
         IF(ISTATE(1).NE.30) GO TO 500
         CALL SETARA(BASE,LX,IPOURC)
         DO 260 I=1,LX
         CALL REDGET(INDC,NITMA,BASE(IPOURC+I-1),TEXT12,DBLINP)
         IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
  260    CONTINUE
         CALL LCMPUT(IPLIST,'POURCE',LX,2,BASE(IPOURC))
         CALL RLSARA(BASE(IPOURC))
      ELSE IF(TEXT12.EQ.'PROCEL') THEN
*        CELL PROBABILITIES FOR DO-IT-YOURSELF OPTION.
         IF(ISTATE(1).NE.30) GO TO 500
         CALL SETARA(BASE,LX*LX,IPROCE)
         DO 270 I=1,LX
         DO 270 J=1,LX
         IOFJ=(J-1)*LX+I
         CALL REDGET(INDC,NITMA,BASE(IPROCE+IOFJ-1),TEXT12,DBLINP)
         IF(INDC.NE.2) CALL XABORT(NAMSBR//': REAL DATA EXPECTED.')
  270    CONTINUE
         CALL LCMPUT(IPLIST,'PROCEL',LX*LX,2,BASE(IPROCE))
         CALL RLSARA(BASE(IPROCE))
      ELSE IF((TEXT12(2:2).EQ.'+').OR.(TEXT12(2:2).EQ.'-').OR.
     1   (TEXT12.EQ.'HBC')) THEN
*        INPUT BOUNDARY CONDITIONS.
         IF(TEXT12.EQ.'X-') THEN
            ISURF=1
            IF(LX.EQ.0) GO TO 500
         ELSE IF(TEXT12.EQ.'X+') THEN
            ISURF=2
            IF(LX.EQ.0) GO TO 500
         ELSE IF(TEXT12.EQ.'R+') THEN
            ISURF=2
            IF(LR.EQ.0) GO TO 500
         ELSE IF(TEXT12.EQ.'Y-') THEN
            ISURF=3
            IF(LY.EQ.0) GO TO 500
         ELSE IF(TEXT12.EQ.'Y+') THEN
            ISURF=4
```

```
            IF(LY.EQ.0) GO TO 500
         ELSE IF(TEXT12.EQ.'Z-') THEN
            ISURF=5
            IF(LZ.EQ.0) GO TO 500
         ELSE IF(TEXT12.EQ.'Z+') THEN
            ISURF=6
            IF(LZ.EQ.0) GO TO 500
         ELSE IF(TEXT12.EQ.'HBC') THEN
            ISURF=1
            IF(.NOT.LHEX) CALL XABORT(NAMSBR//': HBC PROHIBITED.')
            CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
            IF(INDC.NE.3) CALL XABORT
     >        (NAMSBR//': CHARACTER DATA EXPECTED.')
            DO 280 I=1,MAXHEX
            IF(TEXT12.EQ.CHEX(I)) THEN
               IHEX=I
               GO TO 285
            ENDIF
  280       CONTINUE
            CALL XABORT(NAMSBR//': INVALID TYPE OF HEXAGONAL SYMMETRY.')
  285       CALL LCMPUT(IPLIST,'IHEX',1,1,IHEX)
         ELSE
            GO TO 500
         ENDIF
         CALL REDGET(INDC,NITMA,FLOTT,TEXT4,DBLINP)
         IF(INDC.NE.3) CALL XABORT(NAMSBR//': CHARACTER DATA EXPECTED.')
         DO 290 I=1,MAXCOD
         IF(TEXT4.EQ.COND(I)) THEN
            NCODE(ISURF)=I
            GO TO 295
         ENDIF
  290    CONTINUE
         CALL XABORT(NAMSBR//': INVALID TYPE OF BOUNDARY CONDITION.')
  295    IF(TEXT4.EQ.'ALBE') THEN
            CALL REDGET(INDC,NITMA,FLOTT,TEXT4,DBLINP)
            IF(INDC.EQ.1) THEN
               ICODE(ISURF)=NITMA
               MINICO=MIN(MINICO,NITMA)
            ELSE IF(INDC.EQ.2) THEN
               ZCODE(ISURF)=FLOTT
            ELSE
               CALL XABORT(NAMSBR//': INTEGER OR REAL DATA EXPECTED.')
            ENDIF
         ELSE IF(TEXT4.EQ.'REFL') THEN
            ZCODE(ISURF)=1.0
         ELSE IF(TEXT4.EQ.'VOID') THEN
            ZCODE(ISURF)=0.0
         ENDIF
      ELSE IF(TEXT12.EQ.';') THEN
*        END-OF-GEOMETRY.
         GO TO 320
      ELSE IF(TEXT12.EQ.':::') THEN
*        INPUT A SUB GEOMETRY.
         CALL REDGET(INDC,NITMA,FLOTT,TEXT12,DBLINP)
         IF(INDC.NE.3) CALL XABORT
     >     (NAMSBR//': CHARACTER DATA EXPECTED.')
```

```
         CALL REDGET(INDC,NITMA,FLOTT,TEXT4,DBLINP)
         IF((INDC.NE.3).OR.(TEXT4.NE.':=')) GO TO 500
         CALL REDGET(INDC,NITMA,FLOTT,TEXT4,DBLINP)
         IF((INDC.NE.3).OR.(TEXT4.NE.'GEO:')) GO TO 500
         CALL LCMLEN(IPLIST,TEXT12,ILONG,ITYX)
         IF(ILONG.NE.0) THEN
            IF(ITYX.NE.0) CALL XABORT
     >        (NAMSBR//': INVALID GEOMETRY NAME.')
         ELSE
            ISTATE(9)=ISTATE(9)+1
         ENDIF
         CALL LCMSIX(IPLIST,TEXT12,1)
         IMPX2=IMPX
         CALL GEOIN2(TEXT12,IPLIST,LEVEL+1,IMPX2,MAXMI2)
         CALL LCMSIX(IPLIST,' ',2)
         ISTATE(7)=MAX(ISTATE(7),MAXMI2)
      ELSE
         CALL XABORT(NAMSBR//': '//TEXT12//' IS AN INVALID KEY WORD.')
      ENDIF
      GO TO 30
*
  320 TEXT12='L_GEOM'
      READ(TEXT12,'(3A4)') (KCHAR(I1),I1=1,3)
      CALL LCMPUT(IPLIST,'SIGNATURE',3,3,KCHAR)
      CALL LCMPUT(IPLIST,'STATE-VECTOR',NSTATE,1,ISTATE)
      CALL LCMPUT(IPLIST,'NCODE',6,1,NCODE)
      CALL LCMPUT(IPLIST,'ZCODE',6,2,ZCODE)
      CALL LCMPUT(IPLIST,'ICODE',6,1,ICODE)
      IF(MINMIX.LT.0)
     >  CALL XABORT(NAMSBR//': NEGATIVE MIXTURE NUMBERS INVALID')
      IF(MINICO.LT.1)
     >  CALL XABORT(NAMSBR//': ALBEDO NUMBER MUST BE GREATER THAN 0')
      MAXMIX=ISTATE(7)
      IF(IMPX.GT.0) THEN
        NAMT=' '
        CALL LCMNXT(IPLIST,NAMT,TEXT12,TEXT13,LCM)
        WRITE(IOUT,6000) LEVEL,GEONAM,TEXT12,TYPE(ISTATE(1))
      ENDIF
      IF(IMPX.GT.1) THEN
        WRITE(IOUT,6010) ISTATE(1),TYPE(ISTATE(1)),(ISTATE(I),I=2,13)
      ENDIF
      IF((ISTATE(8).EQ.1).AND.(ISTATE(9).EQ.0)) GO TO 500
      RETURN
  500 CALL XABORT(NAMSBR//': INVALID DATA.')
*
 6000 FORMAT(/' CREATION OF A LEVEL ',I3,' GEOMETRY'/
     >        ' GEOMETRY NAME    = ',4X,A12/
     >        ' LINKED LIST NAME = ',4X,A12/
     >        ' GEOMETRY TYPE    = ',4X,A16)
 6010 FORMAT(/' GEOMETRY PARAMETER VECTOR:'/
     > ' ITYPE = ',I6,' (',A16,')'/
     > ' LR    = ',I6,' (NUMBER OF TUBES)'/
     > ' LX    = ',I6,' (X-DIMENSION INDEX)'/
     > ' LY    = ',I6,' (Y-DIMENSION INDEX)'/
     > ' LZ    = ',I6,' (Z-DIMENSION INDEX)'/
     > ' LREG  = ',I6,' (NUMBER OF REGIONS)'/
```

```
     > ' MAXMIX= ',I6,' (MAX. NB. OF MIXTURES/0=TRANSPARENT GEOMETRY)'/
     > ' ISUB1 = ',I6,' (1=COMMAND CELL IS USED/0=ELSE)'/
     > ' ISUB2 = ',I6,' (NUMBER OF SUB GEOMETRIES)'/
     > ' IMERGE= ',I6,' (1=CELL-MERGING/0=ELSE)'/
     > ' ISPLIT= ',I6,' (1=MESH-SPLITTING/0=ELSE)'/
     > ' IBIHET= ',I6,' (1=DOUBLE HETEROGENEITY/0=ELSE)'/
     > ' ICLUST= ',I6,' (NUMBER OF CLUSTER RINGS)'/)
      END
```

A.2 The EXCELT: Module

A.2.1 Subroutine LELCHK.f

```
*DECK LELCHK
      LOGICAL FUNCTION LELCHK(  NSOLD,  NVOLD, VOLOLD, MATOLD,  ICOLD,
     >                          NSNEW,  NVNEW, VOLNEW, MATNEW,  ICNEW,
     >                           IPRT )
************************************************************************
*                                                                      *
*           NAME: LELCHK                                               *
*      COMPONENT: EXCELL                                               *
*          LEVEL: 2 (CALLED BY 'EXCELT')                               *
*        VERSION: 1.0                                                  *
*       CREATION: 91/08                                                *
*       MODIFIED: 00/03 (R.R.) DECLARE ALL VARIABLE TYPES              *
*         AUTHOR: R. ROY                                               *
*                                                                      *
*     SUBROUTINE: THIS ROUTINE WILL CHECK COMPATIBILITY BETWEEN DATA   *
*                 IN THE OLD TRACKING FILE AND IN THE NEW GEOMETRY.    *
*                 THIS ROUTINE DOES NOT STOP THE EXECUTION.            *
*                                                                      *
*--------+------------- V A R I A B L E S -------------+--+-----------*
*  NAME  /                  DESCRIPTION                /IO/MOD(DIMENS)*
*--------+-------------------------------------------+--+-----------*
* NSOLD  / # OF SURFACES             IN TRACKING FILE.  /I./INT        *
* NVOLD  / # OF ZONES                IN TRACKING FILE.  /I./INT        *
* VOLOLD / VOLUMES & SURFACES        IN TRACKING FILE.  /I./REL(-NS:NV)*
* MATOLD / #ING OF SURFACES & ZONES  IN TRACKING FILE.  /I./INT(-NS:NV)*
* ICOLD  / INDEX OF B.C.             IN TRACKING FILE.  /I./INT(6)     *
* NSNEW  / # OF SURFACES             IN NEW GEOMETRY.   /I./INT        *
* NVNEW  / # OF ZONES                IN NEW GEOMETRY.   /I./INT        *
* VOLNEW / VOLUMES & SURFACES        IN NEW GEOMETRY.   /I./REL(-NS:NV)*
* MATNEW / #ING OF SURFACES & ZONES  IN NEW GEOMETRY.   /I./INT(-NS:NV)*
* ICNEW  / INDEX OF B.C.             IN NEW GEOMETRY.   /I./INT(6)     *
* IPRT   / PRINTING LEVEL ( 0: NO PRINT)                /I./INT        *
************************************************************************
      IMPLICIT    NONE
C
      INTEGER     NSOLD,NVOLD,MATOLD(-NSOLD:NVOLD),ICOLD(6),IPRT,IOUT,
     >            NSNEW,NVNEW,MATNEW(-NSOLD:NVOLD),ICNEW(6),IR,NERROC
      REAL        VOLOLD(-NSOLD:NVOLD),VOLNEW(-NSNEW:NVNEW),
     >            ZERO,HUND,EMAX
      PARAMETER ( IOUT=6, ZERO=0.0, HUND=100.0, EMAX=1.E-5 )
```

```
      LELCHK= .TRUE.
C
C1.1) CHECK # OF ZONES ------------------------------------------------
      IF( NVOLD.NE.NVNEW )THEN
         IF( IPRT.GT.0 )THEN
            WRITE(IOUT,'(40H *** INCONSISTENT # OF ZONES            )')
         ENDIF
         LELCHK=.FALSE.
         GO TO 999
      ENDIF
C
C1.2) CHECK # OF FACES ------------------------------------------------
      IF( NSOLD.NE.NSNEW )THEN
         IF( IPRT.GT.0 )THEN
            WRITE(IOUT,'(40H *** INCONSISTENT # OF FACES            )')
         ENDIF
         LELCHK=.FALSE.
         GO TO 999
      ENDIF
C
C1.3) CHECK CONSISTENCY OF INDEX *ICODE* ------------------------------
      DO 10 IR= 1, 6
         IF( ICOLD(IR).NE.ICNEW(IR) )THEN
            IF( IPRT.GT.0 )THEN
               WRITE(IOUT,'(9H   ICODE(,I1,3H)= ,I6,5H(WAS ,I6,1H))')
     >                                  IR,      ICNEW(IR), ICOLD(IR)
            ENDIF
            IF( ICOLD(IR).LE.0.OR.ICNEW(IR).LE.0 )THEN
               LELCHK=.FALSE.
               GO TO 999
            ENDIF
         ENDIF
   10 CONTINUE
C
C1.4) CHECK IF SOME FACES HAVE ICODE=0 --------------------------------
      DO 20 IR= -NSOLD, -1
         IF( ICNEW(-MATNEW(IR)).EQ.0 )THEN
            IF( IPRT.GT.0 )THEN
               WRITE(IOUT,'(9H    FACE(,I1,3H)= ,I6,12H HAS ICODE=0 )')
     >                                 -IR,      MATNEW(IR)
            ENDIF
            LELCHK=.FALSE.
            GO TO 999
         ENDIF
   20 CONTINUE
C
C2)   CHECK CONSISTENCY OF VECTORS *VOLSUR* AND *MATALB* --------------
      NERROC= 0
      DO 30 IR= -NSOLD, NVOLD
         IF( VOLOLD(IR)-VOLNEW(IR).GT.ZERO )THEN
            NERROC= NERROC+1
            IF( IR.EQ.0 ) GO TO 30
            LELCHK= LELCHK.AND.
     >              ABS((VOLNEW(IR)-VOLOLD(IR))/VOLOLD(IR)).LE.EMAX
         ENDIF
         IF( MATOLD(IR).NE.MATNEW(IR) )THEN
```

```
            NERROC= NERROC+1
            IF( IR.LE.0 ) LELCHK= .FALSE.
         ENDIF
   30 CONTINUE
      IF( IPRT.GT.0 )THEN
         WRITE(IOUT,'(1H )')
         IF( NERROC.EQ.0 )THEN
            WRITE(IOUT,'(60H ECHO = >>> CONSISTENCY BETWEEN '//
     >                 'TRACKING FILE AND GEOMETRY                 /)')
         ELSE
            WRITE(IOUT,'(60H ECHO = >>> WARNING: INCONSISTENT '//
     >                 'TRACKING FILE                              /)')
            DO 40 IR= -NSOLD, NVOLD
               IF( IR.EQ.0 ) GO TO 40
               IF( VOLOLD(IR)-VOLNEW(IR).GT.ZERO )THEN
               IF( IR.LE.0 )THEN
                  WRITE(IOUT,'(15H ERROR ON FACE(,I4,3H)= ,F10.7,1H%)')
     >                      -IR,HUND*(VOLNEW(IR)-VOLOLD(IR))/VOLOLD(IR)
               ELSE
                  WRITE(IOUT,'(15H ERROR ON ZONE(,I4,3H)= ,F10.7,1H%)')
     >                       IR,HUND*(VOLNEW(IR)-VOLOLD(IR))/VOLOLD(IR)
               ENDIF
               ENDIF
               IF( MATOLD(IR).NE.MATNEW(IR) )THEN
               IF( IR.LE.0 )THEN
                  WRITE(IOUT,'(9H    FACE(,I1,3H)= ,I6,5H(WAS ,I6,1H))')
     >                                     -IR,     MATNEW(IR),MATOLD(IR)
               ELSE
                  WRITE(IOUT,'(9H MIXTURE(,I1,3H)= ,I6,5H(WAS ,I6,1H))')
     >                                      IR,     MATNEW(IR),MATOLD(IR)
               ENDIF
               ENDIF
   40       CONTINUE
         ENDIF
      ENDIF
C
  999 RETURN
      END
```

A.2.2 Subroutine LELCRN.f

```
*DECK LELCRN
      FUNCTION LELCRN( CENTEC, RAYONC, X, Y)
************************************************************************
*                                                                      *
*           NAME: LELCRN                                               *
*      COMPONENT: EXCELL                                               *
*          LEVEL: 5 (CALLED BY 'KELRNG' & 'XELVOL')                    *
*        VERSION: 1.0                                                  *
*       CREATION: 90/02                                                *
*       MODIFIED: 00/03 (R.R.) DECLARE ALL VARIABLE TYPES              *
*         AUTHOR: ROBERT ROY                                           *
*                                                                      *
*     SUBROUTINE: THIS ROUTINE WILL DECIDE IF THE CROWN INTERSECT      *
```

```
*                 A RECTANGULAR MESH.                                  *
*                                                                      *
*--------+-------------- V A R I A B L E S -------------+--+-----------*
*  NAME  /                  DESCRIPTION                 /IO/MOD(DIMENS)*
*--------+----------------------------------------------+--+-----------*
* CENTEC / COORDIANTES OF CENTER.                       /I./REL(2)     *
* RAYONC / INNER AND OUTER RADIUS**2 OF THE CROWN.      /I./REL(2)     *
* X      / X OF THE SQUARE.                             /I./REL(2)     *
* Y      / Y OF THE SQUARE.                             /I./REL(2)     *
* LELCRN / .T. IF INTERSECTION EXISTS.                  /.O/LOGICAL    *
************************************************************************
C
      IMPLICIT NONE
      LOGICAL  LELCRN
C
      REAL CENTEC(2), RAYONC(2), X(2), Y(2), R
      INTEGER NBEXT, NBINT, IX, IY
C
      NBEXT=0
      NBINT=0
      DO 10 IX=1, 2
      DO 10 IY=1, 2
         R= (X(IX)-CENTEC(1))*(X(IX)-CENTEC(1))
     >    + (Y(IY)-CENTEC(2))*(Y(IY)-CENTEC(2))
         IF( R.LE.RAYONC(1) ) NBINT= NBINT+1
         IF( R.GE.RAYONC(2) ) NBEXT= NBEXT+1
   10 CONTINUE
      IF( NBINT.EQ.4 )THEN
C
C        RECTANGLE IS CONTAINED INSIDE THE INTERNAL RADIUS
         LELCRN=.FALSE.
      ELSEIF( NBEXT.EQ.4 )THEN
         IF( Y(1).LT.CENTEC(2).AND.CENTEC(2).LT.Y(2) )THEN
            IF( CENTEC(1).LT.X(1) )THEN
               LELCRN= (X(1)-CENTEC(1))*(X(1)-CENTEC(1)).LT.RAYONC(2)
            ELSEIF( X(2).LT.CENTEC(1) )THEN
               LELCRN= (X(2)-CENTEC(1))*(X(2)-CENTEC(1)).LT.RAYONC(2)
            ELSE
               LELCRN=.TRUE.
            ENDIF
         ELSEIF( X(1).LT.CENTEC(1).AND.CENTEC(1).LT.X(2) )THEN
            IF( CENTEC(2).LT.Y(1) )THEN
               LELCRN= (Y(1)-CENTEC(2))*(Y(1)-CENTEC(2)).LT.RAYONC(2)
            ELSEIF( Y(2).LT.CENTEC(2) )THEN
               LELCRN= (Y(2)-CENTEC(2))*(Y(2)-CENTEC(2)).LT.RAYONC(2)
            ELSE
               LELCRN=.TRUE.
            ENDIF
         ELSE
            LELCRN=.FALSE.
         ENDIF
      ELSE
         LELCRN=.TRUE.
      ENDIF
C
      RETURN
```

```
      END
```

A.2.3 Subroutine XELCOP.f

```
*DECK XELCOP
      SUBROUTINE XELCOP( IFILE1, IFILE2)
************************************************************************
*                                                                      *
*           NAME: XELCOP                                               *
*      COMPONENT: EXCELL                                               *
*          LEVEL: 2 (CALLED BY 'EXCELT')                               *
*        VERSION: 1.0                                                  *
*       CREATION: 91/07                                                *
*       MODIFIED: 00/03 (R.R.) DECLARE ALL VARIABLE TYPES              *
*         AUTHOR: ROBERT ROY                                           *
*                                                                      *
*     SUBROUTINE: THIS ROUTINE WILL COPY A DRAGON TRACKING FILE;       *
*                 THE FILE *IFILE1* IS COPIED OVER *IFILE2*.           *
*                                                                      *
*           NOTE: THE FILES "IFILE1" AND "IFILE2" ARE SUPPOSED TO BE:  *
*                 1) CONNECTED AND OPENED;                             *
*                 2) PLACED FOR ACCESSING THE FIRST RECORD (REWIND).   *
*                                                                      *
*--------+-------------- V A R I A B L E S -------------+--+-----------*
*  NAME  /                  DESCRIPTION                /IO/MOD(DIMENS)*
*--------+---------------------------------------------+--+-----------*
* IFILE1 / FIRST  TRACKING FILE # (AT INPUT).          /I./INT        *
* IFILE2 / SECOND TRACKING FILE # (AT OUTPUT).         /I./INT        *
************************************************************************
      IMPLICIT           NONE
C
      REAL               WEIGHT
      INTEGER            IFILE1,IFILE2,NCOMNT,NTRK,IREC,IC,IR,
     >                   NDIM,ISPEC,NV,NS,NALBG,NCOR,NANGL,MXSEG,IANG,
     >                   LINE,NUNKNO,VOLSUR,MATALB,ANGLES,DENSTY,
     >                   ICODE,ALBEDO,NRSEG,SEGLEN
      CHARACTER          CTRK*4, COMENT*80
      INTEGER            IOUT
      PARAMETER        ( IOUT=6 )
C
      REAL               RD
      COMMON             RD(1)
      INTEGER            ID(1)
      EQUIVALENCE       (RD(1),ID(1))
C
C.1)  READ AND COPY FIRST RECORDS (HEADER, COMMENTS) ------------------
C
      IREC= 1
      READ (IFILE1,ERR=991) CTRK,NCOMNT,NTRK
      WRITE(IFILE2,ERR=992) CTRK,NCOMNT,NTRK
      DO 10 IC= 1, NCOMNT
         IREC= IREC+1
         READ (IFILE1,ERR=991) COMENT
         WRITE(IFILE2,ERR=992) COMENT
```

```
   10 CONTINUE
C
C.2)  READ AND COPY MAIN RECORD AND GET USEFUL DIMENSIONS -------------
C
      IREC= IREC+1
      READ (IFILE1,ERR=991) NDIM,ISPEC,NV,NS,NALBG,NCOR,NANGL,MXSEG
      WRITE(IFILE2,ERR=992) NDIM,ISPEC,NV,NS,NALBG,NCOR,NANGL,MXSEG
      NUNKNO= NV+NS+1
C
C.2.1) ALLOCATE SPACE TO COPY SUBSEQUENT RECORDS
      CALL SETARA( RD,     NUNKNO, VOLSUR)
      CALL SETARA( ID,     NUNKNO, MATALB)
      CALL SETARA( ID,      NALBG,  ICODE)
      CALL SETARA( RD,      NALBG, ALBEDO)
      CALL SETARA( RD, NDIM*NANGL, ANGLES)
      CALL SETARA( RD,      NANGL, DENSTY)
      CALL SETARA( RD,      MXSEG, SEGLEN)
      CALL SETARA( ID,      MXSEG,  NRSEG)
C
C.2.2) COPY ALL RECORDS BEFORE TRACKS
      IREC= IREC+1
      READ (IFILE1,ERR=991) (RD(VOLSUR+IR),IR=0,NUNKNO-1)
      WRITE(IFILE2,ERR=992) (RD(VOLSUR+IR),IR=0,NUNKNO-1)
      IREC= IREC+1
      READ (IFILE1,ERR=991) (ID(MATALB+IR),IR=0,NUNKNO-1)
      WRITE(IFILE2,ERR=992) (ID(MATALB+IR),IR=0,NUNKNO-1)
      IREC= IREC+1
      READ (IFILE1,ERR=991) (ID( ICODE+IR),IR=0,NALBG-1)
      WRITE(IFILE2,ERR=992) (ID( ICODE+IR),IR=0,NALBG-1)
      IREC= IREC+1
      READ (IFILE1,ERR=991) (RD(ALBEDO+IR),IR=0,NALBG-1)
      WRITE(IFILE2,ERR=992) (RD(ALBEDO+IR),IR=0,NALBG-1)
      IREC= IREC+1
      READ (IFILE1,ERR=991) (RD(ANGLES+IR),IR=0,NDIM*NANGL-1)
      WRITE(IFILE2,ERR=992) (RD(ANGLES+IR),IR=0,NDIM*NANGL-1)
      IREC= IREC+1
      READ (IFILE1,ERR=991) (RD(DENSTY+IR),IR=0,NANGL-1)
      WRITE(IFILE2,ERR=992) (RD(DENSTY+IR),IR=0,NANGL-1)
C
C.3)   NOW, COPY ALL TRACKS -------------------------------------------
C
   20 CONTINUE
         IREC= IREC + 1
         READ (IFILE1,END=40,ERR=991) IANG,LINE,WEIGHT,
     >                       (ID(NRSEG +IR),IR=0,LINE-1),
     >                       (RD(SEGLEN+IR),IR=0,LINE-1)
         WRITE(IFILE2,       ERR=992) IANG,LINE,WEIGHT,
     >                       (ID(NRSEG +IR),IR=0,LINE-1),
     >                       (RD(SEGLEN+IR),IR=0,LINE-1)
      GO TO 20
C
   40 CONTINUE
C
C.4)   RELEASE TEMPORARY SPACE AND REWIND BOTH FILES ------------------
C
      CALL RLSARA( ID(  NRSEG ))
```

```
      CALL RLSARA( RD( SEGLEN ))
      CALL RLSARA( RD( DENSTY ))
      CALL RLSARA( RD( ANGLES ))
      CALL RLSARA( RD( ALBEDO ))
      CALL RLSARA( ID(  ICODE ))
      CALL RLSARA( ID( MATALB ))
      CALL RLSARA( RD( VOLSUR ))
      REWIND IFILE1
      REWIND IFILE2
      RETURN
C
  991 WRITE(IOUT,'(30H ERROR= RECORD DESTROYED...    )')
      WRITE(IOUT,'(31H ERROR= UNABLE TO READ  RECORD ,I10)') IREC
      WRITE(IOUT,'(31H ERROR=              ON FILE FT,I2.2)') IFILE1
      CALL XABORT( 'XELCOP: --- READ  TRACKING FILE FAILED' )
  992 WRITE(IOUT,'(30H ERROR= NOT ENOUGH SPACE...    )')
      WRITE(IOUT,'(31H ERROR= UNABLE TO WRITE RECORD ,I8.8)') IREC
      WRITE(IOUT,'(31H ERROR=              ON FILE FT,I2.2)') IFILE1
      CALL XABORT( 'XELCOP: --- WRITE TRACKING FILE FAILED' )
C
      END
```

A.2.4 Subroutine XELCRN.f

```
*DECK XELCRN
      SUBROUTINE XELCRN(IPRINT,RANN2,NRSPX,NRSPY,SPAT,AREAI)
C
C-------------------------    XELCRN    -------------------------------
C
C 1- PROGRAMME STATISTICS:
C          NAME: XELCRN
C     COMPONENT: EXLELL GEOMETRY ANALYSIS
C     CALLED BY: XELVOL
C       CALLING: XELPSC, XELPSI
C       VERSION: 1.0
C      CREATION: 97/10/31
C        AUTHOR: G. MARLEAU
C           USE: FIND 2-D SURFACE OF INTERSECTION BETWEEN
C                ANNULAR REGION AND CARTESIAN PLANE
C 2- INPUT
C   IPRINT : PRINT LEVEL                            I
C            ACTIVE IF >=10
C   RANN2  : ANNULAR REGION  RADIUS**2              R
C   NRSPX  : NUMBER OF MESH IN X- DIRECTION         I
C   NRSPY  : NUMBER OF MESH IN X- DIRECTION         I
C   SPAT   : SPATIAL MESH X-DIRECTION               R(NRSPX+1,NRSPY+1)
C            SPAT(1,1)       = LOWER X - POSITION
C            SPAT(NRSPX+1,1) = UPPER X - POSITION
C            SPAT(1,2)       = LOWER Y - POSITION
C            SPAT(NRSPY+1,2) = UPPER Y - POSITION
C 3- OUTPUT
C   AREAI  : AREA OF INTERSECTION                   R(NRSPX,NRSPY)
C 5- INTERNAL PARAMETERS
C   IOUT   : OUTPUT UNIT  = 6                       I
```

```
C   PI     : VALUE OF PI = 3.14159265359            R
C   NAMSBR : SUBROUTINE NAME = 'XELCRN'             C*6
C
C-------------------------    XELCRN    -------------------------------
C
      IMPLICIT     NONE
      INTEGER      IPRINT,NRSPX,NRSPY
      REAL         RANN2,SPAT(NRSPX+1,NRSPY+1),
     >             AREAI(NRSPX,NRSPY)
C----
C  INTERNAL PARAMETERS
C----
      INTEGER      IOUT
      REAL         PI
      CHARACTER    NAMSBR*6
      PARAMETER   (IOUT=6,PI=3.141592653589,NAMSBR='XELCRN')
C----
C  LOCAL VARIABLES
C----
      INTEGER      IRP(2,2),IX,NMX,IY,NMY
      REAL         XELPSC,XELPSI,XYPOS(2,2),XYPOS2(2,2),
     >             SPXY(2,2),SIXY(2,2),RANN,SURANN
C----
C  COMPUTE GENERAL ANNULAR REGION INFORMATIONS
C    RANN   = ANNULAR REGION RADIUS
C    SURANN = ANNULAR SURFACE
C  COMPUTE CARTESIAN PARAMETERS
C    NMX =NRSPX+1
C    NMY =NRSPY+1
C  INITIALIZE AREAI TO 0.0
C----
      RANN=SQRT(RANN2)
      SURANN=PI*RANN2
      NMX=NRSPX+1
      NMY=NRSPY+1
      CALL XDRSET(AREAI,NRSPX*NRSPY,0.0)
C----
C  PRINT INITIAL MESH IF REQUIRED
C-----
      IF(IPRINT .GE. 10) THEN
        WRITE(IOUT,6000)
        WRITE(IOUT,6002) 'ANNULAR RADIUS  '
        WRITE(IOUT,6003) RANN
        WRITE(IOUT,6002) 'ANNULAR SURFACE '
        WRITE(IOUT,6003) SURANN
        WRITE(IOUT,6002) 'X-DIRECTED MESH '
        WRITE(IOUT,6003) (SPAT(IX,1),IX=1,NRSPX+1)
        WRITE(IOUT,6002) 'Y-DIRECTED MESH '
        WRITE(IOUT,6003) (SPAT(IY,2),IY=1,NRSPY+1)
        WRITE(IOUT,6002) 'X-Y SURFACES    '
        WRITE(IOUT,6003) (( (SPAT(IX+1,1)-SPAT(IX,1))
     >                     *(SPAT(IY+1,2)-SPAT(IY,2)),
     >                     IX=1,NRSPX),IY=1,NRSPY)
      ENDIF
C----
C  CYCLE OVER CARTESIAN Y-DIRECTIONS STARTING FROM THE END
```

```
C  AND LOCATE Y-MESH POSITION WITH RESPECT TO ANNULUS CENTER
C----
      SPXY(2,2)=0.0
      DO 110 IY=NMY,1,-1
        XYPOS(2,1)=SPAT(IY,2)
        XYPOS2(2,1)=XYPOS(2,1)*XYPOS(2,1)
C----
C  FIND IF ANNULUS ABOVE, BELOW OR INTERSECT CURRENT Y-PLANE
C  AND COMPUTE
C    SPXY = ANNULAR SURFACE BELOW CURRENT PLANE
C  IF ANNULUS BELOW CURRENT PLANE (XYPOS(2,1)>= RANN)
C    IRPY(2,1)=-1
C    SPXY(2,1)=SURANN
C  IF ANNULUS ABOVE CURRENT PLANE (XYPOS(2,1)<= -RANN)
C    IRPY(2,1)= 1
C    SPXY(2,1)=0.0
C  IF ANNULUS INTERSECT CURRENT ( -RANN < XYPOS(2,1) < RANN)
C    IRPY(2,1)= 0
C    SPXY=XELPSC(RANN,XYPOS(2,1))
C----
        IF(XYPOS(2,1) .GE. RANN) THEN
          IRP(2,1)=-1
          SPXY(2,1)=SURANN
        ELSE IF(XYPOS(2,1) .LE. -RANN) THEN
          IRP(2,1)=1
          SPXY(2,1)=0.0
        ELSE
          IRP(2,1)=0
          SPXY(2,1)=XELPSC(RANN,XYPOS(2,1))
        ENDIF
C----
C  FOR LAST PLANE IN Y DIRECTION OR
C  Y-PLANE ABOVE ANNULAR VOLUME
C  GO TO LABEL 111
C----
        IF(IY .EQ. NMY .OR. IRP(2,1) .EQ. -1) GO TO 111
C----
C  CYCLE OVER CARTESIAN X-DIRECTIONS STARTING FROM THE END
C  AND LOCATE X-MESH POSITION WITH RESPECT TO ANN CENTER
C----
        SPXY(1,2)=0.0
        SIXY(2,1)=0.0
        SIXY(2,2)=0.0
        DO 120 IX=NMX,1,-1
          XYPOS(1,1)=SPAT(IX,1)
          XYPOS2(1,1)=XYPOS(1,1)*XYPOS(1,1)
C----
C  FIND IF ANNULUS LEFT, RIGHT OR INTERSECT CURRENT X-PLANE
C  AND COMPUTE
C    SPXY      THE  ANNULAR SURFACE LEFT OF CURRENT PLANE
C    SIXY(1,1) THE INTERSECTION BETWEEN THE PART OF THE ANNULUS
C              THE LEFT OF X-PLANE
C              AND THE PART OF THE ANNULUS AT
C              THE BOTTOM OF CURRENT Y-PLANE
C    SIXY(1,2) THE INTERSECTION BETWEEN THE PART OF THE ANNULUS
C              THE LEFT OF X-PLANE
```

```
C              AND THE PART OF THE ANNULUS AT
C              THE TOP OF PREVIOUS Y-PLANE
C  IF ANNULUS TO THE LEFT OF CURRENT PLANE (XYPOS(1,1)>= RANN)
C    IRPY(1,1)=-1
C    SPXY(1,1)=SURANN
C    SIXY(1,1)=SPXY(2,1)
C    SIXY(1,2)=SPXY(2,2)
C  IF ANNULUS TO THE RIGHT OF CURRENT (XYPOS(1,1)<= -RANN)
C    IRPY(1,1)= 1
C    SPXY(1,1)=0.0
C    SIXY(1,1)=0.0
C    SIXY(1,2)=0.0
C  IF ANNULUS INTERSECT CURRENT PLANE ( -RANN < XYPOS(1,1) < RANN)
C    IRPY(1,1)= 0
C    SPXY=XELPSC(RANN,XYPOS(1,1))
C    SIXY(1,1)=GEOPSI(1,RANN2,XYPOS,XYPOS2,SPXY)
C    SIXY(1,2)=GEOPSI(2,RANN2,XYPOS,XYPOS2,SPXY)
C----
          SPXY(1,1)=0.0
          SIXY(1,1)=0.0
          SIXY(1,2)=0.0
          IF(XYPOS(1,1) .GE. RANN) THEN
            IRP(1,1)=-1
            SPXY(1,1)=SURANN
            SIXY(1,1)=SPXY(2,1)
            SIXY(1,2)=SPXY(2,2)
          ELSE IF(XYPOS(1,1) .LE. -RANN) THEN
            IRP(1,1)=1
          ELSE
            IRP(1,1)=0
            SPXY(1,1)=XELPSC(RANN,XYPOS(1,1))
            IF(IRP(2,1) .EQ. 0)
     >        SIXY(1,1)=XELPSI(1,RANN2,XYPOS,XYPOS2,SPXY)
            IF(IRP(2,2) .EQ. 0)
     >        SIXY(1,2)=XELPSI(2,RANN2,XYPOS,XYPOS2,SPXY)
          ENDIF
C----
C  FOR LAST PLANE IN X DIRECTION OR
C  X-PLANE TO THE RIGHT OF ANNULAR VOLUME
C  GO TO LABEL 121
C----
          IF(IX .EQ. NMX .OR. IRP(1,1) .EQ. -1) GO TO 121
C----
C  GET SURFACE INTERSECTION BETWEEN ANNULUS AND CARTESIAN REGION
C  LOCATED BETWEEN X-PLANES (IX-> IX+1) AND Y-PLANES (IX -> IY+1)
C  AND STORE IN AREAI(IX,IY)
C----
            AREAI(IX,IY)=SURANN
     >       -SPXY(1,1)-SPXY(1,2)-SPXY(2,1)-SPXY(2,2)
     >       +SIXY(1,1)+SIXY(2,1)+SIXY(1,2)+SIXY(2,2)
C----
C  WHEN ANNULUS ALL LOCATED TO THE RIGHT OF CURRENT X-PLANE
C  EXIT FROM IX LOOP BY GOING TO LABLE 122
C---
          IF(IRP(1,1) .EQ. 1) GO TO 122
 121      CONTINUE
```

```
C----
C  RESET IN LOCATION 2 VALUES COMPUTED WITH LOCATION 1
C  WITH ADEQUATE CHANGE OF SIGN FOR SURFACE DIRECTION
C  NAMELY SURFACES LOCATED ON THE LEFT OF X-PLANE BECOME SURFACES
C  LOCATED ON THE RIGHT OF X-PLANE
C----
          SIXY(2,1)=SPXY(2,1)-SIXY(1,1)
          SIXY(2,2)=SPXY(2,2)-SIXY(1,2)
          XYPOS(1,2)=XYPOS(1,1)
          XYPOS2(1,2)=XYPOS2(1,1)
          IRP(1,2)=-IRP(1,1)
          SPXY(1,2)=SURANN-SPXY(1,1)
 120    CONTINUE
 122    CONTINUE
C----
C  WHEN ANNULUS ALL LOCATED ABOVE CURRENT Y-PLANE
C  EXIT FROM IY LOOP BY GOING TO LABLE 112
C---
        IF(IRP(2,1) .EQ. 1) GO TO 112
 111    CONTINUE
C----
C  RESET IN LOCATION 2 VALUES COMPUTED WITH LOCATION 1
C  WITH ADEQUATE CHANGE OF SIGN FOR SURFACE DIRECTION
C  NAMELY SURFACES LOCATED ON THE BELOW Y-PLANE BECOME SURFACES
C  LOCATED ABOVE Y-PLANE
C----
        XYPOS(2,2)=XYPOS(2,1)
        XYPOS2(2,2)=XYPOS2(2,1)
        IRP(2,2)=-IRP(2,1)
        SPXY(2,2)=SURANN-SPXY(2,1)
 110  CONTINUE
 112  CONTINUE
C----
C  PRINT SURFACE INTERSECTIONS IF REQUIRED
C-----
      IF(IPRINT.GE.10) THEN
        WRITE(IOUT,6002) 'CART-ANN AREA   '
        WRITE(IOUT,6003) ((AREAI(IX,IY),IX=1,NRSPX),IY=1,NRSPY)
        WRITE(IOUT,6001)
      ENDIF
C----
C  RETURN
C----
      RETURN
C----
C  PRINT FORMAT
C----
 6000 FORMAT(/5X,'------ OUTPUT FROM XELCRN ------ ')
 6001 FORMAT(5X,' -------------------------------- '/)
 6002 FORMAT(5X,A16)
 6003 FORMAT(1P,5E16.6)
      END
```

A.2.5 Subroutine XELEQN.f

```
*DECK XELEQN
      SUBROUTINE XELEQN( NDIM, NANGLE, ANGEQN )
************************************************************************
*                                                                      *
*           NAME: XELEQN                                               *
*      COMPONENT: EXCELL                                               *
*          LEVEL: 4 (CALLED BY 'XELTI2' & 'XELTI3')                    *
*        VERSION: 1.0                                                  *
*       CREATION: 89/01                                                *
*       MODIFIED: 00/03 (R.R.) DECLARE ALL VARIABLE TYPES              *
*         AUTHOR: ROBERT ROY                                           *
*                                                                      *
*     SUBROUTINE: THIS ROUTINE WILL COPY GENERATED ANGLES ACCORDING    *
*                 TO THE "EQN" STANDARD.                               *
*                                                                      *
*--------+-------------- V A R I A B L E S -------------+--+-----------*
*  NAME  /                  DESCRIPTION                /IO/MOD(DIMENS)*
*--------+---------------------------------------------+--+-----------*
* NDIM   / # OF DIMENSIONS (2 OR 3).                   /I./INT        *
* NANGLE / # OF ANGLES.                                /I./INT        *
* ANGEQN / BASIS FOR ANGLES IN 2D.                     /.O/REL(2,2) OR*
*        /                  OR 3D.                     /  /REL(3,3)   *
************************************************************************
C
      IMPLICIT   NONE
C
      INTEGER    NDIM, NANGLE
C
      REAL       SN2 ( 1), SN4 ( 2), SN6 ( 4), SN8 ( 6), SN10( 8),
     >           SN12(11), SN14(14), SN16(17), SNT (63),
     >           ANGEQN( NDIM, NDIM), THETA, DTHETA
      INTEGER    MU2 ( 1), MU4 ( 3), MU6 ( 6), MU8 (10), MU10(15),
     >           MU12(21), MU14(28), MU16(36), MUT(120),
     >           ET2 ( 1), ET4 ( 3), ET6 ( 6), ET8 (10), ET10(15),
     >           ET12(21), ET14(28), ET16(36), ETT(120),
     >           XH2 ( 1), XH4 ( 3), XH6 ( 6), XH8 (10), XH10(15),
     >           XH12(21), XH14(28), XH16(36), XHT(120),
     >           INSN( 9), JNMU( 9)
      EQUIVALENCE (SNT( 1), SN2), (SNT( 2), SN4), (SNT( 4), SN6),
     >            (SNT( 8), SN8), (SNT(14),SN10), (SNT(22),SN12),
     >            (SNT(33),SN14), (SNT(47),SN16)
      EQUIVALENCE (MUT( 1), MU2), (MUT( 2), MU4), (MUT( 5), MU6),
     >            (MUT(11), MU8), (MUT(21),MU10), (MUT(36),MU12),
     >            (MUT(57),MU14), (MUT(85),MU16)
      EQUIVALENCE (ETT( 1), ET2), (ETT( 2), ET4), (ETT( 5), ET6),
     >            (ETT(11), ET8), (ETT(21),ET10), (ETT(36),ET12),
     >            (ETT(57),ET14), (ETT(85),ET16)
      EQUIVALENCE (XHT( 1), XH2), (XHT( 2), XH4), (XHT( 5), XH6),
     >            (XHT(11), XH8), (XHT(21),XH10), (XHT(36),XH12),
     >            (XHT(57),XH14), (XHT(85),XH16)
      INTEGER     NANG, NO2LIM, INDEL, NO2, ICUR, IPOS, IEND
      REAL        XPOS, YPOS, ZPOS, X, Y, Z, SUPX, SUPY, SUPZ,
     >            OOSUPX, OOSUPY, OOSUPZ, XOSUPX, YOSUPY, ZOSUPZ
      REAL        PI
      PARAMETER ( PI = 3.1415926535 )
      SAVE
```

```
C
      DATA  NANG,  NO2LIM / -1,  8  /
      DATA  INSN/  0,  1,  3,  7, 13, 21, 32, 46, 63/
      DATA  JNMU/  0,  1,  4, 10, 20, 35, 56, 84,120/
C
      DATA  SN2 /  .577350269/
      DATA  SN4 /  .350021174,  .868890300/
      DATA  SN6 /  .2561429  ,  .9320846  ,
     >             .2663443  ,  .6815646  /
      DATA  SN8 /  .1971380  ,  .9603506  ,
     >             .2133981  ,  .5512958  ,  .8065570  ,
     >             .5773503  /
      DATA  SN10/  .1631408  ,  .9730212  ,
     >             .1755273  ,  .6961286  ,
     >                          .4567576  ,  .8721024  ,
     >             .4897749  ,  .7212773  /
      DATA  SN12/  .1370611  ,  .9810344  ,
     >             .1497456  ,  .3911744  ,  .9080522  ,
     >                          .6040252  ,  .7827706  ,
     >             .4213515  ,  .8030727  ,
     >             .4249785  ,  .6400755  /
      DATA  SN14/  .1196230  ,  .9855865  ,
     >             .1301510  ,  .3399238  ,  .9314035  ,
     >                          .5326134  ,  .8362916  ,
     >                          .7010923  ,
     >             .3700559  ,  .8521252  ,
     >             .3736108  ,  .5691823  ,  .7324250  ,
     >             .577350269/
      DATA  SN16/  .1050159  ,  .9889102  ,
     >             .1152880  ,  .3016701  ,  .9464163  ,
     >                          .4743525  ,  .8727534  ,
     >                          .6327389  ,  .7657351  ,
     >             .3284315  ,  .8855877  ,
     >             .3332906  ,  .5107319  ,  .7925089  ,
     >                          .6666774  ,
     >             .5215431  ,  .6752671  /
C
      DATA  MU2 /  1/
      DATA  MU4 /  1,  1,  2/
      DATA  MU6 /  1,  3,  1,  4,  4,  2/
      DATA  MU8 /  1,  3,  3,  1,  4,  6,  4,  5,  5,  2/
      DATA  MU10/  1,  3,  3,  3,  1,  5,  7,  7,  5,  4,
     >             8,  4,  6,  6,  2/
      DATA  MU12/  1,  3,  3,  3,  3,  1,  4,  8, 10,  8,
     >             4,  6, 11, 11,  6,  7,  9,  7,  5,  5,
     >             2/
      DATA  MU14/  1,  3,  3,  3,  3,  3,  1,  4,  9, 11,
     >            11,  9,  4,  6, 12, 14, 12,  6,  8, 13,
     >            13,  8,  7, 10,  7,  5,  5,  2/
      DATA  MU16/  1,  3,  3,  3,  3,  3,  3,  1,  4, 10,
     >            12, 12, 12, 10,  4,  6, 13, 16, 16, 13,
     >             6,  8, 15, 17, 15,  8,  9, 14, 14,  9,
     >             7, 11,  7,  5,  5,  2/
C
      DATA  ET2 /  1/
      DATA  ET4 /  1,  2,  1/
```

```
      DATA  ET6 /  1,  4,  2,  3,  4,  1/
      DATA  ET8 /  1,  4,  5,  2,  3,  6,  5,  3,  4,  1/
      DATA  ET10/  1,  5,  4,  6,  2,  3,  7,  8,  6,  3,
     >             7,  4,  3,  5,  1/
      DATA  ET12/  1,  4,  6,  7,  5,  2,  3,  8, 11,  9,
     >             5,  3, 10, 11,  7,  3,  8,  6,  3,  4,
     >             1/
      DATA  ET14/  1,  4,  6,  8,  7,  5,  2,  3,  9, 12,
     >            13, 10,  5,  3, 11, 14, 13,  7,  3, 11,
     >            12,  8,  3,  9,  6,  3,  4,  1/
      DATA  ET16/  1,  4,  6,  8,  9,  7,  5,  2,  3, 10,
     >            13, 15, 14, 11,  5,  3, 12, 16, 17, 14,
     >             7,  3, 12, 16, 15,  9,  3, 12, 13,  8,
     >             3, 10,  6,  3,  4,  1/
C
      DATA  XH2 /  1/
      DATA  XH4 /  2,  1,  1/
      DATA  XH6 /  2,  4,  1,  4,  3,  1/
      DATA  XH8 /  2,  5,  4,  1,  5,  6,  3,  4,  3,  1/
      DATA  XH10/  2,  6,  4,  5,  1,  6,  8,  7,  3,  4,
     >             7,  3,  5,  3,  1/
      DATA  XH12/  2,  5,  7,  6,  4,  1,  5,  9, 11,  8,
     >             3,  7, 11, 10,  3,  6,  8,  3,  4,  3,
     >             1/
      DATA  XH14/  2,  5,  7,  8,  6,  4,  1,  5, 10, 13,
     >            12,  9,  3,  7, 13, 14, 11,  3,  8, 12,
     >            11,  3,  6,  9,  3,  4,  3,  1/
      DATA  XH16/  2,  5,  7,  9,  8,  6,  4,  1,  5, 11,
     >            14, 15, 13, 10,  3,  7, 14, 17, 16, 12,
     >             3,  9, 15, 16, 12,  3,  8, 13, 12,  3,
     >             6, 10,  3,  4,  3,  1/
C
      IF( NDIM.EQ.3 )THEN
         IF( NANGLE.NE.NANG )THEN
            NANG  = NANGLE
            INDEL = 0
            NO2   = NANGLE/2
            IF( NO2.EQ.0 )RETURN
            IF( NO2.LT.1 .OR. NO2.GT.NO2LIM )
     >         CALL XABORT('XELEQN: TOO MANY ANGLES ')
            IPOS  = INSN( NO2 )
            ICUR  = JNMU( NO2 )
            IEND  = JNMU( NO2 + 1)
         ENDIF
         INDEL = INDEL + 1
         IF    ( MOD(INDEL, 3).EQ.1 )THEN
            IF    ( MOD(INDEL, 4).EQ.1 )THEN
               ICUR  = ICUR + 1
               IF( ICUR.GT.IEND )
     >            CALL XABORT('XELEQN: NO MORE ANGLES ')
               XPOS  = SNT( MUT(ICUR) + IPOS )
               YPOS  = SNT( ETT(ICUR) + IPOS )
               ZPOS  = SNT( XHT(ICUR) + IPOS )
               X     = XPOS
               Y     = YPOS
               Z     = ZPOS
```

```
               SUPX  = SQRT( 1.0 - X * X )
               SUPY  = SQRT( 1.0 - Y * Y )
               SUPZ  = SQRT( 1.0 - Z * Z )
               OOSUPX= 1.0 / SUPX
               OOSUPY= 1.0 / SUPY
               OOSUPZ= 1.0 / SUPZ
            ELSEIF( MOD(INDEL, 4).EQ.2 )THEN
               X     = -XPOS
               Y     =  YPOS
            ELSEIF( MOD(INDEL, 4).EQ.3 )THEN
               X     =  XPOS
               Y     = -YPOS
            ELSE
               X     = -XPOS
               Y     = -YPOS
            ENDIF
            XOSUPX=  X  / SUPX
            YOSUPY=  Y  / SUPY
            ZOSUPZ=  Z  / SUPZ
C
C           SOLID ANGLE DIRECTION
            ANGEQN( 1, 1 )= X
            ANGEQN( 2, 1 )= Y
            ANGEQN( 3, 1 )= Z
C
C           DIRECTIONS PERPENDICULAR TO THIS SOLID ANGLE
            ANGEQN( 1, 2 )= -Y * OOSUPZ
            ANGEQN( 2, 2 )=  X * OOSUPZ
            ANGEQN( 3, 2 )=         0.0
C
            ANGEQN( 1, 3 )=  X * ZOSUPZ
            ANGEQN( 2, 3 )=  Y * ZOSUPZ
            ANGEQN( 3, 3 )=      - SUPZ
         ELSEIF( MOD(INDEL, 3).EQ.2 )THEN
C
C           SOLID ANGLE DIRECTION
            ANGEQN( 1, 1 )= X
            ANGEQN( 2, 1 )= Y
            ANGEQN( 3, 1 )= Z
C
C           DIRECTIONS PERPENDICULAR TO THIS SOLID ANGLE
            ANGEQN( 1, 2 )= -Z * OOSUPY
            ANGEQN( 2, 2 )=         0.0
            ANGEQN( 3, 2 )=  X * OOSUPY
C
            ANGEQN( 1, 3 )=  X * YOSUPY
            ANGEQN( 2, 3 )=      - SUPY
            ANGEQN( 3, 3 )=  Z * YOSUPY
         ELSE
C
C           SOLID ANGLE DIRECTION
            ANGEQN( 1, 1 )= X
            ANGEQN( 2, 1 )= Y
            ANGEQN( 3, 1 )= Z
C
C           DIRECTIONS PERPENDICULAR TO THIS SOLID ANGLE
```

```
            ANGEQN( 1, 2 )=         0.0
            ANGEQN( 2, 2 )= -Z * OOSUPX
            ANGEQN( 3, 2 )=  Y * OOSUPX
C
            ANGEQN( 1, 3 )=      - SUPX
            ANGEQN( 2, 3 )=  Y * XOSUPX
            ANGEQN( 3, 3 )=  Z * XOSUPX
         ENDIF
      ELSEIF( NDIM.EQ.2 )THEN
         IF( NANGLE.NE.NANG )THEN
            NANG  = NANGLE
            IF( NANG.EQ.0 )RETURN
            DTHETA =   PI / NANG
            IF( NANG.GT.0 )THEN
               THETA  = -0.5 * DTHETA
            ELSE
               THETA  =  0.5 * DTHETA
            ENDIF
            INDEL  = 0
         ENDIF
         INDEL = INDEL + 1
         IF( INDEL.GT.NANG ) CALL XABORT( 'XELEQN: NO MORE ANGLES ' )
         THETA = THETA + DTHETA
C
C        SOLID ANGLE DIRECTION
         ANGEQN( 1, 1 )=  COS(THETA)
         ANGEQN( 2, 1 )=  SIN(THETA)
C
C        DIRECTIONS PERPENDICULAR TO THIS SOLID ANGLE
         ANGEQN( 1, 2 )= -SIN(THETA)
         ANGEQN( 2, 2 )=  COS(THETA)
      ELSE
         CALL XABORT( 'XELEQN: *** FALSE NDIM VALUE')
      ENDIF
      RETURN
      END
```

A.2.6 Subroutine XELPRC.f

```
*DECK XELPRC
      SUBROUTINE XELPRC (IPGEOM,GEONAM,NDIM,NNCYL,NNSUR,NNVOL,NAXREM,
     >                   ISPLT)
************************************************************************
*                                                                      *
*           NAME: XELPRC                                               *
*      COMPONENT: EXCELL                                               *
*          LEVEL: 4 (CALLED BY 'XELDCL')                               *
*        VERSION: 1.0                                                  *
*       CREATION: 89/12                                                *
*       MODIFIED: 97/11 (G.M.) ELIMINATE SPLIT>2 ABORT                 *
*                 00/03 (R.R.) DECLARE ALL VARIABLE TYPES              *
*         AUTHOR: ROBERT ROY                                           *
*                                                                      *
*     SUBROUTINE: THIS ROUTINE READS A CELL GEOMETRY ON LCM AND        *
```

```
*                 CHECK IF THE GEOMETRY IS ACCEPTABLE FOR "EXCELL".    *
*                                                                      *
*--------+-------------- V A R I A B L E S -------------+--+-----------*
*  NAME  /                  DESCRIPTION                /IO/MOD(DIMENS)*
*--------+---------------------------------------------+--+-----------*
* IPGEOM / POINTER TO THE GEOMETRY (L_GEOM)             /I./INT        *
* GEONAM / GEOMETRY NAME                                /I./CAR*12     *
* NDIM   / # OF DIMENSIONS ( 2 OR 3)                    /I./INT        *
* NNCYL  / # OF CYLINDERS IN THE GEOMETRY               /.O/INT        *
* NNSUR  / # OF SURFACES                                /.O/INT        *
* NNVOL  / # OF VOLUMES                                 /.O/INT        *
* NAXREM / MAX # OF COORDINATES TO SPECIFY THAT CELL    /.O/INT        *
************************************************************************
C
      IMPLICIT     NONE
C
C     DECLARE      DUMMY ARGUMENTS
      INTEGER      IPGEOM, NDIM, NNCYL, NNSUR, NNVOL, NAXREM, ISPLT(*)
      CHARACTER*12 GEONAM
C
C     DECLARE      LOCAL VARIABLES
      INTEGER      NLCM, NIXS, NIST, NSTATE
      PARAMETER  ( NLCM=33, NIXS=19, NIST=4, NSTATE=20 )
      CHARACTER*12 LCMNM(NLCM)
      INTEGER      LNLCM(NLCM),INVLCM(NIXS),INVSTA(NIST),
     >             ISTATE(NSTATE)
      INTEGER      ILCM, IIXS, IIST, ITYPE, LR, LX, LY, LZ, ISPLIT,
     >             JX, JY, JZ, JR, JL, ILEN, ITYLCM
C
      DATA INVLCM/  6, 11, 12, 14, 15,    16, 17, 18, 19, 20,
     >             21, 22, 23, 24, 25,    26, 27, 28, 32 /
      DATA INVSTA/ 8,  9, 12, 13 /
      DATA LCMNM /  'MIX',  'MESHX',  'MESHY',   'MESHZ',  'RADIUS',
     >             'SIDE', 'SPLITX', 'SPLITY',  'SPLITZ',  'SPLITR',
     >             'CELL',  'COORD',  'MERGE',    'TURN', 'CLUSTER',
     >             'NPIN',   'RPIN',   'APIN',   'MICRO',      'NS',
     >               'RS', 'MILIEU', 'MIXDIL',   'FRACT',   'MIXGR',
     >           'POURCE', 'PROCEL',   'IHEX',   'NCODE',   'ZCODE',
     >            'ICODE', 'GENERATING', 'CENTER'/
C
      DO 10 ILCM= 1, NLCM
         CALL LCMLEN(IPGEOM,LCMNM(ILCM),LNLCM(ILCM),ITYLCM)
   10 CONTINUE
C
C     ELIMINATES THE INVALID OPTIONS
      DO 20 IIXS= 1, NIXS
        IF( LNLCM(INVLCM(IIXS)).NE.0 )
     >     CALL XABORT( 'XELPRC:*'//GEONAM//'* IS '//
     >                  'NOT A VALID CELL GEOMETRY FOR EXCELL'//
     >                  ' (LCM BLOCK *'//LCMNM(INVLCM(IIXS))//'*)')
   20 CONTINUE
      CALL LCMLEN(IPGEOM,'STATE-VECTOR',ILEN,ITYLCM)
      IF( ILEN.NE.NSTATE )
     >   CALL XABORT( 'XELPRC: GEOMETRY HAS INVALID STATE VECTOR')
      CALL LCMGET(IPGEOM,'STATE-VECTOR',ISTATE)
      DO 30 IIST= 1, NIST
```

```
        IF( ISTATE(INVSTA(IIST)).NE.0 )
     >     CALL XABORT( 'XELPRC: INVALID GEOMETRY FOR EXCELL')
   30 CONTINUE
C
      ITYPE=  ISTATE(1)
      LR=     ISTATE(2)
      LX=     MAX(1,ISTATE(3))
      LY=     MAX(1,ISTATE(4))
      LZ=     MAX(1,ISTATE(5))
      NNVOL=  ISTATE(6)
      ISPLIT= ISTATE(11)
C
C     GET THE SPLITTING INFORMATION, AND COMPUTE JR, JX, JY, JZ VALUES
      IF( ISPLIT.GT.0 )THEN
         CALL LCMLEN(IPGEOM,'SPLITR',ILEN,ITYLCM)
         IF( ILEN.EQ.0 )THEN
            JR= LR
         ELSEIF( ILEN.NE.LR )THEN
            CALL XABORT( 'XELPRC: R-SPLITTING NOT ACCEPTED' )
         ELSE
            CALL LCMGET(IPGEOM,'SPLITR',ISPLT)
            JR=   0
            DO 15 JL= 1, ILEN
               JR= JR + ABS(ISPLT(JL))
   15       CONTINUE
         ENDIF
         CALL LCMLEN(IPGEOM,'SPLITX',ILEN,ITYLCM)
         IF( ILEN.EQ.0 )THEN
            JX= LX
         ELSEIF( ILEN.NE.LX )THEN
            CALL XABORT( 'XELPRC: X-SPLITTING NOT ACCEPTED' )
         ELSE
            CALL LCMGET(IPGEOM,'SPLITX',ISPLT)
            JX=   0
            DO 25 JL= 1, ILEN
               JX= JX + ISPLT(JL)
   25       CONTINUE
         ENDIF
         CALL LCMLEN(IPGEOM,'SPLITY',ILEN,ITYLCM)
         IF( ILEN.EQ.0 )THEN
            JY= LY
         ELSEIF( ILEN.NE.LY )THEN
            CALL XABORT( 'XELPRC: Y-SPLITTING NOT ACCEPTED' )
         ELSE
            CALL LCMGET(IPGEOM,'SPLITY',ISPLT)
            JY=   0
            DO 35 JL= 1, ILEN
               JY= JY + ISPLT(JL)
   35       CONTINUE
         ENDIF
         CALL LCMLEN(IPGEOM,'SPLITZ',ILEN,ITYLCM)
         IF( ILEN.EQ.0 )THEN
            JZ= LZ
         ELSEIF( ILEN.NE.LZ )THEN
            CALL XABORT( 'XELPRC: Z-SPLITTING NOT ACCEPTED' )
         ELSE
```

```
            JZ= 0
            CALL LCMGET(IPGEOM,'SPLITZ',ISPLT)
            DO 45 JL= 1, ILEN
               JZ= JZ + ISPLT(JL)
   45       CONTINUE
         ENDIF
      ELSE
         JR= LR
         JX= LX
         JY= LY
         JZ= LZ
      ENDIF
C
      IF( ITYPE.EQ.0 )THEN
C
C        VIRTUAL ELEMENT
         NNVOL= 0
         NNCYL= 0
         NNSUR= 0
         NAXREM= 0
      ELSE
         IF( NDIM.EQ.2 )THEN
            NNSUR= 2 * (JX+JY)
            NNVOL=  JX*JY
            IF( ITYPE.EQ.5 )THEN
C              FOR *CAR2D* GEOMETRY
C
               NNCYL=  0
C
C              X-AXIS:JX+1, Y-AXIS:JY+1, Z-AXIS:2
               NAXREM= JX+JY+4
            ELSEIF( ITYPE.EQ.3 )THEN
C              FOR *TUBE* GEOMETRY
C
               NNCYL=  1
               IF( JX.NE.1 .OR. JY.NE.1 )THEN
                  CALL XABORT( 'XELPRC: FOR TUBE, PLEASE NO XY SPLIT')
               ENDIF
               NNVOL=  NNVOL+JX*JY*JR
C
C              X-AXIS:JX+1, Y-AXIS:JY+1, Z-AXIS:2, R-AXIS:JR+3
               NAXREM= JX+JY+JR+7
            ELSEIF( ITYPE.EQ.20 )THEN
C              FOR *CARCEL* GEOMETRY
C
               NNCYL=  1
               NNVOL=  NNVOL+JX*JY*JR
C
C              X-AXIS:JX+1, Y-AXIS:JY+1, Z-AXIS:2, R-AXIS:JR+3
               NAXREM= JX+JY+JR+7
            ELSE
               CALL XABORT('XELPRC: INVALID CELL GEOMETRY FOR EXCELL=>'
     >                     //GEONAM(1:12) )
            ENDIF
         ELSE
            NNSUR=  2 * (JX*JY+JX*JZ+JY*JZ )
```

```
            NNVOL=  JX*JY*JZ
            IF( ITYPE.EQ.7 )THEN
C              FOR *CAR3D* GEOMETRY
C
               NNCYL=  0
C
C              X-AXIS:JX+1, Y-AXIS:JY+1, Z-AXIS:JZ+1
               NAXREM= JX+JY+JZ+3
            ELSEIF( ITYPE.EQ. 6 .OR. ITYPE.EQ.21 .OR.
     >              ITYPE.EQ.22 .OR. ITYPE.EQ.23 )THEN
C              FOR *TUBEZ*, *CARCELX*, *CARCELY* OR *CARCELZ* GEOMETRY
C
              NNCYL= 1
              IF( ITYPE.EQ.6 )THEN
                 IF( JX.NE.1 .OR. JY.NE.1 ) THEN
                    CALL XABORT('XELPRC: FOR TUBEZ, PLEASE NO XY SPLIT')
                 ENDIF
              ELSEIF( ITYPE.EQ.23 )THEN
                 NNSUR= NNSUR+2*JR*JX*JY
              ELSEIF( ITYPE.EQ.22 )THEN
                 NNSUR= NNSUR+2*JR*JX*JZ
              ELSEIF( ITYPE.EQ.21 )THEN
                 NNSUR= NNSUR+2*JR*JY*JZ
              ENDIF
              NNVOL= NNVOL+JR*JX*JY*JZ
C
C             X-AXIS:JX+1, Y-AXIS:JY+1, Z-AXIS:JZ+1, R-AXIS:JR+3
              NAXREM= JX+JY+JZ+JR+6
            ELSE
            CALL XABORT( 'XELPRC: INVALID CELL GEOMETRY FOR EXCELL=>'//
     >                   GEONAM(1:12) )
            ENDIF
         ENDIF
      ENDIF
C
      RETURN
      END
```

A.2.7 Subroutine XELPRP.f

```
*DECK XELPRP
      SUBROUTINE XELPRP(IPGEOM, GEONAM,  NDIM,  NTYPO, NBLOCK,  NBMIX,
     >                  MAXGRI, ALBEDO, ICODE,  NCODE, LCLSYM, LCLTRA,
     >                  MRGSUR, LEAKSW,   LL1,   LL2,  L1CELL, NEXTGE,
     >                  IFCSYM, IPRT)
************************************************************************
*                                                                      *
*           NAME: XELPRP                                               *
*      COMPONENT: EXCELL                                               *
*          LEVEL: 3 (CALLED BY 'XELTRK')                               *
*        VERSION: 1.0                                                  *
*       CREATION: 89/12                                                *
*       MODIFIED: 97/11 (G.M.) INTRODUCE PERIODIC B.C.                 *
*                 00/03 (R.R.) DECLARE ALL VARIABLE TYPES              *
```

```
*         AUTHOR: ROBERT ROY                                           *
*                                                                      *
*     SUBROUTINE: THIS ROUTINE READS THE GEOMETRY ON LCM AND           *
*                 CHECK IF THE GEOMETRY IS ACCEPTABLE FOR "EXCELL".    *
*                                                                      *
*--------+------------- V A R I A B L E S ------------+--+-----------*
*  NAME  /                DESCRIPTION                 /IO/MOD(DIMENS)*
*--------+--------------------------------------------+--+-----------*
* IPGEOM / POINTER TO THE GEOMETRY (L_GEOM)           /I./INT        *
* GEONAM / GEOMETRY NAME                              /I./CAR*12     *
* NDIM   / # OF DIMENSIONS ( 2 OR 3)                  /.O/INT        *
* NTYPO / # OF TYPES                                  /.O/INT        *
* NBLOCK / # OF BLOCKS                                /.O/INT        *
* NBMIX  / # OF MIXTURES                              /.O/INT        *
* MAXGRI / GRID DIMENSIONS (NX*NY*NZ)                 /.O/INT(3)     *
* ALBEDO / GEOMETRIC ALBEDOS ON THE SIX FACES.        /.O/REL(6)     *
* ICODE  / INDEX FOR BOUNDARY CONDITIONS.             /.O/INT(6)     *
* NCODE  / TYPE OF BOUNDARY CONDITIONS.               /.O/INT(6)     *
* LCLSYM / SYMMETRY FLAGS (0:NO,-1/+1:SYM)            /.O/INT(3)     *
* LCLTRA / TRANSLATION FLAGS (0:NO,+1:TRA)            /.O/INT(3)     *
* MRGSUR / SIMILARITY BETWEEN FACES                   /.O/INT(-6:-1) *
* LEAKSW / LEAKAGE SWITCH                             /.O/LOG        *
* LL1    / DIAGONAL SYMMETRY (2,3)                    /.O/LOG        *
* LL2    / DIAGONAL SYMMETRY (1,4)                    /.O/LOG        *
* L1CELL / TO INDICATE THAT THERE IS ONLY 1 CELL      /.O/LOG        *
* NEXTGE / RECTANGULAR(0)/CIRCULAR(1) BOUNDARY        /.O/INT        *
* IFCSYM / # OF SYMMETRY IN FULL ASSEMBLY (1,2,3,4,5) /.O/INT        *
* IPRT   / PRINTING LEVEL.                            /I./INT        *
**********************************************************************
C
      IMPLICIT     NONE
C
      INTEGER      IPGEOM, NDIM,  NTYPO, NBLOCK, NBMIX, NEXTGE,
     >             IFCSYM, IPRT
      INTEGER      MAXGRI(3),LCLSYM(3),LCLTRA(3),
     >             NCODE(6),ICODE(6),MRGSUR(-6:-1)
      LOGICAL      LEAKSW,LL1,LL2,L1CELL
      REAL         ALBEDO(6)
C
      INTEGER      NLCM, NIXS, NIST, NSTATE, IOUT
      PARAMETER  ( NLCM=33, NIXS=16, NIST=2,NSTATE=20, IOUT=6 )
      INTEGER      LNLCM(NLCM),INVLCM(NIXS),INVSTA(NIST),
     >             ISTATE(NSTATE),JCODE(6)
      REAL         ZCODE(6)
      LOGICAL      SWALBE(6)
      CHARACTER    LCMNM(NLCM)*12, GEONAM*12, CORIEN(-6:0)*4
      INTEGER      ILCM, IDIR, IIXS, ILONG, ITPLCM, ISUR, ITYPE,
     >             IIST, LREG, ISUB1, ISUB2, ISPLIT, ITRAN, I2, IAL
C
      DATA         CORIEN
     >       / ' Z+ ',' Z- ',' Y+ ',' Y- ',' X+ ',' X- ','    ' /
      DATA INVLCM/  6, 12, 15, 16,    17, 18, 19, 20, 21,
     >             22, 23, 24, 25, 26,    27, 28 /
      DATA INVSTA/ 12, 13 /
      DATA LCMNM /  'MIX',  'MESHX',  'MESHY',   'MESHZ',  'RADIUS',
     >             'SIDE', 'SPLITX', 'SPLITY',  'SPLITZ',  'SPLITR',
```

```
     >             'CELL',  'COORD',  'MERGE',    'TURN', 'CLUSTER',
     >             'NPIN',   'RPIN',   'APIN',   'MICRO',      'NS',
     >               'RS', 'MILIEU', 'MIXDIL',   'FRACT',   'MIXGR',
     >           'POURCE', 'PROCEL',   'IHEX',   'NCODE',   'ZCODE',
     >            'ICODE', 'GENERATING', 'CENTER'/
C
      IFCSYM=    1
      DO 10 ILCM= 1, NLCM
         CALL LCMLEN(IPGEOM, LCMNM(ILCM), LNLCM(ILCM), ITPLCM )
   10 CONTINUE
      IFCSYM=    1
      DO 11 IDIR=1,3
        LCLSYM(IDIR)=0
        LCLTRA(IDIR)=0
 11   CONTINUE
C
C     ELIMINATES THE INVALID OPTIONS
      DO 20 IIXS= 1, NIXS
        IF( LNLCM(INVLCM(IIXS)).NE.0 )
     >     CALL XABORT( 'XELPRP:*'//GEONAM//'* IS '//
     >                  'NOT A VALID GEOMETRY FOR EXCELL'//
     >                  ' (LCM BLOCK *'//LCMNM(INVLCM(IIXS))//'*)')
   20 CONTINUE
      CALL LCMLEN(IPGEOM,'STATE-VECTOR',ILONG,ITPLCM)
      IF( ILONG.NE.NSTATE )
     >   CALL XABORT( 'XELPRP: GEOMETRY HAS INVALID STATE VECTOR')
      CALL LCMGET(IPGEOM,'STATE-VECTOR',ISTATE)
      DO 30 IIST= 1, NIST
        IF( ISTATE(INVSTA(IIST)).NE.0 )
     >     CALL XABORT( 'XELPRP: INVALID GEOMETRY FOR EXCELL')
   30 CONTINUE
      DO 35 ISUR= 1, 6
         SWALBE( ISUR)= .FALSE.
         ALBEDO( ISUR)= 1.0
         MRGSUR(-ISUR)= -ISUR
         ICODE ( ISUR)= -ISUR
   35 CONTINUE
C
      ITYPE=  ISTATE(1)
      LREG=   ISTATE(6)
      NBMIX=  ISTATE(7)
      ISUB1=  ISTATE(8)
      ISUB2=  ISTATE(9)
      ISPLIT= ISTATE(11)
      NEXTGE= 0
C
      IF( ISUB1.NE.0 )THEN
C
C        MANY CELLS
         L1CELL= .FALSE.
         MAXGRI(1)= MAX(1,ISTATE(3))
         MAXGRI(2)= MAX(1,ISTATE(4))
         MAXGRI(3)= MAX(1,ISTATE(5))
         NTYPO= ISUB2
         IF( ITYPE.EQ.5 )THEN
            NDIM= 2
```

```
            SWALBE(1)=.TRUE.
            SWALBE(2)=.TRUE.
            SWALBE(3)=.TRUE.
            SWALBE(4)=.TRUE.
            ICODE (5)= 0
            ICODE (6)= 0
         ELSEIF( ITYPE.EQ.7 )THEN
            NDIM= 3
            SWALBE(1)=.TRUE.
            SWALBE(2)=.TRUE.
            SWALBE(3)=.TRUE.
            SWALBE(4)=.TRUE.
            SWALBE(5)=.TRUE.
            SWALBE(6)=.TRUE.
         ELSE
            CALL XABORT( 'XELPRP: INVALID GEOMETRY FOR EXCELL')
         ENDIF
      ELSE
C
C        JUST ONE CELL
         L1CELL= .TRUE.
         MAXGRI(1)= 1
         MAXGRI(2)= 1
         MAXGRI(3)= 1
         NTYPO= 1
         IF( ITYPE.EQ. 3 .OR. ITYPE.EQ. 5 .OR.
     >        ITYPE.EQ.20 )THEN
            NDIM= 2
            IF( ITYPE.EQ.3 )THEN
               NEXTGE= 1
               ICODE (1)= 0
               SWALBE(2)=.TRUE.
               ICODE (3)= 0
               ICODE (4)= 0
               ICODE (5)= 0
               ICODE (6)= 0
            ELSE
               SWALBE(1)=.TRUE.
               SWALBE(2)=.TRUE.
               SWALBE(3)=.TRUE.
               SWALBE(4)=.TRUE.
               ICODE (5)= 0
               ICODE (6)= 0
            ENDIF
         ELSEIF( ITYPE.EQ. 6 .OR. ITYPE.EQ. 7 .OR.
     >            ITYPE.EQ.21 .OR. ITYPE.EQ.22 .OR. ITYPE.EQ.23 )THEN
            NDIM= 3
            IF( ITYPE.EQ.6 )THEN
               NEXTGE= 1
               ICODE (1)= 0
               SWALBE(2)=.TRUE.
               ICODE (3)= 0
               ICODE (4)= 0
               SWALBE(5)=.TRUE.
               SWALBE(6)=.TRUE.
            ELSE
```

```
               SWALBE(1)=.TRUE.
               SWALBE(2)=.TRUE.
               SWALBE(3)=.TRUE.
               SWALBE(4)=.TRUE.
               SWALBE(5)=.TRUE.
               SWALBE(6)=.TRUE.
            ENDIF
         ELSE
            CALL XABORT( 'XELPRP: INVALID GEOMETRY FOR EXCELL')
         ENDIF
      ENDIF
C
C     RECOVERS B.C.
      CALL LCMGET(IPGEOM,'NCODE',NCODE)
      CALL LCMGET(IPGEOM,'ZCODE',ZCODE)
      CALL LCMGET(IPGEOM,'ICODE',JCODE)
C
C     TREATMENT OF DIAGONAL B.C.
      LL1= .FALSE.
      LL2= .FALSE.
      ITRAN=0
      I2=0
      DO 50 IAL=1, 6
         IF( .NOT.SWALBE(IAL) ) GO TO 50
         IF( JCODE(IAL).NE.0 )THEN
            IF( ICODE(IAL).EQ.0 )THEN
               CALL XABORT('XELPRP: INVALID BOUNDARY CONDITION.')
            ENDIF
            ICODE(IAL)= JCODE(IAL)
            ZCODE(IAL)= 1.0
         ELSEIF( NCODE(IAL).EQ.0 )THEN
            CALL XABORT('XELPRP: A BOUNDARY CONDITION IS MISSING.')
         ENDIF
         IF( NCODE(IAL).EQ.2 )THEN
            ZCODE(IAL)= 1.0
         ELSEIF( NCODE(IAL).EQ.3 )THEN
            I2=I2+1
         ELSEIF( NCODE(IAL).EQ.4 )THEN
            ITRAN=ITRAN+1
            ZCODE(IAL)= 1.0
         ELSEIF( NCODE(IAL).EQ.6 )THEN
            NCODE(IAL)= 1
         ELSEIF( NCODE(IAL).GE.7)THEN
            CALL XABORT('XELPRP: INVALID B.C. FOR EXCELL')
         ENDIF
   50 CONTINUE
C
C     DIAGONAL  B.C.
      IF( I2.GT.0 )THEN
         IF( I2.NE.2 )
     >      CALL XABORT('XELPRP: NO MORE THAN 2 DIAGONAL CONDITIONS')
         IF( MAXGRI(1).NE.MAXGRI(2))
     >      CALL XABORT('XELPRP: LX=LY WITH A DIAGONAL SYMMETRY.')
         LL1=((NCODE(2).EQ.3).AND.(NCODE(3).EQ.3))
         LL2=((NCODE(1).EQ.3).AND.(NCODE(4).EQ.3))
         IFCSYM= IFCSYM+1
```

```
         IF( LL1 )THEN
            NCODE(2)=  NCODE(4)
            NCODE(3)=  NCODE(1)
            ICODE(2)=  ICODE(4)
            ICODE(3)=  ICODE(1)
            MRGSUR(-2)= -4
            MRGSUR(-3)= -1
            ZCODE(2)=  ZCODE(4)
            ZCODE(3)=  ZCODE(1)
         ELSEIF( LL2 )THEN
            NCODE(1)=  NCODE(3)
            NCODE(4)=  NCODE(2)
            ICODE(1)=  ICODE(3)
            ICODE(4)=  ICODE(2)
            MRGSUR(-1)= -3
            MRGSUR(-4)= -2
            ZCODE(1)=  ZCODE(3)
            ZCODE(4)=  ZCODE(2)
         ELSE
            CALL XABORT('XELPRP: THE DIAGONAL CONDITIONS '//
     >                  'X+: DIAG Y-: DIAG AND '//
     >                  'X-: DIAG Y+: DIAG ARE THE ONLY PERMITTED.')
         ENDIF
      ENDIF
C
C     TRANSLATION BC (PERIODIC CELL)
C     ONLY PAIRS PERMITTED:
C       1) X- TRAN X+ TRAN
C       2) Y- TRAN Y+ TRAN
C       3) Z- TRAN Z+ TRAN
      IF( ITRAN.GT.0 )THEN
         IF( MOD(ITRAN,2).EQ.1 )THEN
            CALL XABORT('XELPRP: TRANSLATION SYMETRIES COME IN PAIRS')
         ENDIF
         DO 45 IAL=1,6,2
            IF(SWALBE(IAL)) THEN
               IF( NCODE(IAL).EQ.4 .AND. NCODE(IAL+1).EQ.4 )THEN
                  LCLTRA((IAL+1)/2)=1
                  MRGSUR(-IAL  )=-IAL-1
                  MRGSUR(-IAL-1)=-IAL
                  ITRAN=ITRAN-2
               ENDIF
            ENDIF
 45      CONTINUE
         IF( ITRAN.NE.0 )THEN
            CALL XABORT('XELPRP: WRONG PAIRS OF TRANSLATION SYMETRIES')
         ENDIF
      ENDIF
C
C     SYMMETRIC B.C.
      DO 40 IAL= 1, 6
         IF( .NOT.SWALBE(IAL) ) GO TO 40
         ALBEDO( IAL)= ZCODE(IAL)
         IF( NCODE(IAL).EQ.5 )THEN
C            IF( MAXGRI((IAL+1)/2).LT.2 )THEN
C               CALL XABORT('XELPRP: SYM. WITH ONLY ONE CELL PER LINE')
```

```
C            ELSE
               MAXGRI((IAL+1)/2)= 2*MAXGRI((IAL+1)/2)-1
C            ENDIF
            IF( LCLSYM((IAL+1)/2).NE.0 )THEN
               CALL XABORT('XELPRP: 2 SYMMETRIES ON SAME FACE')
            ELSE
               IFCSYM= IFCSYM+1
               IF( MOD(IAL,2).EQ.0 )THEN
                  LCLSYM((IAL+1)/2)= +1
                  MRGSUR(-IAL)=  MRGSUR(-IAL+1)
                  ALBEDO( IAL)=  ZCODE(IAL-1)
                  ICODE ( IAL)=  ICODE(IAL-1)
               ELSE
                  LCLSYM((IAL+1)/2)= -1
                  MRGSUR(-IAL)=  MRGSUR(-IAL-1)
                  ALBEDO( IAL)=  ZCODE(IAL+1)
                  ICODE ( IAL)=  ICODE(IAL+1)
               ENDIF
            ENDIF
         ENDIF
   40 CONTINUE
C
      NBLOCK= MAXGRI(1)*MAXGRI(2)*MAXGRI(3)
      LEAKSW= .TRUE.
      DO 60 ISUR= 1, 6
         LEAKSW= LEAKSW .AND. ALBEDO( ISUR).EQ.1.0
   60 CONTINUE
      LEAKSW= .NOT. LEAKSW
      IF( IPRT.GT.2 )THEN
         IF( LEAKSW )THEN
            WRITE(IOUT,'(1H )')
         WRITE(IOUT,'(40H *** ONLY FOR GEOMETRIC ALBEDOS ***        )')
         WRITE(IOUT,'(21H PERCENT LEAKAGE X-: ,F5.1,6H% X+: ,F5.1,1H%'//
     >              '/21H (FULL UNFOLD    Y-: ,F5.1,6H% Y+: ,F5.1,1H%'//
     >              '/21H   ASSEMBLY)     Z-: ,F5.1,6H% Z+: ,F5.1,1H%)')
     >              (100.*(1.0-ALBEDO(IAL)), IAL= 1,6)
            WRITE(IOUT,'(1H )')
         ELSE
            WRITE(IOUT,'(1H )')
         WRITE(IOUT,'(40H *** ONLY FOR GEOMETRIC ALBEDOS ***        )')
         WRITE(IOUT,'(40H *** NO LEAKAGE ON THE ASSEMBLY ***        )')
            WRITE(IOUT,'(1H )')
         ENDIF
         WRITE(IOUT,'(/21H SIMILAR FACES   X-: ,A5,6H  X+: ,A5'//
     >            '/21H (FULL UNFOLD    Y-: ,A5,6H  Y+: ,A5'//
     >            '/21H   ASSEMBLY)     Z-: ,A5,6H  Z+: ,A5)')
     >           (CORIEN(MRGSUR(IAL)), IAL=-1,-6,-1)
         WRITE(IOUT,'(1H )')
      ENDIF
      IF( NEXTGE.NE.0 )THEN
           CALL XABORT( 'XELPRP:*'//GEONAM//'* IS '//
     >                  'A TUBE/TUBEZ GEOMETRY (NOT AVAILABLE)')
      ENDIF
C
      RETURN
      END
```

A.2.8 Subroutine XELPSC.f

```
*DECK XELPSC
      FUNCTION XELPSC(RANN,PLANE)
C
C--------------------------    XELPSC    -------------------------------
C
C 1- PROGRAMME STATISTICS:
C           NAME: XELPSC
C      COMPONENT: EXCELL GEOMETRY ANALYSIS
C      CALLED BY: XELCRN
C        CALLING: ------
C        VERSION: 1.0
C       CREATION: 97/10/31
C         AUTHOR: G. MARLEAU
C            USE: COMPUTE ANNULAR SURFACE BELOW CARTESIAN PLANE
C 2- INPUT
C   RANN   : ANNULAR RADIUS                                 R
C   PLANE  : CARTESIAN PLANE LOCATION                       R
C 3- OUTPUT
C   XELPSC : ALLULAR SURFACE BELOW PLANE                    R
C
C--------------------------    XELPSC    -------------------------------
C
      IMPLICIT     NONE
      REAL         XELPSC,RANN,PLANE
C----
C  LOCAL VARIABLES
C----
      REAL         RANN2,PLANE2,ALPHA
C----
C  METHOD
C  1) FIND HALF-ANGLE COVERED BY THE TWO INTERSECTION POINTS
C     BETWEEN PLANE AND ANNULAR REGION
C     -- ALPHA=ACOS(-PLANE/RANN)
C  2) COMPUTED ANNULAR SURFACE COVERED BY THIS HALF-ANGLE
C     -- 0.5*RANN2*ALPHA
C  3) ADD SURFACE COVERED BY INTERNAL RECTANGLE IN THIS HALF-ANGLE
C     -- 0.5*PLANE*SQRT(RANN2-PLANE2)
C  4) DOULBLE SURFACE FOR FULL ANGLE
C----
      RANN2=RANN*RANN
      PLANE2=PLANE*PLANE
      ALPHA=ACOS(-PLANE/RANN)
      XELPSC=RANN2*ALPHA+PLANE*SQRT(RANN2-PLANE2)
      RETURN
      END
```

A.2.9 Subroutine XELPSI.f

```
*DECK XELPSI
      FUNCTION XELPSI(ITYP,RANN2,XYPOS,XYPOS2,SPXY)
C
C--------------------------    XELPSI    -------------------------------
C
C 1- PROGRAMME STATISTICS:
C           NAME: XELPSI
C      COMPONENT: EXCELL GEOMETRY ANALYSIS
C      CALLED BY: XELCRN
C        CALLING: ------
C        VERSION: 1.0
C       CREATION: 97/10/31
C         AUTHOR: G. MARLEAU
c            USE: COMPUTE INTERSECTION SURFACE BETWEEN
C                 PART OF ANNULAR REGION TO THE LEFT OF X-PLANE
C                 AND EITHER THE PART OF THE ANNULAR REGION
C                 ABOVE Y-PLANER THE PART BELOW THE Y-PLANE
C 2- INPUT
C   ITYP   : TYPE OF CALCULATION                            I
C            =1 -> ABOVE Y-PLANE
C            =2 -> BELOW Y-PLANE
C   RANN2  : PIN RADIUS SQUARED                             R
C   XYPOS  : CARTESIAN PLANE LOCATION                       R(2,2)
C            (1,1)  LEFT   X-PLANE
C            (1,2)  RIGHT  X-PLANE
C            (2,1)  BOTTOM Y-PLANE
C            (2,2)  TOP    Y-PLANE
C   XYPOS2 : CARTESIAN MESH SQUARED                         R(2,2)
C            SAME NOTATION AS ABOVE
C   SPXY   : ANNULAR SURFACE OUTSIDE OF PLANES              R(2,2)
C            SAME NOTATION AS ABOVE
C 3- OUTPUT
C   XELPSI : INTERSECTION SURFACE                           R
C 5- INTERNAL PARAMETERS
C   PI     : VALUE OF PI = 3.14159265359                    R
C
C--------------------------    XELPSI    -------------------------------
C
      IMPLICIT     NONE
      INTEGER      ITYP
      REAL         XELPSI,RANN2,XYPOS(2,2),XYPOS2(2,2),SPXY(2,2)
C----
C  LOCAL PARAMETERS
C----
      REAL         PI
      PARAMETER   (PI=3.141592653589)
      REAL         SQANN,YFC,XFC
C----
C  TEST IF POINT OF INTEREST IS LOCATED INSIDE
C  ANNULAR REGION
C----
      IF(XYPOS2(2,ITYP)+XYPOS2(1,1).LT.RANN2) THEN
C----
C  FOR POINT INSIDE ANNULAR REGION
C  1) (SUM OF ANNULAR INTERSECTION SURFACES)/2
C     -INTERSECTION SURFACE
```

```
C     +(INTERNAL REGION CARTESIAN SURFACE)/4
C     =(ANNULAR SURFACE)/4
C----
        SQANN=0.25*PI*RANN2
        YFC=-XYPOS(2,ITYP)
        IF(ITYP.EQ.1) THEN
          XFC=-XYPOS(1,1)
        ELSE
          XFC=XYPOS(1,1)
        ENDIF
        XELPSI=0.5*(SPXY(1,1)+SPXY(2,ITYP))+XFC*YFC-SQANN
      ELSE
        IF(ITYP.EQ.1) THEN
          IF(XYPOS(2,ITYP).LT.0.AND.XYPOS(1,1).LT.0) THEN
            XELPSI=0.0
          ELSE IF(XYPOS(2,ITYP).GT.0.AND.XYPOS(1,1).GT.0) THEN
            XELPSI=SPXY(2,ITYP)+SPXY(1,1)-PI*RANN2
          ELSE IF(XYPOS(2,ITYP).GT.0.AND.XYPOS(1,1).LT.0) THEN
            XELPSI=SPXY(1,1)
          ELSE IF(XYPOS(2,ITYP).LT.0.AND.XYPOS(1,1).GT.0) THEN
            XELPSI=SPXY(2,ITYP)
          ENDIF
        ELSE
          IF(XYPOS(2,ITYP).LT.0.AND.XYPOS(1,1).LT.0) THEN
            XELPSI=SPXY(1,1)
          ELSE IF(XYPOS(2,ITYP).GT.0.AND.XYPOS(1,1).GT.0) THEN
            XELPSI=SPXY(2,ITYP)
          ELSE IF(XYPOS(2,ITYP).GT.0.AND.XYPOS(1,1).LT.0) THEN
            XELPSI=0.0
          ELSE IF(XYPOS(2,ITYP).LT.0.AND.XYPOS(1,1).GT.0) THEN
            XELPSI=SPXY(2,ITYP)+SPXY(1,1)-PI*RANN2
          ENDIF
        ENDIF
      ENDIF
      RETURN
      END
```

A.3 The ASM: Module

A.3.1 Subroutine PIJABC.f

```
*DECK PIJABC
      SUBROUTINE PIJABC(NREG,NSOUT,NPRB,SIGTAL,MATRT,PROB,IDL,
     >                  PSST,PSVT)
C
C-------------------------    PIJABC    -------------------------------
C
C 1- SUBROUTINE STATISTICS:
C     NAME     : PIJABC
C     LEVEL    : 2 (CALLED BY 'EXCELP')
C     USE      : THIS ROUTINE RECONSTRUCT COLLISION PROBABILITIES (CP)
C                FOR  ALL ZONES ELIMINATING SURFACES FROM THE SYSTEM.
C     MODIFIED : 91-05-14 (G.M.)
```

```
C                 91-07-12 (R.R.)
C                 94-05-12 (I.P.) ( PIJK )
C                 98-02-11 (G.M.) ( PERIODIC B.C. )
C     AUTHOR   : R. ROY (87-05-01)
C
C 2- PARAMETERS:
C  INPUT
C     NREG    : # OF ZONES FOR GEOMETRY.               I
C     NSOUT   : # OF SURFACES FOR GEOMETRY.            I
C     NPRB    : NUMBER OF PROBABILITIES IN PROB I
C     SIGTAL  : ALBEDO-SIGT VECTOR                     R(-NSOUT:NREG)
C     MATRT   : REFLECTION/TRANSMISSION VECTOR         I(NSOUT)
C     PROB    : -CP- MATRIX FOR ALL TYPES.             R(NPRB)
C  OUTPUT
C     PROB    : -CP- MATRIX FOR ALL TYPES.             R(NPRB)
C     PSST    : WORKING AREA FOR PSST                  D(NSOUT,NSOUT)
C               PSST=(A**(-1)-PSS)**(-1)
C     PSVT    : WORKING AREA FOR PSVT                  D(NSOUT,NREG)
C               PSVT=PSST*PSV
C  WORK
C     IDL     : PSS MATRIX DIAGONAL LOCATION           I(NSOUT)
C
C  3-EXTERNAL ROUTINE CALLED
C     ALINVD  : INVERSE A DOUBLE PRECISION MATRIX
C     XABORT  : DRAGON ABORT ROUTINE
C
C----------------------------------------------------------------------
      IMPLICIT         NONE
C----
C VARIABLES
C-----
      INTEGER          NREG,NSOUT,NPRB,NSP1,IPSS,ISUR,ISX,IS,JSX,JS,IER,
     1                 IV,JV,IVSI,IVVI,ISV,IVS,IVV
      INTEGER          MATRT(NSOUT),IDL(NSOUT)
C
      REAL             SIGTAL(-NSOUT:NREG),PROB(NPRB)
      DOUBLE PRECISION PSST(NSOUT,NSOUT),PSVT(NSOUT,NREG)
C----
C  EVALUATE MATRIX (A**(-1)-PSS)
C----
      NSP1=NSOUT+1
      IPSS=0
      ISUR=(NSOUT*NSP1)/2
      ISX=0
      DO 100 IS=-NSOUT,-1,1
        ISX=ISX+1
        JSX=0
        ISUR=ISUR+1
        DO 101 JS=-NSOUT,IS,1
          JSX=JSX+1
          IPSS=IPSS+1
          IF((SIGTAL(IS).EQ.0.0).OR.(SIGTAL(JS).EQ.0.0)) THEN
            PSST(ISX,JSX)= 0.0D0
          ELSE
            PSST(ISX,JSX)=-DBLE(PROB(IPSS))
          ENDIF
```

```
          IF(JS.NE.IS) THEN
            PSST(JSX,ISX)=PSST(ISX,JSX)
          ENDIF
 101    CONTINUE
        IF(SIGTAL(IS) .EQ. 0.0)THEN
          PSST(ISX,ISX)=DBLE(PROB(ISUR))
        ELSE
          JS=-MATRT(-IS)
          IF(JS .EQ. IS) THEN
            PSST(ISX,ISX)=PSST(ISX,ISX)+DBLE(PROB(ISUR)/SIGTAL(IS))
          ELSE IF(JS .LT. IS) THEN
            JSX=NSOUT+JS+1
            PSST(ISX,JSX)=PSST(ISX,JSX)+DBLE(PROB(ISUR)/SIGTAL(IS))
            PSST(JSX,ISX)=PSST(ISX,JSX)
          ENDIF
        ENDIF
 100  CONTINUE
C----
C  INVERSE MATRIX PSST=(A**(-1)-PSS)
C----
      CALL ALINVD(NSOUT,PSST,NSOUT,IER,IDL)
C----
C  CHECK IF INVERSE IS VALID
C----
      IF(IER .NE. 0 ) CALL XABORT
     >  ('PIJABC: IMPOSSIBLE TO INVERT PSS COUPLING MATRIX')
      IVSI=(NSP1*(NSP1+1))/2
      IVVI=IVSI+NSP1
      DO 110 IV=1,NREG
C----
C    PSVT(IS,IV)=SUM(JSS) PSST(ISS,JSS)*PSV(JSS,IV)
C----
        DO 111 IS=1,NSOUT
          PSVT(IS,IV)=0.0D0
 111    CONTINUE
        DO 120 IS=1,NSOUT
          DO 121 JS=1,NSOUT
            ISV=IVSI+JS
            PSVT(IS,IV)=PSVT(IS,IV)+PSST(IS,JS)*DBLE(PROB(ISV))
 121      CONTINUE
 120    CONTINUE
        IVV=IVVI
        DO 130 JV=1,IV
          IVV=IVV+1
          ISV=0
          IVS=IVSI
          DO 131 IS=-NSOUT,-1,1
            ISV=ISV+1
            IVS=IVS+1
            IF(SIGTAL(IS).NE.0.0) THEN
              PROB(IVV)=PROB(IVV)+PROB(IVS)*PSVT(ISV,JV)
            ENDIF
 131      CONTINUE
 130    CONTINUE
        IVSI=IVSI+NSP1+IV
        IVVI=IVVI+NSP1+IV
```

```
 110  CONTINUE
      RETURN
      END
```

A.3.2 Subroutine PIJCPL.f

```
*DECK PIJCPL
      SUBROUTINE PIJCPL(NREGIO,NBMIX ,NELPIJ,MATCOD,VOLUME,XSSIGT,
     >                  PIJSYM,PIS   )
C
C--------------------------  PIJCPL  --------------------------------
C
C   1-  PROGRAMME STATISTICS:
C
C          NAME       :  PIJCPL
C          FUNCTION   :  COMPUTE CP MATRIX LEAKAGE MATRIX
C          DATE       :  2000/01/21
C          AUTHOR     :  G. MARLEAU
C
C   2-  PARAMETERS:
C      INPUT
C         NREGIO  : NUMBER OF REGIONS CONSIDERED       I
C         NBMIX   : NUMBER OF MIXTURES                 I
C         NELPIJ  : DIMENSION OF SYMMETRIC PIJ MATRIX  I
C         MATCOD  : MATERIAL CODE IN REGION            I(NREGIO)
C         VOLUME  : VOLUME OF REGION                   R(NREGIO)
C         XSSIGT  : TOTAL MACROSCOPIC X.S.             R(NBMIX)
C         PIJSYM  : GROUP CONDENSED REDUCE/SYMMETRIC   R(NELPIJ)
C                   PIJ MATRIX
C      OUTPUT
C         PIS     : SCRATCH STORAGE.                   R(NREGIO)
C
C---------------------------   PIJCPL  -------------------------------
C
      IMPLICIT   NONE
      INTEGER    NREGIO,NBMIX,NELPIJ
      INTEGER    MATCOD(NREGIO)
      REAL       VOLUME(NREGIO),XSSIGT(0:NBMIX),
     >           PIJSYM(NELPIJ),PIS(NREGIO)
C----
C LOCAL VARIABLES
C----
      INTEGER          INDPOS,I,J,MATNUM
      DOUBLE PRECISION SUM
C----
C  INTRINSIC FUNCTION FOR POSITION IN CONDENSE PIJ MATRIX
C----
      INDPOS(I,J)=MAX(I,J)*(MAX(I,J)-1)/2+MIN(I,J)
      DO 100 I=1,NREGIO
        SUM=0.0D0
        DO 110 J=1,NREGIO
          MATNUM=MATCOD(J)
          SUM=SUM+XSSIGT(MATNUM)*PIJSYM(INDPOS(I,J))/VOLUME(I)
110     CONTINUE
```

```
        PIS(I)=1.0D0-SUM
100   CONTINUE
      RETURN
      END
```

A.3.3 Subroutine PIJNOS.f

```
*DECK PIJNOS
      SUBROUTINE PIJNOS(NREGIO,VOLUME,PIJSYM,PIJSCT)
C
C---------------------------  PIJNOS  ---------------------------------
C
C   1-  PROGRAMME STATISTICS:
C
C          NAME       :  PIJNOS (VECTORIZE COMPILATION POSSIBLE)
C          FUNCTION   :  CP MATRIX WITHOUT SCATTERING MODIFICATION
C          DATE       :  27-03-1991
C          MODIFIED   :  94-07-21  (I. PETROVIC, G. MARLEAU)
C          AUTHOR     :  R.ROY
C
C   2-  PARAMETRES D'ENTREE ET DE RETOUR:
C
C         NREGIO  : NUMBER OF REGIONS CONSIDERED        I            I
C         VOLUME  : VOLUME OF REGION                    R(NREGIO)    I
C         PIJSCT  : PIJ OR PIJK OR PIJK* MATRIX         R(2*NREGIO**2)D
C         PIJSYM  : GROUP CONDENSED REDUCE/SYMMETRIC    R(NREGIO*
C                   PIJ OR PIJK MATRIX                 (NREGIO+1)/2  D
C         ITYP    : 7 DIRECTIONAL PIJK*                 I
C         PIJSYM  : GROUP FULL DIRECTIONAL PIJK* MATRIX R(NREGIO**2)
C
C---------------------------   PIJNOS  --------------------------------
C
      IMPLICIT NONE
C----
C INTERNAL FUNCTION
C-----
      INTEGER    INDPOS
C----
C VARIABLES
C----
      INTEGER    NREGIO,INDPIJ,I,J
      REAL       FACT
      REAL       VOLUME(*),PIJSYM(*),PIJSCT(NREGIO,*)
C----
C  INTRINSIC FUNCTION FOR POSITION IN CONDENSE PIJ MATRIX
C----
      INDPOS(I,J)=MAX(I,J)*(MAX(I,J)-1)/2+MIN(I,J)
C----
C  DIVIDE PIJSYM BY VOLUME
C----
      DO 20 I=1,NREGIO
        FACT=1.0/VOLUME(I)
        DO 10 J=1,NREGIO
          INDPIJ=INDPOS(I,J)
```

```
          PIJSCT(I,J)=FACT*PIJSYM(INDPIJ)
 10     CONTINUE
 20   CONTINUE
      RETURN
      END
```

A.3.4 Subroutine PIJRDG.f

```
*DECK PIJRDG
      SUBROUTINE PIJRDG(IPRT,NREG,NSOUT,SIGTAL,PROB)
C
C-------------------------    PIJRDG    -------------------------------
C
C 1- SUBROUTINE STATISTICS:
C     NAME     : PIJRDG
C     LEVEL    : 2 (CALLED BY 'EXCELP')
C     USE      : DIAGONAL NORMALIZATION OF COLLISION PROBS (CP)
C     MODIFIED : 91-07-12 (R.R.)
C     MODIFIED : 91-05-17 (G.M.)
C     AUTHOR   : R. ROY (89-06-01)
C     REFERENCE: 'NORMALIZATION TECHNIQUES FOR CP MATRICES',
C                 R.ROY AND G.MARLEAU,
C                 CONF/PHYSOR-90, MARSEILLE/FRANCE, V 2, P IX-40 (1990).
C
C 2- PARAMETERS:
C  INPUT
C     IPRT    : PRINT LEVEL                         I
C     NREG    : # OF ZONES FOR GEOMETRY.            I
C     NSOUT   : # OF SURFACES FOR GEOMETRY.         I
C     SIGTAL  : ALBEDO-SIGT VECTOR                  R(-NSOUT:NREG)
C     PROB    : -CP- MATRIX FOR ALL TYPES.          R(NPRB)
C               NPRB=(NSOUT+NREG+1)*(NSOUT+NREG+2)/2
C  OUTPUT
C     PROB    : -CP- MATRIX FOR ALL TYPES.          R(NPRB)
C
C-------------------------    PIJRDG    -------------------------------
C
      IMPLICIT   NONE
      INTEGER    IPRT,NREG,NSOUT,
     >           IR,JR,IPRB,IPRF,IUNK,JUNK,IVOL
      REAL       PROB(*),SIGTAL(-NSOUT:NREG),BILAN
      IPRB= 0
      IUNK= 0
      IVOL= NSOUT*(NSOUT+1)/2
C
C     RENORMALIZE ALL DIAGONAL ELEMENTS OF MATRIX *PROB*
      DO 100 IR = -NSOUT, NREG
         IUNK= IUNK+1
         BILAN=0.0
         DO 10 JR= -NSOUT, IR-1
            IPRB= IPRB+1
            IF( JR.LT.0.OR.SIGTAL(JR).GT.0.0 )THEN
               BILAN=BILAN + PROB(IPRB)
            ENDIF
```

```
   10    CONTINUE
         IPRB= IPRB+1
         IPRF= IPRB
         JUNK= IUNK
         DO 20 JR=  IR+1 , NREG
            IPRF= IPRF+JUNK
            JUNK= JUNK+1
            IF( JR.LT.0.OR.SIGTAL(JR).GT.0.0 )THEN
               BILAN=BILAN + PROB(IPRF)
            ENDIF
   20    CONTINUE
         IF( IR.LT.0 )THEN
            IVOL= IVOL+1
            PROB(IPRB)= PROB(IVOL)-BILAN
         ELSEIF( IR.GT.0 )THEN
            IVOL= IVOL+IUNK-1
            IF( SIGTAL(IR).GT.0.0 )THEN
C
C              VOIDS ARE NOT BE RENORMALIZED
               PROB(IPRB)= PROB(IVOL)-BILAN
            ENDIF
         ELSE
            IVOL= IVOL+1
         ENDIF
 100  CONTINUE
C
      RETURN
      END
```

A.3.5 Subroutine PIJRGL.f

```
*DECK PIJRGL
      SUBROUTINE PIJRGL(IPRT,NREG,NSOUT,SIGTAL,PROB,RI)
C
C-------------------------    PIJRGL    -------------------------------
C
C 1- SUBROUTINE STATISTICS:
C     NAME     : PIJRGL
C     LEVEL    : 2 (CALLED BY 'EXCELP')
C     USE      : NORMALIZATION OF COLLISION PROBS USING GELBARD SCHEME
C     MODIFIED : 91-07-12 (R.R.)
C     MODIFIED : 91-05-17 (G.M.)
C     AUTHOR   : R. ROY (89-06-01)
C     REFERENCE: 'NORMALIZATION TECHNIQUES FOR CP MATRICES',
C                 R.ROY AND G.MARLEAU,
C                 CONF/PHYSOR-90, MARSEILLE/FRANCE, V 2, P IX-40 (1990).
C
C 2- PARAMETERS:
C  INPUT
C     IPRT    : PRINT LEVEL                          I
C     NREG    : # OF ZONES FOR GEOMETRY.             I
C     NSOUT   : # OF SURFACES FOR GEOMETRY.          I
C     SIGTAL  : ALBEDO-SIGT VECTOR                   R(-NSOUT:NREG)
C     PROB    : -CP- MATRIX FOR ALL TYPES.           R(NPRB)
```

```
C                NPRB=(NSOUT+NREG+1)*(NSOUT+NREG+2)/2
C  OUTPUT
C     PROB    : -CP- MATRIX FOR ALL TYPES.           R(NPRB)
C  WORK
C     RI      : GENERALISED NORMALIZATION FACTOR     R(-NSOUT:NREG)
C
C------------------------    PIJRGL    -------------------------------
C
      IMPLICIT   NONE
      INTEGER    IPRT,NREG,NSOUT,IUNOUT,IPRINT,
     >           IPRB,IPRF,IUNK,JUNK,IVOL,JVOL,IR,JR,
     >           NSURM,NSURC,NVOLM,NVOLC,IP
      PARAMETER (IUNOUT=6, IPRINT=4)
      REAL       PROB(*),SIGTAL(-NSOUT:NREG),RBARRE,GBARRE,
     >           RI(-NSOUT:NREG)
      RBARRE=0.0
      GBARRE=0.0
      IPRB= 0
      IUNK= 0
      IVOL= NSOUT*(NSOUT+1)/2
C
C     COMPUTE R-SUB(I) FACTORS AND: GBARRE, RBARRE
      DO 30 IR=-NSOUT, NREG
         IUNK= IUNK+1
         RI(IR)=0.0
         DO 10 JR=-NSOUT, IR
            IPRB= IPRB+1
            IF( JR.LT.0.OR.SIGTAL(JR).GT.0.0 )THEN
               RI(IR)=RI(IR)+PROB(IPRB)
            ENDIF
   10    CONTINUE
         IPRF= IPRB
         JUNK= IUNK
         DO 20 JR= IR+1 , NREG
            IPRF= IPRF+JUNK
            JUNK= JUNK+1
            IF( JR.LT.0.OR.SIGTAL(JR).GT.0.0 )THEN
               RI(IR)=RI(IR)+PROB(IPRF)
            ENDIF
   20    CONTINUE
         IF( IR.LT.0 )THEN
            IVOL= IVOL+1
            RI(IR)= PROB(IVOL)-RI(IR)
            GBARRE= GBARRE+PROB(IVOL)
            RBARRE= RBARRE+RI(IR)
         ELSEIF( IR.GT.0 )THEN
            IVOL= IVOL+IUNK-1
            RI(IR)= PROB(IVOL)-RI(IR)
            IF( SIGTAL(IR).GT.0.0 )THEN
               GBARRE= GBARRE+PROB(IVOL)
               RBARRE= RBARRE+RI(IR)
            ENDIF
         ELSE
            IVOL= IVOL+1
            RI(IR)=0.0
         ENDIF
```

```
   30 CONTINUE
      GBARRE=1.0/GBARRE
      RBARRE=RBARRE*GBARRE
C
C     RENORMALIZE PROB MATRIX
      IVOL= NSOUT*(NSOUT+1)/2
      IPRB= 0
      IUNK= 0
      DO 210 IR   = -NSOUT, NREG
         IF( IR.LE.0 )THEN
            IVOL= IVOL+1
         ELSE
            IVOL= IVOL+IUNK
         ENDIF
         IUNK= IUNK+1
         JVOL= NSOUT*(NSOUT+1)/2
         JUNK= 0
         DO 200 JR= -NSOUT, IR
            IF( JR.LE.0 )THEN
               JVOL= JVOL+1
            ELSE
               JVOL= JVOL+JUNK
            ENDIF
            JUNK= JUNK+1
            IPRB= IPRB+1
            IF( IR.NE.0.AND.JR.NE.0 )THEN
               PROB(IPRB)= PROB(IPRB)+(PROB(JVOL)*RI(IR)
     >         +PROB(IVOL)*RI(JR)-PROB(IVOL)*PROB(JVOL)*RBARRE)*GBARRE
            ENDIF
 200     CONTINUE
 210  CONTINUE
C
C     PRINT IF REQUESTED
      IF( IPRT.GE.IPRINT )THEN
         WRITE(IUNOUT,'(19H0  GLOBAL FACTORS: ,
     >         8H RBARRE=,1P,F11.5,5X,7HGBARRE=,F11.5)')
     >            RBARRE,               GBARRE
         WRITE(IUNOUT,'(30H0 SURFACE ADJUSTMENT FACTORS             /)')
         NSURC = -1
         DO 300 IP  = 1, (9 +NSOUT) / 10
            NSURM= MAX( -NSOUT, NSURC-9 )
            WRITE(IUNOUT,'(10X,10( A5,    I6)/)')
     >                     (' SUR ',-IR,IR= NSURC, NSURM, -1)
            WRITE(IUNOUT,'(10H R-SUB(I) ,10F11.5)')
     >                   (RI(IR),IR=NSURC,NSURM,-1)
            NSURC = NSURC - 10
 300     CONTINUE
         WRITE(IUNOUT,'(30H0  VOLUME ADJUSTMENT FACTORS             /)')
         NVOLC =  1
         DO 310 IP  = 1, (9 + NREG) / 10
            NVOLM= MIN( NREG, NVOLC+9 )
            WRITE(IUNOUT,'(10X,10( A5 ,  I6)/)')
     >                  (' VOL ',IR,IR=NVOLC,NVOLM, 1)
            WRITE(IUNOUT,'(10H R-SUB(I) ,10F11.5)')
     >                   (RI(IR),IR=NVOLC,NVOLM, 1)
            NVOLC = NVOLC + 10
```

```
 310     CONTINUE
      ENDIF
C
      RETURN
      END
```

A.3.6 Subroutine PIJRHL.f

```
*DECK PIJRHL
      SUBROUTINE PIJRHL(IPRT,NREG,NSOUT,SIGTAL,PROB,CHI,WEIG)
C
C-------------------------    PIJRHL    -------------------------------
C
C 1- SUBROUTINE STATISTICS:
C     NAME     : PIJRHL
C     LEVEL    : 2 (CALLED BY 'EXCELP')
C     USE      : NON-LINEAR NORMALIZATION OF COLLISION PROBS
C     AUTHOR   : R. ROY (94-04-18)
C     MODIFIED : E. VARIN (97-01-16)
C     REFERENCE: 'NORMALIZATION TECHNIQUES FOR CP MATRICES',
C                 R.ROY AND G.MARLEAU,
C                 CONF/PHYSOR-90, MARSEILLE/FRANCE, V 2, P IX-40 (1990).
C                 'HELIOS: ANGULARLY DEPENDENT COLLISION PROBABILITIES'
C                 E.A. VILLARINO, R.J.J.STAMM'LER
C                 AND A.A.FERRI AND J.J.CASAL
C                 Nucl.Sci.Eng. 112,16-31, 1992.
C
C 2- PARAMETERS:
C  INPUT
C     NREG    : # OF ZONES FOR GEOMETRY.             I
C     NSNEG   : # OF SURFACES FOR GEOMETRY.          I
C     SIGTAL  : ALBEDO-SIGT VECTOR                   R(-NSOUT:NREG)
C     PROB    : -CP- MATRIX FOR ALL TYPES.           R(NPRB)
C               NPRB=(NSOUT+NREG+1)*(NSOUT+NREG+2)/2
C  OUTPUT
C     PROB    : -CP- MATRIX FOR ALL TYPES.           R(NPRB)
C  WORK
C     WEIG    : ADDITIVE WEIGHT                      R(-NSOUT:NREG,3)
C     CHI     : WORK AREA                            R(-NSOUT:NREG)
C
C  3-INTERNAL PARAMETERS
C     EPSCON  : CONVERGENCE CRITERIA = 1.0E-6
C     NITMAX  : MAXIMUM NUMBER OF ITERATIONS = 20
C
C-------------------------    PIJRHL    -------------------------------
C
      IMPLICIT   NONE
      INTEGER    IPRT,NREG,NSOUT,IUNOUT,NITMAX,NIT,IPRINT,
     >           IR,JR,IP,IPRB,IND,I,J,CPTLB,CPTAC,CTOT,
     >           NSURC,NSURM,NVOLC,NVOLM
      REAL       SIGTAL(-NSOUT:NREG)
      LOGICAL    NOTCON
      REAL       PROB(*),WEIG(-NSOUT:NREG,3),
     >           CHI(-NSOUT:NREG),WFSPAD,WFSP,EPSCON,R1,R2,MU,
```

```
     >           TOTCON,TMPCON
      DOUBLE PRECISION  NOM,DENOM,DMU
      PARAMETER (IUNOUT=6, IPRINT=10, EPSCON=1.0E-6, NITMAX=20)
C
C----- INTRINSIC FUNCTION FOR POSITION IN CONDENSE PIJ MATRIX
C
      IND(I,J)=(MAX(I+NSOUT+1,J+NSOUT+1)*
     >         (MAX(I+NSOUT+1,J+NSOUT+1)-1))/2
     >         +MIN(I+NSOUT+1,J+NSOUT+1)
C
      NOTCON= .FALSE.
      CPTLB = 3
      CPTAC = 3
      CTOT = CPTAC+CPTLB
C
C     INITIALISATION OF WEIGHTS
      DO 60 IR=-NSOUT, NREG
         WEIG(IR,1)=0.0
         WEIG(IR,2)=0.5
         WEIG(IR,3)=0.5
   60 CONTINUE
      DO 50 IR=-NSOUT, NREG
         CHI(IR)= 1.0
         IF( IR.GE.0.AND.SIGTAL(IR).EQ.0.0 )THEN
            CHI(IR)= 0.0
         ENDIF
   50 CONTINUE
C
C
C     MAIN ITERATION LOOP
      IF(IPRT.GT.2) WRITE(IUNOUT,'(A24)')
     >      'ITER.     MU      ERROR '
      DO 110 NIT=1,NITMAX
C
         DO 220 IR= -NSOUT, NREG
            WFSPAD = PROB(IND(IR,0))
     >                    + CHI(IR)*PROB(IND(IR,IR))*WEIG(IR,3)
            WFSP = CHI(IR)*PROB(IND(IR,IR))
            DO 200 JR=-NSOUT, NREG
               WFSPAD = WFSPAD - CHI(JR)*WEIG(JR,3)*PROB(IND(IR,JR))
               WFSP = WFSP + CHI(JR)*PROB(IND(IR,JR))
  200       CONTINUE
            WEIG(IR,3) = WFSPAD / WFSP
  220    CONTINUE
C
C        ACCELERATION TECHNIQUE
         IF(  MOD(NIT-1,CTOT).GE.CPTAC )THEN
            NOM   = 0.0D0
            DENOM = 0.0D0
            DO 10 IR=-NSOUT, NREG
               R1= WEIG(IR,2) - WEIG(IR,1)
               R2= WEIG(IR,3) - WEIG(IR,2)
               NOM = NOM + R1*(R2-R1)
               DENOM = DENOM + (R2-R1)*(R2-R1)
   10       CONTINUE
            IF(DENOM.EQ.0.0D0) THEN
```

```
              DMU = 1.0D0
            ELSE
              DMU = - NOM / DENOM
            ENDIF
            MU = REAL(DMU)
            IF( MU.GT.2.0 .OR. MU.LT.0.0 )CALL XABORT('PIJRHL: '
     >         //'PROBLEM OF ACCELERATION')
            DO 20 IR=-NSOUT, NREG
               WEIG(IR,3) = WEIG(IR,2) + MU *
     >                           (WEIG(IR,3) - WEIG(IR,2))
               WEIG(IR,2) = WEIG(IR,1) + MU *
     >                           (WEIG(IR,2) - WEIG(IR,1))
   20       CONTINUE
         ELSE
            MU = 1.0
         ENDIF
C
C        CALCULATIONS OF SQUARE DISTANCE BETWEEN 2 ITERATIONS
C        AND UPDATING THE SOLUTION
         TOTCON = 0.0
         DO 100 IR=-NSOUT, NREG
            TMPCON=ABS(WEIG(IR,3)-WEIG(IR,2))/WEIG(IR,3)
            TOTCON=MAX(TMPCON,TOTCON)
            WEIG(IR,1)= WEIG(IR,2)
            WEIG(IR,2)= WEIG(IR,3)
  100    CONTINUE
         IF( IPRT.GT.2 ) WRITE(IUNOUT,'(I3,F9.5,E15.7)') NIT,MU,TOTCON
C
C        CONVERGENCE TEST
         IF( TOTCON.LT.EPSCON )GO TO 120
C
  110 CONTINUE
      NOTCON=.TRUE.
      WRITE(IUNOUT,'(35H PIJRHL: WEIGHTS NOT CONVERGED          )')
  120 CONTINUE
C
C     RENORMALIZE "PIJ" SYMMETRIC MATRIX
      IPRB = 0
      DO 240 IR   = -NSOUT, NREG
         DO 230 JR= -NSOUT, IR
            IPRB= IPRB+1
            IF( IR.NE.0.AND.JR.NE.0 )THEN
                PROB(IPRB)=PROB(IPRB)*(WEIG(IR,1)+WEIG(JR,1))
            ENDIF
  230    CONTINUE
  240 CONTINUE
C
C     PRINT WEIGHT FACTORS IF THERE IS A PROBLEM...
      IF( NOTCON .OR. IPRT.GE.IPRINT )THEN
         WRITE(IUNOUT,'(30H0 SURFACE WEIGHTS FACTORS               /)')
         NSURC = -1
         DO 300 IP  = 1, (9 +NSOUT) / 10
            NSURM= MAX( -NSOUT, NSURC-9 )
            WRITE(IUNOUT,'(10X,10( A5,    I6)/)')
     >                     (' SUR ',-IR,IR= NSURC, NSURM, -1)
            WRITE(IUNOUT,'(10H WEIGHT   ,10F11.5)')
```

```
     >                   (WEIG(IR,1),IR=NSURC,NSURM,-1)
            NSURC = NSURC - 10
 300     CONTINUE
         WRITE(IUNOUT,'(30H0  VOLUME WEIGHTS FACTORS                /)')
         NVOLC =  1
         DO 310 IP  = 1, (9 + NREG) / 10
            NVOLM= MIN( NREG, NVOLC+9 )
            WRITE(IUNOUT,'(10X,10( A5 ,  I6)/)')
     >                  (' VOL ',IR,IR=NVOLC,NVOLM, 1)
            WRITE(IUNOUT,'(10H WEIGHT   ,10F11.5)')
     >                   (WEIG(IR,1),IR=NVOLC,NVOLM, 1)
            NVOLC = NVOLC + 10
 310     CONTINUE
      ENDIF
C
      RETURN
 8002 FORMAT(//' S U R F / S U R F    C O N T R I B U T I O N S'//
     >9X,'BEGIN S',6X,'END S ',11X,'CIJ.    ',11X, 'WSPACE  ',
     >                         11X,'PROBS.  ')
 8003 FORMAT(6X,I10,5X,I10,5X,1P,E15.7,5X,E15.7,5X,E15.7 )
      END
```

A.3.7 Subroutine PIJRNL.f

```
*DECK PIJRNL
      SUBROUTINE PIJRNL(IPRT,NREG,NSOUT,SIGTAL,PROB,CIJ,
     >                  WSPACE,WFSP,IDL,WEIG)
C
C-------------------------    PIJRNL    -------------------------------
C
C 1- SUBROUTINE STATISTICS:
C     NAME     : PIJRNL
C     LEVEL    : 2 (CALLED BY 'EXCELP')
C     USE      : NON-LINEAR NORMALIZATION OF COLLISION PROBS
C     MODIFIED : 91-07-12 (R.R.)
C     MODIFIED : 91-05-31 (G.M.)
C     AUTHOR   : R. ROY (89-06-01)
C     REFERENCE: 'NORMALIZATION TECHNIQUES FOR CP MATRICES',
C                 R.ROY AND G.MARLEAU,
C                 CONF/PHYSOR-90, MARSEILLE/FRANCE, V 2, P IX-40 (1990).
C
C 2- PARAMETERS:
C  INPUT
C     IPRT    : PRINT LEVEL                         I
C     NREG    : # OF ZONES FOR GEOMETRY.            I
C     NSOUT   : # OF SURFACES FOR GEOMETRY.         I
C     SIGTAL  : ALBEDO-SIGT VECTOR                  R(-NSOUT:NREG)
C     PROB    : -CP- MATRIX FOR ALL TYPES.          R(NPRB)
C               NPRB=(NSOUT+NREG+1)*(NSOUT+NREG+2)/2
C  OUTPUT
C     PROB    : -CP- MATRIX FOR ALL TYPES.          R(NPRB)
C  WORK
C     CIJ     : MODIFIED CP PROB MATRIX             R(NPRB)
C     WSPACE  : NON-LINEAR SYSTEM MATRIX            R(NPRB)
```

```
C     WFSP    : NON LINEAR SYSTEM SOLUTION           R(-NSOUT:NREG)
C     IDL     : WSPACE DIAGONAL LOCATION             R(-NSOUT:NREG)
C     WEIG    : NON-LINEAR WEIGHT                    R(-NSOUT:NREG)
C
C  3-INTERNAL PARAMETERS
C     EPSCON  : CONVERGENCE CRITERIA = 1.0E-8
C     NITMAX  : MAXIMUM NUMBER OF ITERATIONS = 10
C
C-------------------------    PIJRNL    -------------------------------
C
      IMPLICIT   NONE
      INTEGER    IPRT,NREG,NSOUT,IDL(*),IUNOUT,NITMAX,NIT,
     >           NUNKNO,IPRB,IPRF,IVOL,IDIA,IUNK,JUNK,IR,JR,
     >           NSURC,NSURM,NVOLC,NVOLM,IP
      REAL       PROB(*),SIGTAL(-NSOUT:NREG),
     >           WFSP(-NSOUT:NREG),WEIG(-NSOUT:NREG),
     >           CIJ(*),WSPACE(*),EPSCON,TOTCON,WFSPAD
      PARAMETER (IUNOUT=6, EPSCON=1.0E-8, NITMAX=10)
C
C     CHARGE MATRIX "CIJ"
      NUNKNO=NREG+NSOUT+1
      IPRB= 0
      IUNK= 0
      IVOL= NSOUT*(NSOUT+1)/2
      DO 20 IR   = -NSOUT, NREG
         IUNK= IUNK+1
         IF( IR.LT.0.OR.SIGTAL(IR).GT.0.0 )THEN
            DO 10 JR= -NSOUT, IR-1
               IPRB= IPRB+1
               IF( JR.LT.0.OR.SIGTAL(JR).GT.0.0 )THEN
                  CIJ(IPRB)= PROB(IPRB)
               ELSE
                  CIJ(IPRB)= 0.0
               ENDIF
   10       CONTINUE
         ELSE
            DO 15 JR= -NSOUT, IR-1
               IPRB= IPRB+1
               CIJ(IPRB)= 0.0
   15       CONTINUE
         ENDIF
         IPRB= IPRB+1
         IDL(IUNK)= IPRB
         IF( IR.LT.0 )THEN
            IVOL= IVOL+1
            CIJ(IPRB)= PROB(IPRB)
         ELSEIF( IR.GT.0 )THEN
            IVOL= IVOL+IUNK-1
            IF( SIGTAL(IR).GT.0.0 )THEN
               CIJ(IPRB)= PROB(IPRB)
            ELSE
               CIJ(IPRB)= PROB(IVOL)
            ENDIF
         ELSE
            IVOL= IVOL+1
            CIJ(IPRB)= 1.0
```

```
         ENDIF
   20 CONTINUE
C
C     COPY MATRIX "CIJ" IN THE "WSPACE" ARRAY FOR INVERSION
C          AND ADD TO THE DIAGONAL ALL TERMS OF A LINE
      IPRB= 0
      IUNK= 0
      IDIA= 0
      DO 50 IR   = -NSOUT, NREG
         IUNK= IUNK+1
         IDIA= IDIA+IUNK
         WSPACE(IDIA)= CIJ(IDIA) + CIJ(IDIA)
         DO 30 JR= -NSOUT, IR-1
            IPRB= IPRB+1
            WSPACE(IPRB)= CIJ(IPRB)
            WSPACE(IDIA)= WSPACE(IDIA) + CIJ(IPRB)
   30    CONTINUE
         IPRB= IPRB+1
         IPRF= IPRB
         JUNK= IUNK
         DO 40 JR=  IR+1 , NREG
            IPRF= IPRF+JUNK
            JUNK= JUNK+1
            WSPACE(IDIA)= WSPACE(IDIA) + CIJ(IPRF)
   40    CONTINUE
   50 CONTINUE
      IF( IPRT.GT.100 )THEN
         WRITE(IUNOUT,8002)
         IPRB= 0
         DO 52 IR= -NSOUT, NREG
         DO 52 JR= -NSOUT, IR
            IPRB= IPRB+1
            WRITE(IUNOUT,8003) IR, JR, CIJ(IPRB),
     >                             WSPACE(IPRB),PROB(IPRB)
   52    CONTINUE
      ENDIF
C
C     INVERSION OF THE INITIAL SYSTEM JACOBIAN MATRIX
      CALL ALLDLF(NUNKNO,WSPACE,IDL)
C
C     INITIALISATION OF WEIGHTS
      DO 60 IR=-NSOUT, NREG
         WEIG(IR)=1.0
   60 CONTINUE
      WEIG(0)= 0.0
C
C     THE NON-LINEAR SYSTEM FOR WEIGHTS IS:
C      F1(W1, W2, ... WN)= W1*(W1*C11+W2*C12+ ... +WN*C1N) - TRUE1
C      F2(W1, W2, ... WN)= W2*(W1*C21+W2*C22+ ... +WN*C2N) - TRUE2
C      ...
C      FN(W1, W2, ... WN)= WN*(W1*CN1+W2*CN2+ ... +WN*CNN) - TRUEN
C     FORMING THE SYSTEM USING WEIGHTS "WEIG" & CONTRIBUTIONS "CIJ"
C
C     MAIN ITERATION LOOP
      DO 110 NIT=1,NITMAX
C
```

```
         IPRB= 0
         IUNK= 0
         IVOL= NSOUT*(NSOUT+1)/2
         DO 90 IR=-NSOUT, NREG
            IF( IR.LE.0 )THEN
               IVOL= IVOL+1
            ELSE
               IVOL= IVOL+IUNK
            ENDIF
            IUNK= IUNK+1
            WFSPAD= 0.0
            DO 70 JR=-NSOUT, IR
               IPRB= IPRB+1
               WFSPAD=WFSPAD+WEIG(JR)*CIJ(IPRB)
   70       CONTINUE
            IPRF= IPRB
            JUNK= IUNK
            DO 80 JR= IR+1 , NREG
               IPRF= IPRF+JUNK
               JUNK= JUNK+1
               WFSPAD=WFSPAD+WEIG(JR)*CIJ(IPRF)
   80       CONTINUE
            WFSP(IR)=WEIG(IR)*WFSPAD-PROB(IVOL)
   90    CONTINUE
         IF( IPRT.GT.100 )THEN
            WRITE(IUNOUT,9000)
            DO 92 IR= -NSOUT, NREG
               WRITE(IUNOUT,9001) IR, WFSP(IR)
   92       CONTINUE
         ENDIF
         CALL ALLDLS(NUNKNO,IDL,WSPACE,WFSP)
C
C        CALCULATIONS OF SQUARE DISTANCE BETWEEN 2 ITERATIONS
C        AND UPDATING THE SOLUTION
         TOTCON = 0.0
         DO 100 IR=-NSOUT, NREG
            TOTCON= TOTCON + WFSP(IR)**2
            WEIG(IR)= WEIG(IR) - WFSP(IR)
  100    CONTINUE
         IF( IPRT.GT.100 )THEN
            WRITE(IUNOUT,9004)
            DO 102 IR= -NSOUT, NREG
               WRITE(IUNOUT,9005) IR, WEIG(IR)
  102       CONTINUE
            WRITE(IUNOUT,'( 8H TOTCON: ,E15.7)') TOTCON
         ENDIF
C
C        CONVERGENCE TEST
         IF( TOTCON.LT.EPSCON )GO TO 120
C
  110 CONTINUE
      WRITE(IUNOUT,'(35H PIJRNL: WEIGHTS NOT CONVERGED          )')
  120 CONTINUE
C
C     RECOMPUTE WEIGTHS FOR VOID REGIONS
      IPRB= (NSOUT+1)*(NSOUT+2)/2
```

```
      IVOL= IPRB
      IUNK= NSOUT+1
      DO 220 IR= 1, NREG
         IVOL= IVOL+IUNK
         IUNK= IUNK+1
         IF( SIGTAL(IR).EQ.0.0 )THEN
            WFSPAD= 0.0
            DO 200 JR=-NSOUT, IR
               IPRB= IPRB+1
               IF( JR.LT.0.OR.SIGTAL(JR).GT.0.0 )THEN
                  WFSPAD=WFSPAD+WEIG(JR)*PROB(IPRB)
               ENDIF
  200       CONTINUE
            IPRF= IPRB
            JUNK= IUNK
            DO 210 JR= IR+1 , NREG
               IPRF= IPRF+JUNK
               JUNK= JUNK+1
               IF( JR.LT.0.OR.SIGTAL(JR).GT.0.0 )THEN
                  WFSPAD=WFSPAD+WEIG(JR)*PROB(IPRF)
               ENDIF
  210       CONTINUE
            WEIG(IR)=PROB(IVOL)/WFSPAD
         ELSE
            IPRB= IPRB+IUNK
         ENDIF
  220 CONTINUE
C
C     RENORMALIZE "PIJ" SYMMETRIC MATRIX
      IPRB = 0
      DO 240 IR   = -NSOUT, NREG
         DO 230 JR= -NSOUT, IR
            IPRB= IPRB+1
            IF( IR.NE.0.AND.JR.NE.0 )THEN
               PROB(IPRB)=PROB(IPRB)*WEIG(IR)*WEIG(JR)
            ENDIF
  230    CONTINUE
  240 CONTINUE
C
C     PRINT WEIGHT FACTORS IF REQUESTED
      IF( IPRT .GE. 100 )THEN
         WRITE(IUNOUT,'(30H0 SURFACE WEIGHTS FACTORS                /)')
         NSURC = -1
         DO 300 IP  = 1, (9 +NSOUT) / 10
            NSURM= MAX( -NSOUT, NSURC-9 )
            WRITE(IUNOUT,'(10X,10( A5,    I6)/)')
     >                     (' SUR ',-IR,IR= NSURC, NSURM, -1)
            WRITE(IUNOUT,'(10H WEIGHT   ,10F11.5)')
     >                   (WEIG(IR),IR=NSURC,NSURM,-1)
            NSURC = NSURC - 10
 300     CONTINUE
         WRITE(IUNOUT,'(30H0  VOLUME WEIGHTS FACTORS                /)')
         NVOLC =  1
         DO 310 IP  = 1, (9 + NREG) / 10
            NVOLM= MIN( NREG, NVOLC+9 )
            WRITE(IUNOUT,'(10X,10( A5 ,  I6)/)')
```

```
     >                  (' VOL ',IR,IR=NVOLC,NVOLM, 1)
            WRITE(IUNOUT,'(10H WEIGHT   ,10F11.5)')
     >                   (WEIG(IR),IR=NVOLC,NVOLM, 1)
            NVOLC = NVOLC + 10
 310     CONTINUE
      ENDIF
C
      RETURN
 8002 FORMAT(//' S U R F / S U R F    C O N T R I B U T I O N S'//
     >9X,'BEGIN S',6X,'END S ',11X,'CIJ.    ',11X, 'WSPACE  ',
     >                         11X,'PROBS.  ')
 8003 FORMAT(6X,I10,5X,I10,5X,1P,E15.7,5X,E15.7,5X,E15.7 )
 9000 FORMAT(//' F U N C T I O N     V A L U E S'//
     >9X,'VOL/SUR',6X,'VALUE')
 9001 FORMAT(6X,I10,5X,F10.4)
 9004 FORMAT(//' W E I G H T E D     V A L U E S'//
     >9X,'VOL/SUR',6X,'VALUE')
 9005 FORMAT(6X,I10,5X,F10.4)
      END
```

A.3.8 Subroutine PIJSMD.f

```
*DECK PIJSMD
      SUBROUTINE PIJSMD(IMPX,NBMIX,NREGIO,MATCOD,VOLUME,XSSIGW,XSSIGT,
     >                  ILK,PIJSYM,PIJSCT,IOP)
C
C---------------------------  PIJSMD  --------------------------------
C
C   1-  PROGRAMME STATISTICS:
C
C          NAME       :  PIJSMD
C          FUNCTION   :  EVALUATE SCATTERING MODIFIED CP MATRIX
C          DATE       :  03-07-1988
C          MODIFIED   :  94-07-21  (I. PETROVIC, G. MARLEAU)
C          AUTHOR     :  G.MARLEAU
C
C   2-  PARAMETRES D'ENTREE ET DE RETOUR:
C
C         IMPX    : PRINT/CHECK FLAG.                     I            I
C                   EQUAL TO 0 FOR NO PRINT.
C         NBMIX   : NUMBER OF MIXTURES CONSIDERED         I            I
C         NREGIO  : NUMBER OF REGIONS CONSIDERED          I            I
C         MATCOD  : MATERIAL CODE IN REGION               I(NREGIO)    I
C         VOLUME  : VOLUME OF REGION                      R(NREGIO)    I
C         XSSIGW  : WITHIN GROUP SCATTERING 0 OR 1 HARM.  R(NBMIX+1)   D
C         XSSIGT  : TOTAL MACROSCOPIC X.S.                R(NBMIX+1)   D
C         ILK     : ILK=.TRUE. IF LEAKAKE EXISTS          L            I
C         PIJSYM  : GROUP CONDENSED REDUCE/SYMMETRIC      R(NREGIO*
C                   PIJ OR PIJK MATRIX                    (NREGIO+1)/2 D
C         ITYP    : 1 OR 4: PIJ OR PIJK COL. PROB.        I
C         PIJSCT  : SIGW MODIFIED CP MATRIX               R(2*NREGIO**2)D
C                   (PIJ OR PIJK)
C         IOP     : PIJ OR PIJK OPTION                    I
C                   = 1 FOR PIJ
```

```
C                   = 4 FOR PIJK
C
C----------------------------   PIJSMD  --------------------------------
C
      IMPLICIT  NONE
C----
C PARAMETERS
C----
      INTEGER     IUNOUT
      REAL        EPS1
      PARAMETER  (IUNOUT=6,EPS1=1.0E-4)
C----
C INTERNAL FUNCTIONS (USER-DEFINED)
C----
      INTEGER     INDPOS
C----
C VARIABLES
C----
      INTEGER     IERROR,I,J,INDPIJ
      INTEGER     IMPX,NBMIX,NREGIO,MATCOD(*),IOP
      REAL        VOLTOT
      REAL        VOLUME(*),XSSIGW(0:NBMIX),XSSIGT(0:NBMIX),
     >            PIJSYM(*)
      LOGICAL     ILK
      DOUBLE PRECISION PIJSCT(NREGIO,*),WRK,F1
C----
C  INTRINSIC FUNCTION FOR POSITION IN CONDENSE PIJ MATRIX
C----
      INDPOS(I,J)=MAX(I,J)*(MAX(I,J)-1)/2+MIN(I,J)
C----
C  COMPUTE SCATTERING MODIFIED PIJ
C----
      DO 10 I=1,NREGIO
        DO 11 J=1,NREGIO
          INDPIJ=INDPOS(I,J)
          PIJSCT(I,J)=-XSSIGW(MATCOD(J))*PIJSYM(INDPIJ)
          PIJSCT(I,NREGIO+J)=PIJSYM(INDPIJ)
 11     CONTINUE
        PIJSCT(I,I)=VOLUME(I)+PIJSCT(I,I)
 10   CONTINUE
      CALL ALSBD(NREGIO,NREGIO,PIJSCT,IERROR,NREGIO)
      IF(IERROR.NE.0) CALL XABORT('PIJSMD: SINGULAR MATRIX.')
      DO 20 I=1,NREGIO
        DO 21 J=1,NREGIO
          PIJSCT(I,J)=PIJSCT(I,NREGIO+J)
 21     CONTINUE
 20   CONTINUE
      IF (IMPX.GE.8) THEN
        IF(IOP.EQ.4)THEN
          WRITE(IUNOUT,330) (J,J=1,NREGIO)
        ELSE
          WRITE(IUNOUT,130) (J,J=1,NREGIO)
        ENDIF
        DO 30 I=1,NREGIO
          WRITE(IUNOUT,140) I,(PIJSCT(I,J),J=1,NREGIO)
 30     CONTINUE
```

```
          WRITE(IUNOUT,'(//)')
        ENDIF
        IF((IMPX.GE.10).OR.(IMPX.LT.0).AND.(IOP.EQ.1)) THEN
C----
C  CHECK THE RECIPROCITY CONDITIONS.
C----
          VOLTOT=0.0
          DO 50 I=1,NREGIO
            VOLTOT=VOLTOT+VOLUME(I)
 50       CONTINUE
          VOLTOT=VOLTOT/REAL(NREGIO)
          WRK=0.0D0
          DO 60 I=1,NREGIO
            DO 61 J=1,NREGIO
              WRK=MAX(WRK,ABS(PIJSCT(I,J)*VOLUME(I)
     >           -PIJSCT(J,I)*VOLUME(J))/VOLTOT)
 61         CONTINUE
 60       CONTINUE
          IF (WRK.GE.EPS1) WRITE(IUNOUT,150) WRK
C----
C  CHECK THE CONSERVATION CONDITIONS.
C----
          IF (.NOT.ILK) THEN
            WRK=0.0D0
            DO 70 I=1,NREGIO
              F1=1.0D0
              DO 71 J=1,NREGIO
                F1=F1-PIJSCT(I,J)*(XSSIGT(MATCOD(J))-XSSIGW(MATCOD(J)))
 71           CONTINUE
              WRK=MAX(WRK,ABS(F1))
 70         CONTINUE
            IF (WRK.GE.EPS1) WRITE(IUNOUT,160) WRK
          ENDIF
        ENDIF
        RETURN
  130 FORMAT (//53H SCATTERING MODIFIED COLLISION PROBABILITIES MATRIX :
     1 //(11X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,
     2 I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,
     3 2HJ=,I4,:,5X,2HJ=,I4))
  330 FORMAT (//53H SCATTERING MODIFIED DIRECTIONAL COL. PROB.  MATRIX :
     1 //(11X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,
     2 I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,2HJ=,I4,:,5X,
     3 2HJ=,I4,:,5X,2HJ=,I4))
  140 FORMAT (3H I=,I4,2H: ,1P,11E11.3/(9X,11E11.3))
  150 FORMAT (/50H PIJSMD: THE SCATTERING MODIFIED CP MATRIX DO NOT ,
     1 40HMEET THE RECIPROCITY CONDITIONS. RECIP =,1P,E10.3/)
  160 FORMAT (/50H PIJSMD: THE SCATTERING MODIFIED CP MATRIX DO NOT ,
     1 40HMEET THE CONSERVATION CONDITIONS. LEAK =,1P,E10.3/)
        END
```

A.4 The FLU: Module

A.4.1 Subroutine FLUGET.f

```
*DECK FLUGET
      SUBROUTINE FLUGET(IPFLUX,LEAKSW,NGROUP,NREGIO,NUNKNO,ITPIJ ,
     >                  ITYPEC,ISADJ ,ICOPAR,EPSPAR,COPTIO,ILEAK ,
     >                  IPRINT,INITFL,B2    ,REFKEF,
     >                  KEYFLX,FUNKNO)
C
C--------------------------  FLUGET  ---------------------------------
C
C   1- PROGRAMME STATISTICS:
C       NAME     : FLUGET
C       USE      : READ AND ANALYZE DATA FOR FLUX SOLUTION MODULE
C       MODIFIED : EXTRACTED FROM OLD FLUGPI TO MAKE FLUGPI
C                  COMPATIBLE WITH MOC AND SAD
C                  2000/06/28  (G. MARLEAU)
C
C   2- ROUTINE PARAMETERS:
C    INPUT
C      IPFLUX  : POINTER TO THE SOLUTION                   I
C      LEAKSW  : LEAKAGE SWITCH                            L
C      NGROUP  : NUMBER OF GROUPS.                         I
C      NREGIO  : NUMBER OF REGIONS.                        I
C      NUNKNO  : NUMBER OF UNKNOWN IN THE SYSTEM.          I
C      ITPIJ   : TYPE OF CP AVAILABLE                      I
C                = 1 SCATT MOD PIJ (WIJ)
C                = 2 STAND. PIJ
C                = 3 SCATT MOD PIJ+PIJK (WIJ,WIJK)
C                = 4 STAND. PIJ+PIJK
C    INPUT/OUTPUT
C      ITYPEC  : TYPE OF FLUX EVALUATION                   I
C                = 0  SKIP THE FLUX CALCULATION
C                = 1  DIRECT PROBLEM FISSION SOURCES/
C                     K EFFECTIVE CONVERGENCE
C                = 2  DIRECT PROBLEM FISSION SOURCES/
C                     K EFFECTIVE CONVERGENCE/
C                     FIXED DB2 BUCKLING
C                = 3  DIRECT PROBLEM FISSION SOURCES/
C                     K EFFECTIVE CONVERGENCE/
C                     FIXED B2 BUCKLING
C                     D EVALUATION
C                = 4  DIRECT PROBLEM FISSION SOURCES/
C                     DB2 BUCKLING CONVERGENCE
C                = 5  DIRECT PROBLEM DB2 SOURCES
C                = 6  DIRECT PROBLEM FIXED SOURCES
C      ISADJ   : ADJOINT CALCULATION AND SAVE OPTION       I
C                = 0 ONLY DIRECT FLUX
C                = 1 DIRECT AND PSEUDO ADJOINT FLUX
C                = 2 DIRECT, PSEUDO-ADJOINT AND ADJOINT
C                = 3 DIRECT, PSEUDO ADJOINT AND
C                    GENERALIZED PSEUDO-ADJOINT
C                = 4 DIRECT, PSEUDO ADJOINT, ADJOINT,
C                    GENERALIZED PSEUDO-ADJOINT AND
C                    GENERALIZED ADJOINT
C      ICOPAR  : ITERATION PARAMETERS                      I(6)
C                IFRITR=ICOPAR(1)
C                IACITR=ICOPAR(2)
C                IREBAL=ICOPAR(3)
```

```
C                 MAXINR=ICOPAR(4)
C                 MAXOUT=ICOPAR(5)
C                 ICONTM=ICOPAR(6)
C       EPSPAR  : ITERATION PRECISION                      R(NBEPS)
C                 EPSINR=EPSPAR(1)
C                 EPSOUT=EPSPAR(2)
C                 EPSUNK=EPSPAR(3)
C                 EPSGPA=EPSPAR(4)
C                 CONGPA=EPSPAR(5)
C       COPTIO  : LEAKAGE TYPE                             C*4
C                 'LKRD' (IMPOSED LEAKAGE ), 'B0' (B-0),
C                 'P0' (P-0), 'B1' (B-1), 'P1' (P-1)
C                 'B0TR' (B-0 WITH TRANSPORT CORRECTION).
C                 COPTIO='B0' IS DEFAULT FOR TYPE B AND L
C       ILEAK   : METHOD USED TO INCLUDE LEAKAGE EFFECT    I
C                 = 0 NO DB2 EFFECT (DEFAULT FOR TYPE S AND K)
C                 = 1 HOMOGENEOUS METHOD WITH SCATTERING MODIFIED
C                     CP MATRIX MULTIPLIED BY A PNL FACTOR
C                 = 2 HOMOGENEOUS METHOD REDUCED CP MATRIX
C                     MULTIPLIED BY PNL FACTOR
C                     (DEFAULT FOR TYPE B AND L)
C                 = 3 HOMOGENEOUS METHOD SIGS0-DB2 APPROXIMATION
C                 = 4 HOMOGENEOUS METHOD ALBEDO APPROXIMATION
C                 = 5,6,7,8,9,10 HETEROGENEOUS METHOD WITH PIJK
C                   AND FIXED B->5 OR SEARCH X->6 Y->7 Z->8
C                   R->9 ALL->10
C       IPRINT  : PRINT SELECTION FOR FLU MODULE:          I
C                = 0/1/2/3 NO PRINT/SHORT PRINT/LONG
C       INITFL  : FLUX INITIALIZATION OPTION               I
C                 = 0 DEFAULT INITIALIZATION
C                 = 1 READ FROM INPUT AND STROE IN FLXUNK
C                 = 2 TAKEN FROM DATA STRUCTURE
C       B2      : INITIAL ESTIMATE OF THE BUCKLING FOR     R(4)
C                 THE B2 SEARCH OR IMPOSED BUCKLING.
C       REFKEF  : TARGET K-EFFECTIVE FOR TYPE B OR L       D
C       KEYFLX  : FLUX ELEMENTS IN UNKNOWN SYSTEM.         R(NREGIO)
C       FUNKNO  : UNKNOWN VECTOR SOLVED FOR.               R(NUNKNO,
C                                                            NGROUP)
C---------------------------   FLUGET  --------------------------------
C
      IMPLICIT    NONE
      INTEGER     NBUCKN,NLEAK,NSDIR,NBEPS,ILCMUP,ILCMDN
      CHARACTER   NAMSBR*6
      REAL        EPSCUT
      PARAMETER  (NBUCKN=5,NLEAK=5,NSDIR=6,NBEPS=5,
     >            ILCMUP=1,ILCMDN=2,EPSCUT=1.0E-10,
     >            NAMSBR='FLUGET')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     IPFLUX,NGROUP,NREGIO,NUNKNO,ITPIJ ,
     >            ITYPEC,ISADJ,ILEAK,IPRINT,INITFL
      CHARACTER   COPTIO*4
      INTEGER     ICOPAR(6),KEYFLX(NREGIO)
      LOGICAL     LEAKSW
      REAL        EPSPAR(NBEPS),B2(4),FUNKNO(NUNKNO,NGROUP)
```

```
      DOUBLE PRECISION REFKEF
C----
C  LOCAL PARAMETERS
C----
      CHARACTER   CARLIR*4,CDIRFL*12
      INTEGER     INITLK,IRSDIR(NSDIR),ISDIR,JDIR,ILCMLN,ILCMTY
      DOUBLE PRECISION BRSDIR(NSDIR)
C----
C  INITIALIZE LOCAL OPTIONS
C----
      INITLK=0
      IF(MOD(ITPIJ,2) .EQ. 0) THEN
        ICOPAR(4)=MAX(4*NGROUP,ICOPAR(4))
      ELSE
        ICOPAR(4)=MAX(2*NGROUP,ICOPAR(4))
      ENDIF
      COPTIO='B0'
      DO 100 JDIR=1,NSDIR-1
        BRSDIR(JDIR)=0.0D0
        IRSDIR(JDIR)=0
 100  CONTINUE
      BRSDIR(NSDIR)=1.0D0
      IRSDIR(NSDIR)=0
      IPRINT=1
      CARLIR='    '
C----
C  READ FLU OPTIONS
C----
 1000 CONTINUE
      CALL FLUGPI(IPRINT,ITYPEC,ISADJ ,ICOPAR,EPSPAR,COPTIO,
     >            ILEAK ,INITFL,INITLK,IRSDIR,BRSDIR,CARLIR)
C----
C  VALIDATE OPTIONS
C----
      IF(CARLIR .EQ. ';') THEN
        GO TO 2000
      ELSE IF(CARLIR .EQ. 'INIT') THEN
        IF(INITFL .EQ. 1) THEN
          CALL FLURFL(NGROUP,NREGIO,NUNKNO,KEYFLX,FUNKNO)
        ENDIF
        CARLIR='    '
      ELSE
        CALL XABORT(NAMSBR//
     >  ': READ ERROR - ILLEGAL KEYWORD '//CARLIR)
      ENDIF
      GO TO 1000
 2000 CONTINUE
C----
C  REFERENCE KEFF PROVIDED
C----
      REFKEF=BRSDIR(NSDIR)
      B2(1)=0.0
      B2(2)=0.0
      B2(3)=0.0
      B2(4)=0.0
C----
```

```
C  REFERENCE LEAKAGE PROVIDED
C----
      IF(INITLK .NE. 0) THEN
        CDIRFL='FLUXDIRECT  '
        CALL LCMSIX(IPFLUX,CDIRFL,ILCMUP)
        CALL LCMLEN(IPFLUX,'B2  HETE',ILCMLN,ILCMTY)
        IF(ILCMLN .EQ. 3) THEN
          CALL LCMGET(IPFLUX,'B2  HETE',B2)
        ENDIF
        CALL LCMLEN(IPFLUX,'B2  B1HOM',ILCMLN,ILCMTY)
        IF(ILCMLN .EQ. 1) THEN
          CALL LCMGET(IPFLUX,'B2  B1HOM',B2(4))
        ENDIF
        CALL LCMSIX(IPFLUX,CDIRFL,ILCMDN)
      ENDIF
      IF(ILEAK .EQ. 1 .AND. MOD(ITPIJ,2) .EQ. 1) THEN
C----
C  PNL USED WHEN SKIP IS OFF
C----
        ILEAK=2
      ELSE IF(ILEAK .EQ. 2 .AND. MOD(ITPIJ,2) .EQ. 0) THEN
C----
C  PNLR USED WHEN SKIP IS ON
C----
        ILEAK=1
      ELSE IF(ILEAK .EQ. 5 .AND. ITPIJ .LT. 3) THEN
        CALL XABORT(NAMSBR//
     >  ': HETEROGENEOUS BUCKLING CALCULATIONS REQUIRE PIJK MATRICES')
      ENDIF
      ISDIR=0
      IF(ITYPEC .EQ. 2 ) THEN
        IF(ILEAK .EQ. 5) THEN
          DO 110 JDIR=1,NSDIR-1
            IF(IRSDIR(JDIR) .NE. 1) GO TO 115
 110      CONTINUE
        ELSE
          IF(IRSDIR(5) .EQ. 1) GO TO 115
        ENDIF
        CALL XABORT(NAMSBR//
     >  ': BUCKLING REQUIRED FOR TYPE K WITH IMPOSED BUCKLING')
 115    CONTINUE
        IF(INITLK .NE. 2) THEN
          ITYPEC=3
        ENDIF
      ELSE
        DO 120 JDIR=1,NSDIR-1
          IF(IRSDIR(JDIR) .EQ. -1) THEN
            ISDIR=JDIR
            GO TO 125
          ENDIF
 120    CONTINUE
 125    CONTINUE
      ENDIF
      IF(ILEAK .EQ. 5) THEN
        IF(IRSDIR(5) .NE. 0) THEN
          DO 130 JDIR=1,NSDIR-2
```

```
            IF(IRSDIR(JDIR) .NE. 0) THEN
              CALL XABORT(NAMSBR//
     >        ': GLOBAL BUCKLING INCONSISTENT WITH DIRECTION BUCKLING')
            ENDIF
 130      CONTINUE
          B2(1)=BRSDIR(5)/3.0
          B2(2)=B2(1)
          B2(3)=B2(1)
          B2(4)=BRSDIR(5)
        ELSE IF(IRSDIR(4) .NE. 0) THEN
          DO 140 JDIR=1,2
            IF(IRSDIR(JDIR) .NE. 0) THEN
              CALL XABORT(NAMSBR//
     >        ': RADIAL BUCKLING INCONSISTENT WITH X, Y BUCKLING')
            ENDIF
 140      CONTINUE
          B2(1)=BRSDIR(4)/2.0
          B2(2)=B2(1)
          B2(3)=BRSDIR(3)
          B2(4)=BRSDIR(3)+BRSDIR(4)
        ELSE
          B2(1)=BRSDIR(1)
          B2(2)=BRSDIR(2)
          B2(3)=BRSDIR(3)
          B2(4)=BRSDIR(1)+BRSDIR(2)+BRSDIR(3)
        ENDIF
        ILEAK=ILEAK+ISDIR
      ELSE
        DO 150 JDIR=1,NSDIR-2
          IF(IRSDIR(JDIR) .NE. 0) THEN
            CALL XABORT(NAMSBR//
     >      ': ILLEGAL DIRECTION BUCKLING FOR HOMOGENEOUS LEAKAGE')
          ENDIF
 150    CONTINUE
        B2(4)=BRSDIR(5)
      ENDIF
      IF(LEAKSW) THEN
        IF( (ITYPEC .EQ. 4 .AND. ILEAK .NE. 4) .OR.
     >      (ITYPEC .EQ. 5 .AND. ILEAK .NE. 4) ) THEN
          CALL XABORT(NAMSBR//': B2 CONVERGENCE NOT ALLOWED HERE')
        ENDIF
      ENDIF
      EPSPAR(1)=MAX(EPSPAR(1),EPSCUT)
      EPSPAR(2)=MAX(EPSPAR(2),EPSCUT)
      EPSPAR(3)=MAX(EPSPAR(1),EPSPAR(3),EPSCUT)
      IF(ICOPAR(5) .EQ. 0) THEN
        IF(ITYPEC .EQ. 3 .OR.
     >     ITYPEC .EQ. 4 .OR.
     >     ITYPEC .EQ. 5      ) THEN
          ICOPAR(5)=10*NREGIO+1
        ELSE
          ICOPAR(5)=2*NREGIO-1
        ENDIF
      ENDIF
C----
C  FOR ADJOINT AND GENERALIZED ADJOINT PROBLEM
```

```
C  TEST IF TYPE AND LEAK OPTION ADEQUATE
C  IF NOT SET DEFAULT
C  ILEAK=3 AND ITYPEC =2
C----
      IF(ISADJ .GE. 3) THEN
        IF(ITYPEC .LE. 0 .OR. ITYPEC .GE. 5) THEN
          CALL XABORT(NAMSBR//
     >    ': ILLEGAL TYPE FOR GENERALIZED ADJOINT CALCULATION')
        ELSE IF(ITYPEC .GE. 2) THEN
          IF(ILEAK .GE. 4) THEN
            ILEAK=3
          ENDIF
        ENDIF
      ELSE IF(ISADJ .GE. 1) THEN
        IF(ITYPEC .GE. 2 .AND. ITYPEC .LE. 5) THEN
          IF(ILEAK .GE. 4) THEN
            ILEAK=3
          ENDIF
        ENDIF
      ENDIF
      IF(ITYPEC .EQ. 1) THEN
        ILEAK=0
      ENDIF
      RETURN
      END
```

A.4.2 Subroutine FLUGFL.f

```
*DECK FLUGFL
      SUBROUTINE FLUGFL(IPFLUX,NGROUP,NUNKNO,FUNKNO)
C
C---------------------------  FLUGFL  ---------------------------------
C
C   1- PROGRAMME STATISTICS:
C       NAME     : FLUGFL
C       USE      : GET FLUX FROM IPFLUX
C       MODIFIED : 2000-01-20  (G. MARLEAU)
C       AUTHOR   : G.MARLEAU
C
C   2- ROUTINE PARAMETERS:
C    INPUT:
C      IPFLUX  : FULS DATA STRUCTURE POINTER          I
C      NGROUP  : NUMBER OF GROUPS.                    I
C      NUNKNO  : NUMBER OF UNKNOWN IN THE SYSTEM.     I
C      FUNKNO  : UNKNOWN VECTOR SOLVED FOR.           R(NUNKNO,NGROUP)
C
C---------------------------   FLUGFL  --------------------------------
C
      IMPLICIT    NONE
      CHARACTER   NAMSBR*6
      PARAMETER  (NAMSBR='FLUGFL')
C----
C  ROUTINE PARAMETERS
C----
```

```
      INTEGER     IPFLUX,NGROUP,NUNKNO
      REAL        FUNKNO(NUNKNO,NGROUP)
C----
C  LOCAL PARAMETERS
C----
      CHARACTER   CDIRN*12
      INTEGER     IGROUP,ILCMLN,ILCMTY
C----
C  GET UNKNOWN VECTOR FROM IPFLUX
C----
      DO 100 IGROUP=1,NGROUP
        WRITE(CDIRN,'(4HFLUX,I3)') IGROUP
        CALL LCMLEN(IPFLUX,CDIRN,ILCMLN,ILCMTY)
        IF(ILCMLN .GT. 0 .AND. ILCMLN .LE. NUNKNO) THEN
          CALL LCMGET(IPFLUX,CDIRN,FUNKNO(1,IGROUP))
        ENDIF
 100  CONTINUE
      RETURN
      END
```

A.4.3 Subroutine FLUGPI.f

```
*DECK FLUGPI
      SUBROUTINE FLUGPI(IPRINT,ITYPEC,ISADJ ,ICOPAR,EPSPAR,COPTIO,
     >                  ILEAK ,INITFL,INITLK,IRSDIR,BRSDIR,CARLST)
C
C---------------------------  FLUGPI  ---------------------------------
C
C   1- PROGRAMME STATISTICS:
C       NAME     : FLUGPI
C       USE      : READ DATA FOR FLUX SOLUTION MODULE
C       MODIFIED : MODIFY DEFINITION OF ITYPEC
C                  2000/01/27  (G. MARLEAU)
C                  2000/01/20  (T. COURAU, G. MARLEAU)
C                  1994/07/21  (I. PETROVIC, G. MARLEAU)
C                  1991/03/15  (G. MARLEAU)
C                  1991/01/28  (A. HEBERT)
C                  1986/05/14  (G. MARLEAU)
C
C   2- ROUTINE PARAMETERS:
C    INPUT/OUTPUT
C      IPRINT  : PRINT SELECTION FOR FLU MODULE:          I
C               = 0/1/2/3 NO PRINT/SHORT PRINT/LONG
C      ITYPEC  : TYPE OF FLUX EVALUATION                  I
C                = 0  SKIP THE FLUX CALCULATION
C                = 1  DIRECT PROBLEM FISSION SOURCES/
C                     K EFFECTIVE CONVERGENCE
C                = 2  DIRECT PROBLEM FISSION SOURCES/
C                     K EFFECTIVE CONVERGENCE/
C                     FIXED DB2 BUCKLING
C                = 3  DIRECT PROBLEM FISSION SOURCES/
C                     K EFFECTIVE CONVERGENCE/
C                     FIXED B2 BUCKLING
C                     D EVALUATION
```

```
C                 = 4  DIRECT PROBLEM FISSION SOURCES/
C                      DB2 BUCKLING CONVERGENCE
C                 = 5  DIRECT PROBLEM DB2 SOURCES
C                 = 6  DIRECT PROBLEM FIXED SOURCES
C       ISADJ   : ADJOINT CALCULATION AND SAVE OPTION      I
C                 = 0 ONLY DIRECT FLUX
C                 = 1 DIRECT AND PSEUDO ADJOINT FLUX
C                 = 2 DIRECT, PSEUDO-ADJOINT AND ADJOINT
C                 = 3 DIRECT, PSEUDO ADJOINT AND
C                     GENERALIZED PSEUDO-ADJOINT
C                 = 4 DIRECT, PSEUDO ADJOINT, ADJOINT,
C                     GENERALIZED PSEUDO-ADJOINT AND
C                     GENERALIZED ADJOINT
C       ICOPAR  : ITERATION PARAMETERS                     I(6)
C                 IFRITR=ICOPAR(1)
C                 IACITR=ICOPAR(2)
C                 IREBAL=ICOPAR(3)
C                 MAXINR=ICOPAR(4)
C                 MAXOUT=ICOPAR(5)
C                 ICONTM=ICOPAR(6)
C       EPSPAR  : ITERATION PRECISION                      R(NBEPS)
C                 EPSINR=EPSPAR(1)
C                 EPSOUT=EPSPAR(2)
C                 EPSUNK=EPSPAR(3)
C                 EPSGPA=EPSPAR(4)
C                 CONGPA=EPSPAR(5)
C       COPTIO  : LEAKAGE TYPE                             C*4
C                 'LKRD' (IMPOSED LEAKAGE ), 'B0' (B-0),
C                 'P0' (P-0), 'B1' (B-1), 'P1' (P-1)
C                 'B0TR' (B-0 WITH TRANSPORT CORRECTION).
C                 COPTIO='B0' IS DEFAULT FOR TYPE B AND L
C       ILEAK   : METHOD USED TO INCLUDE LEAKAGE EFFECT    I
C                 = 0 NO DB2 EFFECT (DEFAULT FOR TYPE S AND K)
C                 = 1 HOMOGENEOUS METHOD WITH SCATTERING MODIFIED
C                     CP MATRIX MULTIPLIED BY A PNL FACTOR
C                 = 2 HOMOGENEOUS METHOD REDUCED CP MATRIX
C                     MULTIPLIED BY PNL FACTOR
C                     (DEFAULT FOR TYPE B AND L)
C                 = 3 HOMOGENEOUS METHOD SIGS0-DB2 APPROXIMATION
C                 = 4 HOMOGENEOUS METHOD ALBEDO APPROXIMATION
C                 = 5,6,7,8,9,10 HETEROGENEOUS METHOD WITH PIJK
C                   AND FIXED B->5 OR SEARCH X->6 Y->7 Z->8
C                   R->9 ALL->10
C       INITFL  : FLUX INITIALIZATION OPTION               I
C                 = 0 DEFAULT INITIALIZATION
C                 = 1 READ FROM INPUT AND STROE IN FLXUNK
C                 = 2 TAKEN FROM DATA STRUCTURE
C       INITLK  : LEAKAGE INITIALIZATION                   I
C                 = 0 NONE
C                 = 1 INITIALIZE B2 AND COMPUTE D
C                 = 2 INITIALIZE B2 AND D
C       IRSDIR  : BUCKLING DIRECTION READ                  I(NSDIR)
C       BRSDIR  : BUCKLING VALUE READ                      D(NSDIR)
C       CARLST  : LAST CHARACTER READ                      C*4
C--------------------------   FLUGPI  -------------------------------
C
```

```
      IMPLICIT    NONE
      INTEGER     NBUCKN,NLEAK,NSDIR,NBEPS,ILCMUP,ILCMDN
      CHARACTER   NAMSBR*6
      PARAMETER  (NBUCKN=5,NLEAK=5,NSDIR=6,NBEPS=5,
     >            ILCMUP=1,ILCMDN=2,NAMSBR='FLUGPI')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     IPRINT,ITYPEC,ISADJ,ILEAK,INITFL,INITLK
      CHARACTER   COPTIO*4,CARLST*4
      INTEGER     ICOPAR(6),IRSDIR(NSDIR)
      REAL        EPSPAR(NBEPS)
      DOUBLE PRECISION BRSDIR(NSDIR)
C----
C  INPUT PARAMETERS
C----
      INTEGER     ITYPLU,INTLIR
      CHARACTER   CARLIR*4
      REAL        REALIR
      DOUBLE PRECISION DBLLIR
C----
C  LOCAL PARAMETERS
C----
      INTEGER     ISDIR,JBUC,JLEA,JDIR,IRD
C----
C  DATA
C----
      CHARACTER   CBUCKN(0:NBUCKN)*4,CLEAK(NLEAK)*4,
     >            CSDIR(NSDIR)*4
      SAVE        CBUCKN,CLEAK,CSDIR
      DATA       (CBUCKN(JBUC),JBUC=0,NBUCKN)
     >           /'LKRD','B0','P0','B1','P1','B0TR'/
      DATA       (CLEAK(JLEA),JLEA=1,NLEAK)
     >           /'PNLR','PNL ','SIGS','ALBS','HETE'/
      DATA       (CSDIR(JDIR),JDIR=1,NSDIR)
     >           /'X','Y','Z','R','G','K'/
C----
C  READ OPTION NAME
C----
      ISDIR=0
      IF(CARLST .NE. '    ') THEN
        CARLIR=CARLST
        ITYPLU=3
        GO TO 1010
      ENDIF
 1000 CONTINUE
      CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
 1010 CONTINUE
      IF(ITYPLU .EQ. 10) THEN
        CARLIR=';'
        GO TO 2000
      ENDIF
      IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >': READ ERROR - CHARACTER VARIABLE EXPECTED')
      IF(CARLIR .EQ. ';') THEN
        GO TO 2000
```

```
     ELSE IF(CARLIR .EQ. 'EDIT') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 1) CALL XABORT(NAMSBR//
    >  ': READ ERROR - EDIT LEVEL EXPECTED')
       IPRINT=INTLIR
     ELSE IF(CARLIR .EQ. 'TYPE') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >  ': READ ERROR - TYPE EXPECTED')
       IF(CARLIR .EQ. 'N') THEN
         ITYPEC=0
       ELSE IF(CARLIR .EQ. 'K') THEN
         ITYPEC=1
         ISDIR=6
       ELSE IF(CARLIR .EQ. 'B') THEN
         ITYPEC=4
         ILEAK=2
         ISDIR=5
       ELSE IF(CARLIR .EQ. 'L') THEN
         ITYPEC=5
         ILEAK=2
         ISDIR=5
       ELSE IF(CARLIR .EQ. 'S') THEN
         ITYPEC=6
       ELSE
         CALL XABORT(NAMSBR//
    >    ': INVALID TYPE KEYWORD= '//CARLIR)
       ENDIF
       IF(ITYPEC .GT. 0 .AND. ITYPEC .LT. 6) THEN
         CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
         IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >    ': READ ERROR - BUCKLING OPTION OR KEYWORD EXPECTED')
         DO 100 JBUC=0,NBUCKN
           IF(CARLIR .EQ. CBUCKN(JBUC)) THEN
             COPTIO=CARLIR
             GO TO 105
           ENDIF
100      CONTINUE
         GO TO 1010
105      CONTINUE
         IF(ITYPEC .EQ. 1) THEN
           ITYPEC=2
         ENDIF
         CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
         IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//'
    >    : READ ERROR - LEAKAGE TYPE OR KEYWORD EXPECTED')
         DO 110 JLEA=1,NLEAK
           IF(CARLIR .EQ. CLEAK(JLEA)) THEN
             ILEAK=JLEA
             IF(ILEAK .EQ. 5) THEN
               CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
               IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >          ': READ ERROR - DIRECTION OR KEYWORD EXPECTED')
               DO 111 JDIR=1,NSDIR-1
                 IF(CARLIR .EQ. CSDIR(JDIR)) THEN
                   ISDIR=JDIR
```

```
                   GO TO 1000
                 ENDIF
111            CONTINUE
               GO TO 1010
             ENDIF
             GO TO 1000
           ENDIF
110      CONTINUE
         GO TO 1010
       ENDIF
     ELSE IF(CARLIR .EQ. 'REBA') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >  ': READ ERROR - REBALANCING OPTION EXPECTED')
       IF(CARLIR .EQ. 'OFF ') THEN
         ICOPAR(3)=0
       ELSE IF(CARLIR .EQ. 'ON ') THEN
         ICOPAR(3)=1
       ELSE
         ICOPAR(3)=1
         GO TO 1010
       ENDIF
     ELSE IF(CARLIR .EQ. 'INIT') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >  ': READ ERROR - FLUX INITIALIZATION OPTION REQUIRED')
       IF(CARLIR .EQ. 'OFF ') THEN
         INITFL=0
       ELSE IF(CARLIR .EQ. 'ON  ') THEN
         INITFL=1
         CARLIR='INIT'
         GO TO 2000
       ENDIF
     ELSE IF(CARLIR .EQ. 'THER') THEN
       DO 120 IRD=1,2
         CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
         IF(ITYPLU .EQ. 3) THEN
           GO TO 1010
         ELSE IF(ITYPLU .EQ. 1) THEN
           ICOPAR(4)=INTLIR
         ELSE IF(ITYPLU .EQ. 2) THEN
           EPSPAR(1)=REALIR
         ENDIF
120    CONTINUE
     ELSE IF(CARLIR .EQ. 'EXTE') THEN
       DO 130 IRD=1,2
         CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
         IF(ITYPLU .EQ. 3) THEN
           GO TO 1010
         ELSE IF(ITYPLU .EQ. 1) THEN
           ICOPAR(5)=INTLIR
         ELSE IF(ITYPLU .EQ. 2) THEN
           EPSPAR(2)=REALIR
         ENDIF
130    CONTINUE
     ELSE IF(CARLIR .EQ. 'UNKT') THEN
```

```
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 2) CALL XABORT(NAMSBR//
    >  ': REAL VALUE OF EPSUNK MUST FOLLOW UNKT')
       EPSPAR(3)=REALIR
     ELSE IF(CARLIR .EQ. 'EGPA') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 2) CALL XABORT(NAMSBR//
    >  ': REAL VALUE OF EGPA REQUIRED')
       EPSPAR(4)=REALIR
     ELSE IF(CARLIR .EQ. 'CGPA') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 2) CALL XABORT(NAMSBR//
    >  ': REAL VALUE OF CGPA REQUIRED')
       EPSPAR(5)=REALIR
     ELSE IF(CARLIR .EQ. 'DECO') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >  ': READ ERROR - DECONTAMINATION OPTION EXPECTED')
       IF(CARLIR .EQ. 'OFF ') THEN
         ICOPAR(6)=0
       ELSE IF(CARLIR .EQ. 'ON ') THEN
         ICOPAR(6)=1
       ELSE
         ICOPAR(6)=1
         GO TO 1010
       ENDIF
     ELSE IF(CARLIR .EQ. 'ACCE') THEN
       DO 140 IRD=1,2
         CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
         IF(ITYPLU .NE. 1) CALL XABORT(NAMSBR//
    >   ': READ ERROR - ACCELERATION PARAMETER MISSING')
         ICOPAR(IRD)=INTLIR
140    CONTINUE
     ELSE IF(CARLIR .EQ. 'KEFF') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       JDIR=6
       IF(ITYPLU .EQ. 2) THEN
         BRSDIR(JDIR)=DBLE(REALIR)
         IRSDIR(JDIR)=1
       ELSE IF(ITYPLU .EQ. 4) THEN
         BRSDIR(JDIR)=DBLLIR
         IRSDIR(JDIR)=1
       ELSE
         CALL XABORT(NAMSBR//': READ ERROR - KEFF VALUE EXPECTED')
       ENDIF
     ELSE IF(CARLIR .EQ. 'BUCK') THEN
       JDIR=5
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .EQ. 2) THEN
         BRSDIR(JDIR)=DBLE(REALIR)
         IRSDIR(JDIR)=1
         GO TO 1000
       ELSE IF(ITYPLU .EQ. 4) THEN
         BRSDIR(JDIR)=DBLLIR
         IRSDIR(JDIR)=1
         GO TO 1000
```

```
       ELSE IF(ITYPLU .EQ. 1) THEN
         CALL XABORT(NAMSBR//': READ ERROR - BUCK INFO EXPECTED')
       ENDIF
150    CONTINUE
         DO 160 JDIR=1,NSDIR-1
           IF(CARLIR .EQ. CSDIR(JDIR)) THEN
             CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
             IF(ITYPLU .EQ. 2) THEN
               BRSDIR(JDIR)=DBLE(REALIR)
               IRSDIR(JDIR)=1
               GO TO 165
             ELSE IF(ITYPLU .EQ. 4) THEN
               BRSDIR(JDIR)=DBLLIR
               IRSDIR(JDIR)=1
               GO TO 165
             ELSE
               CALL XABORT(NAMSBR//
    >          ': READ ERROR - DIRECTIONAL BUCKLING EXPECTED')
             ENDIF
           ENDIF
160      CONTINUE
         GO TO 1010
165      CONTINUE
         CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
         IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >    ': READ ERROR - BUCKLING DIRECTION OR KEYWORD EXPECTED')
       GO TO 150
     ELSE IF(CARLIR .EQ. 'IDEM') THEN
       CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
       IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
    >  ': READ ERROR - IDEM TYPE EXPECTED')
       IF(CARLIR .EQ. 'B2') THEN
         INITLK=1
       ELSE IF(CARLIR .EQ. 'DB2') THEN
         INITLK=2
       ELSE
         INITLK=1
         GO TO 1010
       ENDIF
     ELSE IF(CARLIR .EQ. 'FLX') THEN
       ISADJ=0
     ELSE IF(CARLIR .EQ. 'PAF') THEN
       ISADJ=1
     ELSE IF(CARLIR .EQ. 'AF') THEN
       ISADJ=2
     ELSE IF(CARLIR .EQ. 'GPA') THEN
       ISADJ=3
     ELSE IF(CARLIR .EQ. 'GA') THEN
       ISADJ=4
     ELSE
       GO TO 2000
     ENDIF
     GO TO 1000
2000 CONTINUE
     IF(ISDIR .GT. 0) THEN
       IRSDIR(ISDIR)=-1
```

```
      ENDIF
      CARLST=CARLIR
      RETURN
      END
```

A.4.4 Subroutine FLUQFS.f

```
*DECK FLUQFS
      SUBROUTINE FLUQFS(IPMACR,IPRINT,NGROUP,NBMIX ,NREGIO,NUNKNO,
     >                  NIFISS,MATCOD,KEYFLX,CCHI  ,FACTNO,QTOTL ,
     >                  SUNKNO,XSCHI )
C
C--------------------------  FLUQFS  -------------------------------
C
C   1- PROGRAMME STATISTICS:
C       NAME     : FLUQFS
C       USE      : ADD FISSION SOURCES TO SUNKNO
C       MODIFIED : DEAL WITH ADJOINT SOURCE (ITYPEC<0)
C                  00-01-18  (T. COURAU)
C                  94-06-23
C       AUTHOR   : G.MARLEAU
C
C   2- ROUTINE PARAMETERS:
C    INPUT:
C      IPMACR  : POINTER TO THE MACROLIB               I
C      IPRINT  : PRINT SELECTION FOR FLUX MODULES      I
C                = 0/1/2/3 NO PRINT/SHORT PRINT/LONG
C      NGROUP  : NUMBER OF GROUPS                      I
C      NBMIX   : NUMBER OF MIXTURES                    I
C      NREGIO  : NUMBER OF REGIONS                     I
C      NUNKNO  : NUMBER OF UNKNOWN IN THE SYSTEM       I
C      NIFISS  : NUMBER OF FISSILE ISOTOPES            I
C      MATCOD  : MATERIAL CODE IN REGIONS.             I(NREGIO)
C      KEYFLX  : FLUX ELEMENTS IN UNKNOWN SYSTEM       I(NREGIO)
C      FACTNO  : SOURCE NORMALIZATION FACTOR           D
C      CCHI    : FISSION SPECTRUM RECORD NAME          C*12
C      QTOTL   : TOTAL FISSION SOURCE PER ISOTOPE      R(NREGIO,NIFISS)
C    OUTPUT
C      SUNKNO  : SOURCE FOR SYSTEM OF UNKNOWN          R(NUNKNO,NGROUP)
C    SCRATCH STORAGE:
C      XSCHI   : CHI  VECTOR                         R(NBMIX,NIFISS)
C
C   3- INTERNAL PARAMETERS:
C      CGRPNM  : CHARACTER GROUP NAME                  C*12
C      IOUT  : OUTPUT UNIT                           P
C
C--------------------------   FLUQFS  -------------------------------
C
      IMPLICIT    NONE
      INTEGER     IOUT,ILCMUP,ILCMDN
      CHARACTER   NAMSBR*6
      PARAMETER  (IOUT=6,ILCMUP=1,ILCMDN=2,NAMSBR='FLUQFS')
C----
C  ROUTINE PARAMETERS
```

```
C----
      INTEGER     IPMACR,IPRINT,NGROUP,NBMIX,NREGIO,
     >            NUNKNO,NIFISS
      CHARACTER   CCHI*12
      INTEGER     MATCOD(NREGIO),KEYFLX(NREGIO)
      REAL        QTOTL(NREGIO,NIFISS),SUNKNO(NUNKNO,NGROUP),
     >            XSCHI(NBMIX,NIFISS)
      DOUBLE PRECISION FACTNO
C----
C  LOCAL PARAMETERS
C----
      CHARACTER   CGRPNM*12
      INTEGER     IGR,IREG,IFLXL,IBM,IFIS
C----
C  ADD FISSION SOURCES TO SUNKNO AT REGION LOCATION
C----
      DO 100 IGR=1,NGROUP
        WRITE(CGRPNM,'(5HGROUP,I3,1H/,I3)') IGR,NGROUP
        CALL LCMSIX(IPMACR,CGRPNM,1)
        CALL LCMGET(IPMACR,CCHI,XSCHI)
        DO 110 IREG=1,NREGIO
          IFLXL=KEYFLX(IREG)
          IBM=MATCOD(IREG)
          IF(IBM .GT. 0) THEN
            DO 120 IFIS=1,NIFISS
              SUNKNO(IFLXL,IGR)=SUNKNO(IFLXL,IGR)+
     >        QTOTL(IREG,IFIS)*XSCHI(IBM,IFIS)*FACTNO
 120        CONTINUE
            IF(IPRINT .GE. 100) THEN
              WRITE(IOUT,6000) IGR,IREG
              WRITE(IOUT,6001) (IFIS,QTOTL(IREG,IFIS)*
     >          XSCHI(IBM,IFIS)*FACTNO,IFIS=1,NIFISS)
            ENDIF
          ENDIF
 110    CONTINUE
        CALL LCMSIX(IPMACR,' ',2)
 100  CONTINUE
      RETURN
C----
C FORMATS
C----
 6000 FORMAT(' REGIONAL FISSION SOURCES IN GROUP = ',I5,
     >       ' REGION NUMBER = ',I5)
 6001 FORMAT(1P,5(3X,I5,2X,E15.7))
      END
```

A.4.5 Subroutine FLUQFX.f

```
*DECK FLUQFX
      SUBROUTINE FLUQFX(IPMACR,IPRINT,NGROUP,NBMIX ,NREGIO,NUNKNO,
     >                  MATCOD,KEYFLX,CFIXSR,SUNKNO,XSA   )
C
C---------------------------  FLUQFX  ---------------------------------
C
```

```
C   1- PROGRAMME STATISTICS:
C       NAME     : FLUQFX
C       USE      : ADD FIXED SOURCES TO SUNKNO
C       MODIFIED : 94-06-23
C       AUTHOR   : G.MARLEAU
C
C   2- ROUTINE PARAMETERS:
C    INPUT:
C      IPMACR  : POINTER TO THE MACROLIB              I
C      IPRINT  : PRINT SELECTION FOR FLUX MODULES:    I
C                >= 100 PRINT FIXED SOURCES
C      NGROUP  : NUMBER OF GROUPS.                    I
C      NBMIX   : NUMBER OF MIXTURES.                  I
C      NREGIO  : NUMBER OF REGIONS.                   I
C      NUNKNO  : NUMBER OF UNKNOWN IN THE SYSTEM.     I
C      MATCOD  : MATERIAL CODE IN REGIONS.            I(NREGIO)
C      KEYFLX  : FLUX ELEMENTS IN UNKNOWN SYSTEM.     I(NREGIO)
C      CFIXSR  : NAME OF GENERALIZED ADJOINT SOURCE   C*12
C    OUTPUT
C      SUNKNO  : SOURCE FOR SYSTEM OF UNKNOWN.        R(NUNKNO,NGROUP)
C    SCRATCH STORAGE:
C      XSA     : ARBITRARY XS VECTOR                  R(0:NBMIX)
C                XSA(0) ALREADY INITIALIZED TO 0.0
C
C   3- INTERNAL PARAMETERS:
C      CGRPNM  : CHARACTER GROUP NAME                 C*12
C      IOUT  : OUTPUT UNIT                          P
C
C---------------------------   FLUQFX  --------------------------------
C
      IMPLICIT    NONE
      INTEGER     IOUT,ILCMUP,ILCMDN
      CHARACTER   NAMSBR*6
      PARAMETER  (IOUT=6,ILCMUP=1,ILCMDN=2,NAMSBR='FLUQFX')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     IPMACR,IPRINT,NGROUP,NBMIX,NREGIO,NUNKNO
      CHARACTER   CFIXSR*12
      INTEGER     MATCOD(NREGIO),KEYFLX(NREGIO)
      REAL        SUNKNO(NUNKNO,NGROUP),XSA(0:NBMIX)
C----
C  LOCAL PARAMETERS
C----
      CHARACTER   CGRPNM*12
      INTEGER     IGR,IREG,IBM,ILCMLN,ILCMTY
C----
C  ADD FIXED SOURCES TO SUNKNO AT REGION LOCATION
C----
      DO 100 IGR=1,NGROUP
        WRITE(CGRPNM,'(5HGROUP,I3,1H/,I3)') IGR,NGROUP
        CALL LCMSIX(IPMACR,CGRPNM,ILCMUP)
        CALL LCMLEN(IPMACR,CFIXSR,ILCMLN,ILCMTY)
        IF(ILCMLN .EQ. NBMIX) THEN
          CALL LCMGET(IPMACR,CFIXSR,XSA(1))
          DO 110 IREG=1,NREGIO
```

```
            IBM=MATCOD(IREG)
            SUNKNO(KEYFLX(IREG),IGR)=XSA(IBM)
 110      CONTINUE
          IF(IPRINT .GE. 100) THEN
            WRITE(IOUT,6000) IGR
            WRITE(IOUT,6001)
     >        (IREG,XSA(MATCOD(IREG)),IREG=1,NREGIO)
          ENDIF
        ELSE
          CALL XABORT(NAMSBR//
     >    ': FIXED SOURCE '//CFIXSR//' NOT FOUND')
        ENDIF
        CALL LCMSIX(IPMACR,CGRPNM,ILCMDN)
 100  CONTINUE
      RETURN
C----
C FORMATS
C----
 6000 FORMAT(1X,' REGIONAL FIXED SOURCES IN GROUP = ',I5)
 6001 FORMAT(1P,5(3X,I5,2X,E15.7))
      END
```

A.4.6 Subroutine FLUSFL.f

```
*DECK FLUSFL
      SUBROUTINE FLUSFL(IPFLUX,NGROUP,NUNKNO,FUNKNO)
C
C---------------------------  FLUSFL  ---------------------------------
C
C   1- PROGRAMME STATISTICS:
C       NAME     : FLUSFL
C       USE      : SAVE FLUX
C       CREATED  : 2000/01/25
C                  EXTRACTED FROM FLUGFL FOR MORE GENERAL USE
C       AUTHOR   : G.MARLEAU
C
C   2- ROUTINE PARAMETERS:
C    INPUT:
C      IPFLUX  : POINTER TO THE SOLUTION              I
C      NGROUP  : NUMBER OF GROUPS.                    I
C      NUNKNO  : NUMBER OF UNKNOWN IN THE SYSTEM.     I
C      FUNKNO  : UNKNOWN VECTOR SOLVED FOR.           R(NUNKNO,NGROUP)
C
C---------------------------   FLUSFL  --------------------------------
C
      IMPLICIT    NONE
      CHARACTER   NAMSBR*6
      PARAMETER  (NAMSBR='FLUSFL')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     IPFLUX,NGROUP,NUNKNO
      REAL        FUNKNO(NUNKNO,NGROUP)
C----
```

```
C  LOCAL PARAMETERS
C----
      CHARACTER   CDIRN*12
      INTEGER     IGROUP
C----
C  STORE UNKNOWN VECTOR IPFLUX
C----
      DO 100 IGROUP=1,NGROUP
        WRITE(CDIRN,'(4HFLUX,I3)') IGROUP
        CALL LCMPUT(IPFLUX,CDIRN,NUNKNO,2,FUNKNO(1,IGROUP))
 100  CONTINUE
      RETURN
      END
```

A.4.7 Subroutine TRFICF.f

```
*DECK TRFICF
      SUBROUTINE TRFICF(IPSYS ,IPTRK ,IPBTF ,IPRNTF,IDIR  ,NREGIO,
     >                  NUNKNO,MATCOD,VOLUME,KEYFLX,
     >                  FUNKNO,SUNKNO,TITRE)
C
C---------------------------  TRFICF  ---------------------------------
C
C  1- PROGRAMME STATISTICS:
C      NAME     :  TRFICF
C      USE      :  SOLVE ONE GROUP TRANSPORT EQUATION FOR FLUXES
C                  USING THE SCATTERING MODIFIED CP MATRIX.
C      MODIFIED :  91-03-19
C      AUTHOR   :  G.MARLEAU
C
C  2- ROUTINE PARAMETERS:
C    INPUT
C      IPSYS    : POINTER TO THE PIJ                  I
C      IPTRK    : POINTER TO THE TRACKING             I
C      IPBTF    : POINTER TO BINARY TRACKING FILE     I
C      IPRNTF   : PRINT SELECTION FOR FLUX MODULES    I
C      IDIR     : DIRECTION FOR PC                    I
C                  = 0 FOR PIJ OR WIJ
C                  = K FOR PIJK OR WIJK K=1,2,3
C      NREGIO   : NUMBER OF REGIONS CONSIDERED        I
C      NUNKNO   : NUMBER OF UNKNOWN IN THE SYSTEM     I
C      MATCOD   : MIXTURE CODE IN REGION              I(NREGIO)
C      VOLUME   : VOLUME OF REGION                    R(NREGIO)
C      KEYFLX   : FLUX ELEMENTS IN UNKNOWN SYSTEM     I(NREGIO)
C      FUNKNO   : UNKNOWN VECTOR SOLVED FOR           R(NUNKNO)
C      SUNKNO   : SOURCE FOR SYSTEM OF UNKNOWN        R(NUNKNO)
C      TITRE    : TITLE                               C*72
C
C--------------------------    TRFICF    ------------------------------
C
      IMPLICIT    NONE
      INTEGER     IOUT
      CHARACTER   NAMSBR*6
      PARAMETER  (IOUT=6,NAMSBR='TRFICF')
```

```
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     IPSYS,IPTRK,IPBTF,IPRNTF,IDIR,NREGIO,NUNKNO
      CHARACTER   TITRE*72
      INTEGER     MATCOD(NREGIO),KEYFLX(NREGIO)
      REAL        VOLUME(NREGIO),FUNKNO(NUNKNO),SUNKNO(NUNKNO)
C----
C  FUNCTION
C----
      INTEGER     LCMIOF
C----
C  MEMORY ALLOCATION
C----
      INTEGER     IBASE(1)
      REAL        RBASE
      COMMON      RBASE(1)
      EQUIVALENCE(RBASE(1),IBASE(1))
      INTEGER     ICPMAT
C----
C  LOCAL PARAMETERS
C----
      CHARACTER   NAMT*12,NAMLCM*12,NAMMY*12
      INTEGER     ILCMLN,ILCMTY,IREG,JREG,JCPMAT,IPOS,JPOS
      LOGICAL     LCM
C----
C  DATA
C----
      CHARACTER   CNS(0:3)*1,CNFDIR(0:3)*9
      SAVE        CNS,CNFDIR
      DATA        CNS
     >   /'-','1','2','3'/
      DATA        CNFDIR
     >   /'F L U X  ','C U R - X','C U R - Y','C U R - Z'/
C----
C  ALLOCATE STORAGE AND READ SCATTERING MODIFIED COLLISION PROBABILITIES
C----
      NAMT=' '
      CALL LCMNXT(IPSYS,NAMT,NAMLCM,NAMMY,LCM)
      CALL LCMLEN(IPSYS,'DRAGON'//CNS(IDIR)//'PCSCT',ILCMLN,ILCMTY)
      IF(ILCMLN .GT. 0 .AND. LCM) THEN
        ICPMAT=LCMIOF(IPSYS,'DRAGON'//CNS(IDIR)//'PCSCT')
      ELSE IF(ILCMLN .GT. 0) THEN
        CALL SETARA(RBASE,NREGIO*NREGIO,ICPMAT)
        CALL LCMGET(IPSYS,'DRAGON'//CNS(IDIR)//'PCSCT',RBASE(ICPMAT))
      ELSE
        CALL XABORT(NAMSBR//
     >': RECORD DRAGON'//CNS(IDIR)//'PCSCT ABSENT FROM LCM')
      ENDIF
C----
C  PRINT SOURCES WHEN REQUIRED
C----
      IF(IPRNTF .GE. 5) THEN
        WRITE(IOUT,'(12H  SOURCES : ,3X,A9)') CNFDIR(IDIR)
        WRITE(IOUT,'(1P,6(5X,E15.7))')
     >    (SUNKNO(KEYFLX(IREG)),IREG=1,NREGIO)
```

```
      ENDIF
C----
C  SOLVE TRANSPORT EQUATION
C----
      JCPMAT=ICPMAT-1
      DO 10 IPOS=1,NUNKNO
        FUNKNO(IPOS)=0.0
 10   CONTINUE
      DO 30 IREG=1,NREGIO
        IPOS=KEYFLX(IREG)
        DO 20 JREG=1,NREGIO
          JPOS=KEYFLX(JREG)
          FUNKNO(JPOS)=FUNKNO(JPOS)+SUNKNO(IPOS)*RBASE(JCPMAT+JREG)
 20     CONTINUE
        JCPMAT=JCPMAT+NREGIO
 30   CONTINUE
C----
C  PRINT FLUXES WHEN REQUIRED
C----
      IF(IPRNTF .GE. 5) THEN
        WRITE(IOUT,6000) NAMSBR,CNFDIR(IDIR)
        WRITE(IOUT,6001)
     >    (FUNKNO(KEYFLX(IREG)),IREG=1,NREGIO)
      ENDIF
      IF(.NOT. LCM) CALL RLSARA(RBASE(ICPMAT))
      RETURN
C----
C  FORMATS
C----
 6000 FORMAT(1X,A6,' S O L U T I O N  : ',A9)
 6001 FORMAT(1P,6(5X,E15.7))
      END
```

A.4.8 Subroutine TRFICS.f

```
*DECK TRFICS
      SUBROUTINE TRFICS(IPSYS ,IPTRK ,IPBTF ,IPRNTF,IDIR  ,NREGIO,
     >                  NUNKNO,MATCOD,VOLUME,KEYFLX,
     >                  FUNKNO,SUNKNO,TITRE)
C
C-------------------------    TRFICS    -------------------------------
C
C  1- PROGRAMME STATISTICS:
C      NAME      :  TRFICS
C      USE       :  FIND A RESIDUAL VECTOR CORRESPONDING TO A PIJ
C                   FLUX CALCULATION BY TRFICF
C      MODIFIED  :  91-03-19
C      AUTHOR    :  A. HEBERT
C
C  2- INPUT AND OUTPUT PARAMETERS:
C      IPSYS    : POINTER TO THE PIJ                 I
C      IPTRK    : POINTER TO THE TRACKING            I
C      IPBTF    : POINTER TO BINARY TRACKING FILE    I
C      IPRNTF   : PRINT SELECTION FOR FLUX MODULES   I
```

```
C      IDIR     : DIRECTION FOR PC                   I
C                 = 0 FOR PIJ OR WIJ
C                 = K FOR PIJK OR WIJK K=1,2,3
C      NREGIO   : NUMBER OF REGIONS CONSIDERED       I
C      NUNKNO   : NUMBER OF UNKNOWN IN THE SYSTEM    I
C      MATCOD   : MIXTURE CODE IN REGION             I(NREGIO)
C      VOLUME   : VOLUME OF REGION                   R(NREGIO)
C      KEYFLX   : FLUX ELEMENTS IN UNKNOWN SYSTEM    I(NREGIO)
C      FUNKNO   : UNKNOWN VECTOR SOLVED FOR          R(NUNKNO)
C      SUNKNO   : SOURCE FOR SYSTEM AT INPUT         R(NUNKNO)
C               : RESIDUAL VECTOR AT OUTPUT          R(NUNKNO)
C      TITRE    : TITLE                              C*72
C
C---------------------------    TRFICS    -----------------------------
C
      IMPLICIT    NONE
      INTEGER     IOUT
      CHARACTER   NAMSBR*6
      PARAMETER  (IOUT=6,NAMSBR='TRFICF')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     IPSYS,IPTRK,IPBTF,IPRNTF,IDIR,NREGIO,NUNKNO
      CHARACTER   TITRE*72
      INTEGER     MATCOD(NREGIO),KEYFLX(NREGIO)
      REAL        VOLUME(NREGIO),FUNKNO(NUNKNO),SUNKNO(NUNKNO)
C----
C  MEMORY ALLOCATION
C----
      INTEGER     IBASE(1)
      REAL        RBASE
      COMMON      RBASE(1)
      EQUIVALENCE(RBASE(1),IBASE(1))
      INTEGER     IFUNKN
C----
C  LOCAL PARAMETERS
C----
      INTEGER     IUN
C----
C  ALLOCATE MEMORY FOR DUMMY SOLUTION VECTOR AND SOLVE TRANSPORT EQN.
C----
      CALL SETARA(RBASE,NUNKNO,IFUNKN)
      CALL TRFICF(IPSYS ,IPTRK ,IPBTF ,     0,IDIR  ,NREGIO,
     >            NUNKNO,MATCOD,VOLUME,KEYFLX,
     >            RBASE(IFUNKN),SUNKNO,TITRE)
C----
C  COMPUTE RESIDUAL VECTOR
C----
      DO 100 IUN=1,NUNKNO
        SUNKNO(IUN)=FUNKNO(IUN)-RBASE(IFUNKN+IUN-1)
 100  CONTINUE
      CALL RLSARA(RBASE(IFUNKN))
C----
C  PRINT RESIDUAL VECTOR IF REQUIRED
C----
      IF(IPRNTF .GE. 3) THEN
```

```
        WRITE(IOUT,6000) NAMSBR
        WRITE(IOUT,6001)
     >    (SUNKNO(IUN),IUN=1,NUNKNO)
      ENDIF
      RETURN
C----
C  FORMATS
C----
 6000 FORMAT(1X,A6,' R E S I D U A L   V E C T O R   :')
 6001 FORMAT(1P,6(5X,E15.7))
      END
```

A.5 The EDI: Module

A.5.1 Subroutine EDIENE.f

```
*DECK EDIENE
      SUBROUTINE EDIENE(NGROUP,NGCR  ,NGCOND,NTENER,
     >                  IGCR  ,EGCR  ,IGCOND,ENERGY,ENERV )
C
C---------------------------  EDIENE  --------------------------------
C
C  1- PROGRAMME STATISTICS:
C      NAME     : EDIENE
C      USE      : EVALUATE ENERGY LIMITS FOR CONDENSATION
C      MODIFIED : 97-02-05 (G.M.)
C      AUTHOR   : G.MARLEAU
C
C  2- ROUTINE PARAMETERS:
C    INPUT/OUTPUT
C      NGROUP   : NUMBER OF GROUPS                     I
C      NGCR     : NUMBER OF COND GROUP READ ON INPUT   I
C      NGCOND   : NUMBER OF COND GROUP READ ON EDI     I
C      NTENER   : NUMBER OF ENERGY FOUND ON LIB        I
C      IGCR     : NEW GROUP LIMITS                     I(NGROUP+1)
C      EGCR     : NEW ENERGY LIMITS                    R(NGROUP+1)
C      IGCOND   : OLD GROUP LIMITS                     I(NGROUP+1)
C      ENERGY   : ENERGY/LETHARGY/AVERAGE ENERGY       R(2*NGROUP+1)
C      ENERV    : AVERAGE GROUP ENERGY                 R(NGROUP)
C
C---------------------------   EDIENE  -------------------------------
C
      IMPLICIT     NONE
      INTEGER      IOUT
      CHARACTER    NAMSBR*6
      PARAMETER   (IOUT=6,NAMSBR='EDIENE')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     NGROUP,NGCR,NGCOND,NTENER
      INTEGER     IGCR(NGROUP+1),IGCOND(NGROUP+1)
      REAL        EGCR(NGROUP+1),ENERGY(2*NGROUP+1),ENERV(NGROUP)
C----
```

```
C  LOCAL PARAMETERS
C----
      INTEGER     IGC,KDGRP,IGRP,JGRP,IGLIM
C----
C  FIND IF NEW ENERGY OR GROUP SPECIFICATIONS FROM INPUT
C----
      IF(NGCR .GT. 0) THEN
        IGC=0
        IF(EGCR(1) .NE. 0.0) THEN
          IF(NTENER .EQ. 0)  CALL XABORT(NAMSBR//
     >    ': CONDENSATION NOT PERMITTED - NO GROUP STRUCTURE')
          KDGRP=1
          DO 100 IGRP=1,NGROUP+1
            IF(EGCR(IGRP) .LT. ENERGY(NGROUP+1)) THEN
              KDGRP=NGROUP
              IGC=IGC+1
              IGCOND(IGC)=KDGRP
            ELSE IF(EGCR(IGRP) .LT. ENERGY(KDGRP)) THEN
              DO 110 JGRP=KDGRP,NGROUP
                IF(EGCR(IGRP) .GE. ENERGY(JGRP+1)) THEN
                  KDGRP=JGRP
                  IGC=IGC+1
                  IGCOND(IGC)=KDGRP
                  GO TO 115
                ENDIF
 110          CONTINUE
 115          CONTINUE
            ENDIF
            IF(KDGRP .EQ. NGROUP) GO TO 105
 100      CONTINUE
 105      CONTINUE
        ELSE
          DO 120 IGRP=1,NGROUP+1
            IGCOND(IGRP)=IGCR(IGRP)
            IF(IGCR(IGRP) .EQ. NGROUP) THEN
              IGC=IGRP
              GO TO 125
            ENDIF
 120      CONTINUE
 125      CONTINUE
        ENDIF
        NGCOND=IGC
      ENDIF
      IF(NTENER .GT. 0) THEN
C----
C  FIND ENERGY LIMITS, LETHARGY AND AVERAGE ENERGY
C----
        DO 130 IGRP=1,NGROUP
          ENERV(IGRP)=SQRT(ENERGY(IGRP)*ENERGY(IGRP+1))
 130    CONTINUE
        DO 140 IGC=1,NGCOND
          IGLIM=IGCOND(IGC)+1
          ENERGY(IGC+1)=ENERGY(IGLIM)
 140    CONTINUE
        IGLIM=NGCOND+1
        IF(ENERGY(IGLIM) .EQ. 0.0) ENERGY(IGLIM)=1.0E-5
```

```
        DO 150 IGC=1,NGCOND
          IGLIM=IGLIM+1
          ENERGY(IGLIM)=LOG(ENERGY(IGC)/ENERGY(IGC+1))
 150    CONTINUE
      ENDIF
      RETURN
      END
```

A.5.2 Subroutine EDIGET.f

```
*DECK EDIGET
      SUBROUTINE EDIGET(NGROUP,NGCOND,NREGIO,NBMIX ,NMERGE,IFFAC ,
     >                  ILUPS ,NSAVES,NSTATS,CURNAM,OLDNAM,NSPH  ,
     >                  KSPH  ,CNDOOR,MACGEO,NWGTH ,MXISO ,NBMICR,
     >                  NACTI ,IPRINT,MAXPTS,ICALL ,ISOTXS,
     >                  IGCR  ,EGCR  ,IMERGE,MATCOD,ISOCAR,IACTI ,
     >                  MIXMER)
C
C---------------------------  EDIGET  ---------------------------------
C
C  1- PROGRAMME STATISTICS:
C      NAME     : EDIGET
C      USE      : READ EDITION OPTIONS PARAMETERS
C      MODIFIED : 91-04-03 (G.M)
C      AUTHOR   : G.MARLEAU
C
C  2- ROUTINE PARAMETERS:
C      NGROUP   : NUMBER OF GROUPS                       I
C      NGCOND   : NUMBER OF GROUPS CONDENSED             I
C      NREGIO   : NUMBER OF REGIONS                      I
C      NBMIX    : MAXIMUM NUMBER OF MIXTURES             I
C      NMERGE   : NUMBER OF REGIONS MERGED               I
C      IFFAC    : FOUR FACTOR CALCULATION                I
C                 = 0 NO FOUR FACTORS (DEFAUT)
C                 = 1 FOUR FACTOR EVALUATION
C      ILUPS    : REMOVE UP-SCATTERING FROM OUTPUT       I
C      NSAVES   : HOMOGENIZED X-S COMPUTATION+SAVE       I
C                 = 0  NO COMPUTE NO SAVE
C                 = 1  COMPUTE, NO SAVE
C                 = 2  COMPUTE, SAVE XS
C                 = 3  COMPUTE, SAVE MICRO PERTURBATION
C      NSTATS   : STATISTICS LEVEL                       I
C                 = 0  NO STATS
C                 = 1  STATISTICS ON FLUXES
C                 = 2  STATISTICS ON REACTION RATES
C                 = 3  STATISTICS ON FLUXES + RR
C                 =-1  DELTA SIGMA (MERG COMP ONLY)
C      CURNAM   : NAME OF LCM DIRECTORY WHERE THE
C                 CURRENT RATES ARE TO BE STORED         C*12
C      OLDNAM   : NAME OF LCM DIRECTORY WHERE OLD
C                 RATES WERE STORED                      C*12
C      NSPH     : =0 NO CORRECTION (DEFAULT)
C                 =1 THE SPH FACTORS ARE READ FROM LCM
C                 =2 HOMOGENEOUS MACRO-CALCULATION (NON ITERATIVE
```

```
C                    PROCEDURE OR HEBERT-BENOIST SPH-5 PROCEDURE)
C                 =3 ANY TYPE OF PIJ MACRO-CALCULATION
C                 =4 ANY TYPE OF DIFFUSION MACRO-CALCULATION
C      KSPH     : =1 AVERAGE FLUX NORMALIZATION (DEFAULT)
C                 =2 SELENGUT NORMALIZATION
C                 =3 SELENGUT NORMALIZATION WITH SURFACE LEAKAGE
C      CNDOOR   : TYPE OF SPH MACRO-CALCULATION          C*12
C      MACGEO   : NAME OF THE SPH MACRO-GEOMETRY         C*12
C      NWGTH    : = 0 USE FLUX TO MERGE/CONDENSE P1 MATRICES
C                 = 1 USE CURRENT TO MERGE/CONDENSE P1 MATRICES
C                 = 2 USE BUCKLING-WEIGHTED COHERENT METHOD
C                     TO MERGE/CONDENSE P1 MATRICES
C                 = 3 USE BUCKLING-WEIGHTED COHERENT METHOD
C                     AND DIRECTIONAL DIAGONAL CORRECTION
C                     TO MERGE/CONDENSE P1 MATRICES
C      MXISO    : MAXIMUM NUMBER OF ISOTOPES AVAILABLE   I
C      NBMICR   : <-1: GENERATE FULL XS LIBRARY          I
C                      INCLUDING DEPLETION CHAIN AND
C                      INDEPENDANT FISSION SPECTRUM FOR
C                      (-NBMICR-1) SELECTED ISOTOPES
C                 =-1: GENERATE FULL XS LIBRARY
C                      INCLUDING DEPLETION CHAIN AND
C                      INDEPENDANT FISSION SPECTRUM FOR
C                      ALL ISOTOPES
C                 =0 : DO NOT GENERATE MICROSCOPIC
C                      XS LIBRARY
C                 =1:  PROCESS ALL ISOTOPE XS
C                 >1:  PROCESS (NBMICR-1)
C                      SELECTED ISOTOPES
C      NACTI    : NUMBER OF ACTIVATION EDIT              I
C      IPRINT   : PRINT INDEX                            I
C      MAXPTS   : MAXIMUM NUMBER OF MACRO-REGIONS        I
C      ICALL    : MAXIMUM DIRECTORY INDEX IN IPEDIT      I
C      ISOTXS   : ISOTXS ADDITIONAL EDIT FORMAT          I(2)
C                 ISOTXS(1) IS FOR FLIB OR MICR
C                 ISOTXS(2) IS FOR ACTI
C                 =0 NONE ;=1 FOR ISOTXS
C      IGCR     : CONDENSED GROUPS LIMITS                I(NGROUP+1)
C      EGCR     : CONDENSED ENERGY LIMITS                R(NGROUP+1)
C      IMERGE   : MERGED REGIONS POSITION                I(NREGIO)
C      MATCOD   : MIXTURE ASSOCIATED TO EACH REGION      I(NREGIO)
C      ISOCAR   : NAMES OF THE ISOTOPES TO PROCESS       I(2,MXISO)
C      IACTI    : ACTIVATION MIXTURES                    I(NBMIX)
C      MIXMER   : MERGE MIXTURE NUMBER                   I(NBMIX+1)
C
C---------------------------   EDIGET  --------------------------------
C
      IMPLICIT    NONE
      INTEGER     IOUT
      CHARACTER   NAMSBR*6
      PARAMETER  (IOUT=6,NAMSBR='EDIGET')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER     NGROUP,NGCOND,NREGIO,NBMIX,NMERGE,IFFAC,ILUPS,
     >            NSAVES,NSTATS,NSPH,KSPH,NWGTH,MXISO,NBMICR,
```

```
     >             NACTI,IPRINT,MAXPTS,ICALL
      CHARACTER   CURNAM*12,OLDNAM*12,CNDOOR*12,MACGEO*12
      INTEGER     ISOTXS(2),IGCR(NGROUP+1),IMERGE(NREGIO),
     >             MATCOD(NREGIO),ISOCAR(2,MXISO),IACTI(NBMIX),
     >             MIXMER(0:NBMIX)
      REAL        EGCR(NGROUP+1)
C----
C  INPUT PARAMETERS
C----
      INTEGER     ITYPLU,INTLIR
      CHARACTER   CARLIR*12
      REAL        REALIR
      DOUBLE PRECISION DBLLIR
C----
C  LOCAL PARAMETERS
C----
      INTEGER     IREGIO,IGROUP,JGROUP,IMATER,ITC,NMIXME,NTMICR,
     >             ISO
C----
C  INITIALIZE MIXMER
C----
      DO 90 IMATER=0,NBMIX
        MIXMER(IMATER)=IMATER
  90  CONTINUE
C----
C  READ OPTION NAME
C----
 100  CONTINUE
      CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
 101  CONTINUE
      IF(ITYPLU .EQ. 10) GO TO 250
      IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >': READ ERROR - CHARACTER ABLE EXPECTED')
      IF(CARLIR .EQ. ';') THEN
        GO TO 250
      ELSE IF(CARLIR .EQ. 'EDIT') THEN
        CALL REDGET(ITYPLU,IPRINT,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .NE. 1) THEN
          IPRINT=1
          GO TO 101
        ENDIF
      ELSE IF(CARLIR .EQ. 'UPS') THEN
        ILUPS=1
      ELSE IF(CARLIR .EQ. 'P1SCAT') THEN
C----
C  FLUX WEIGHTING OF THE P1 MATRICES.
C----
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >  ': READ ERROR - CHARACTER P1SCAT TYPE EXPECTED')
        IF(CARLIR .EQ. 'FLUX') THEN
          NWGTH=0
        ELSE IF(CARLIR .EQ. 'CURRENT') THEN
          NWGTH=1
        ELSE IF(CARLIR .EQ. 'COHERENT') THEN
          NWGTH=2
```

```
        ELSE IF(CARLIR .EQ. 'DIRECTIONAL') THEN
          NWGTH=3
        ENDIF
      ELSE IF(CARLIR(1:4) .EQ. 'MICR') THEN
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .EQ. 3 .AND. CARLIR(1:4) .EQ. 'ISOT') THEN
          ISOTXS(1)=1
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        ENDIF
        IF(ITYPLU .EQ. 3 .AND. CARLIR .EQ. 'ALL') THEN
          NBMICR=1
        ELSE IF(ITYPLU .EQ. 3 .AND. CARLIR .EQ. 'NONE') THEN
          NBMICR=0
        ELSE IF(ITYPLU .EQ. 1) THEN
          NTMICR=INTLIR
          IF(NTMICR .GT. MXISO) CALL XABORT(NAMSBR//': TOO MANY MICR')
          DO 200 ISO=1,NTMICR
            CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
            IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >      ': READ ERROR - ISOTOPE ALIAS NAME EXPECTED')
            READ(CARLIR,'(2A4)') (ISOCAR(ITC,ISO),ITC=1,2)
  200     CONTINUE
          NBMICR=NTMICR+1
        ELSE
          CALL XABORT(NAMSBR//': READ ERROR - '//
     >    'KEY ISOTXS, ALL, NONE OR INTEGER EXPECTED AFTER MICR')
        ENDIF
      ELSE IF(CARLIR .EQ. 'FLIB') THEN
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .EQ. 3 .AND. CARLIR(1:4) .EQ. 'ISOT') THEN
          ISOTXS(1)=1
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        ENDIF
        IF(ITYPLU .EQ. 3 .AND. CARLIR .EQ. 'ALL') THEN
          NBMICR=-1
        ELSE IF(ITYPLU .EQ. 3 .AND. CARLIR .EQ. 'NONE') THEN
          NBMICR=0
        ELSE IF(ITYPLU .EQ. 1) THEN
          NTMICR=INTLIR
          IF(NTMICR .GT. MXISO) CALL XABORT(NAMSBR//': TOO MANY MICR')
          DO 201 ISO=1,NTMICR
            CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
            IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >      ': READ ERROR - ISOTOPE ALIAS NAME EXPECTED')
            READ(CARLIR,'(2A4)') (ISOCAR(ITC,ISO),ITC=1,2)
  201     CONTINUE
          NBMICR=-NTMICR-1
        ELSE
          CALL XABORT(NAMSBR//': READ ERROR - '//
     >    'KEY ISOTXS, ALL, NONE OR INTEGER EXPECTED AFTER FLIB')
        ENDIF
      ELSE IF(CARLIR(1:4) .EQ. 'ACTI') THEN
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .EQ. 3 .AND. CARLIR(1:4) .EQ. 'ISOT') THEN
          ISOTXS(2)=1
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
```

```
        ENDIF
        IF(ITYPLU .EQ. 3 .AND. CARLIR .EQ. 'NONE') THEN
          NACTI=0
        ELSE
          DO 202 IREGIO=1,NBMIX
            IF(ITYPLU .EQ. 1) THEN
              IF(INTLIR .GT. NBMIX) THEN
                WRITE(IOUT,9000) NAMSBR,INTLIR,NBMIX
              ELSE
                NACTI=NACTI+1
                IACTI(NACTI)=INTLIR
              ENDIF
            ELSE
              GO TO 101
            ENDIF
            IF(IREGIO .LT. NBMIX) THEN
              CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
            ENDIF
 202      CONTINUE
        ENDIF
      ELSE IF(CARLIR .EQ. 'SPH') THEN
C----
C  SPH DIRECTIVE ANALYSIS
C----
        MACGEO=' '
        KSPH=1
  103   CONTINUE
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >   ': READ ERROR - SPH TYPE MISSING')
        IF(CARLIR .EQ. 'SELE') THEN
          KSPH=2
          CNDOOR=CARLIR
          GO TO 103
        ELSE IF(CARLIR .EQ. 'ALBS') THEN
          KSPH=3
          CNDOOR=CARLIR
          GO TO 103
        ELSE IF(CARLIR .EQ. 'MGEO') THEN
          CNDOOR=CARLIR
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >     ': READ ERROR - SPH GEOMETRY MISSING')
          MACGEO=CARLIR
          GO TO 103
        ELSE IF(CARLIR .EQ. 'OFF') THEN
*          NO SPH CORRECTION PERFORMED
          NSPH=0
          KSPH=0
          CNDOOR=' '
        ELSE IF(CARLIR .EQ. 'SPRD') THEN
*          THE SPH FACTORS ARE READ FROM LCM
          NSPH=1
          CNDOOR=' '
        ELSE IF(CARLIR .EQ. 'HOMO') THEN
*          HOMOGENEOUS MACRO CALCULATION (NO ITERATIONS ARE PERFORMED)
```

```
          NSPH=2
          CNDOOR=' '
        ELSE IF(CARLIR .EQ. ':::') THEN
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >    ': READ ERROR - TRACKING TYPE MISSING')
           IF(CARLIR.EQ.'JPMT:') THEN
*              JPM TRANSPORT-TRANSPORT EQUIVALENCE
             NSPH=3
             CNDOOR='JPM'
           ELSE IF(CARLIR.EQ.'SYBILT:') THEN
*              SYBIL TRANSPORT-TRANSPORT EQUIVALENCE
             NSPH=3
             CNDOOR='SYBIL'
           ELSE IF(CARLIR.EQ.'EXCELT:') THEN
*              EXCELL TRANSPORT-TRANSPORT EQUIVALENCE
             NSPH=3
             CNDOOR='EXCELL'
           ELSE IF(CARLIR.EQ.'BIVACT:') THEN
*              BIVAC TRANSPORT-DIFFUSION EQUIVALENCE
             NSPH=4
             CNDOOR='BIVAC'
           ELSE
             CALL XABORT(NAMSBR//': '//CARLIR//
     >       ' IS AN INVALID TRACKING MODULE')
           ENDIF
           GO TO 250
        ELSE
          CALL XABORT(NAMSBR//': INVALID TYPE OF MACRO-CALCULATION')
        ENDIF
      ELSE IF(CARLIR(1:4) .EQ. 'COND') THEN
C----
C  GROUP CONDENSATION DIRECTIVE ANALYSIS
C----
        DO 104 IGROUP=1,NGROUP+1
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .EQ. 3) THEN
            IF(IGROUP .EQ. 1) THEN
              IF(CARLIR .EQ. 'NONE') THEN
                NGCOND=NGROUP
                DO 107 JGROUP=1,NGROUP
                  IGCR(JGROUP)=JGROUP
 107            CONTINUE
                CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
                GO TO 101
              ELSE
                NGCOND=1
                IGCR(NGCOND)=NGROUP
              ENDIF
            ENDIF
            GO TO 101
          ELSE IF(ITYPLU .EQ. 1) THEN
            IF(INTLIR .GT. NGROUP) INTLIR=NGROUP
            IF(NGCOND .GT. 0) THEN
              IF(INTLIR .GT. IGCR(NGCOND)) THEN
                NGCOND=NGCOND+1
```

```
                IGCR(NGCOND)=INTLIR
              ENDIF
            ELSE
              NGCOND=NGCOND+1
              IGCR(NGCOND)=INTLIR
            ENDIF
          ELSE
            IF(NGCOND .GT. 0) THEN
              IF(REALIR .LT. EGCR(NGCOND)) THEN
                NGCOND=NGCOND+1
                EGCR(NGCOND)=REALIR
              ENDIF
            ELSE
              NGCOND=NGCOND+1
              EGCR(NGCOND)=REALIR
            ENDIF
          ENDIF
 104    CONTINUE
      ELSE IF(CARLIR(1:4) .EQ. 'MERG') THEN
C----
C  MERGING DIRECTIVE ANALYSIS
C----
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >    ': READ ERROR - MERGE TYPE MISSING')
        NSPH=0
        KSPH=0
        CNDOOR=' '
        IF(CARLIR(1:4) .EQ. 'COMP') THEN
C----
C  COMPLETE MERGE
C----
          DO 108 IREGIO=1,NREGIO
            IMERGE(IREGIO)=1
 108      CONTINUE
          NMERGE=1
          GO TO 100
        ELSE IF(CARLIR(1:3) .EQ. 'MIX') THEN
C----
C  MERGE BY MIXTURES
C----
          NMIXME=0
          DO 110 IREGIO=1,NREGIO
            NMIXME=MAX(NMIXME,MATCOD(IREGIO))
            IMERGE(IREGIO)=MIXMER(MATCOD(IREGIO))
 110      CONTINUE
          NMERGE=NMIXME
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .EQ. 1) THEN
C----
C  SPECIFY MIXTURES TO BE MERGED
C----
            NMERGE=0
            DO 111 IMATER=1,NBMIX
              DO 112 IREGIO=1,NREGIO
                IF(MATCOD(IREGIO) .EQ. IMATER) THEN
```

```
                  NMERGE=MAX(NMERGE,INTLIR)
                  GO TO 113
                ENDIF
 112          CONTINUE
 113          CONTINUE
              MIXMER(IMATER)=INTLIR
              CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
              IF(ITYPLU .NE. 1) GO TO 116
 111        CONTINUE
 116        CONTINUE
            DO 117 IREGIO=1,NREGIO
              IMERGE(IREGIO)=MIXMER(MATCOD(IREGIO))
 117        CONTINUE
            GO TO 101
          ELSE IF(ITYPLU .EQ. 3) THEN
C----
C  ASSOCIATE ONE REGION BY MIXTURE
C----
            GO TO 101
          ELSE
            CALL XABORT(NAMSBR//
     >      ': READ ERROR - INVALID MERGE NUMBER')
          ENDIF
        ELSE IF(CARLIR(1:4) .EQ. 'REGI') THEN
C----
C  MERGE BY REGIONS
C----
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .NE. 1) CALL XABORT(NAMSBR//
     >    ': READ ERROR - MISSING REGION NUMBER FOR MERGE')
          NMERGE=MAX(0,INTLIR)
          IMERGE(1)=INTLIR
          DO 105 IREGIO=2,NREGIO
            CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
            IF(ITYPLU .NE. 1) CALL XABORT(NAMSBR//
     >      ': READ ERROR - MISSING REGION NUMBER FOR MERGE')
            NMERGE=MAX(NMERGE,INTLIR)
            IMERGE(IREGIO)=INTLIR
 105      CONTINUE
        ELSE IF(CARLIR .EQ. 'NONE') THEN
C----
C  NO MERGE BY REGIONS
C----
          NMERGE=NREGIO
          DO 106 IREGIO=1,NREGIO
            IMERGE(IREGIO)=IREGIO
 106      CONTINUE
          GO TO 100
        ELSE
          CALL XABORT(NAMSBR//
     >    ': READ ERROR - INVALID MERGE TYPE '//CARLIR)
        ENDIF
      ELSE IF(CARLIR .EQ. 'TAKE') THEN
C----
C  TAKE DIRECTIVE ANALYSIS
C----
```

```
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU.NE.3) CALL XABORT(NAMSBR//
     >  ': READ ERROR - TAKE TYPE MISSING')
        IF(CARLIR(1:4) .EQ. 'MIX') THEN
C----
C  TAKE PER MIXTURE
C----
          NMIXME=0
          DO 120 IREGIO=1,NREGIO
            NMIXME=MAX(NMIXME,MATCOD(IREGIO))
 120      CONTINUE
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .EQ. 1) THEN
            CALL XDRSET(MIXMER,NBMIX+1,0)
            NMERGE=0
            DO 122 IMATER=1,NBMIX
C----
C  SPECIFY MIXTURES TO BE SELECTED
C----
              IF(INTLIR .LE. NBMIX .AND. INTLIR .GT. 0)
     >          MIXMER(INTLIR)=IMATER
              NMERGE=NMERGE+1
              CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
              IF(ITYPLU .NE. 1) GO TO 123
 122        CONTINUE
          ENDIF
 123      CONTINUE
          DO 124 IREGIO=1,NREGIO
            IMERGE(IREGIO)=MIXMER(MATCOD(IREGIO))
 124      CONTINUE
          GO TO 101
        ELSE IF(CARLIR(1:4) .EQ. 'REGI') THEN
C----
C  TAKE PER REGIONS
C----
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .NE. 1) CALL XABORT(NAMSBR//
     >    ': MISSING REGION NUMBER FOR TAKE')
          DO 125 IREGIO=1,NREGIO
            IMERGE(IREGIO)=0
 125      CONTINUE
          NMERGE=1
          IMERGE(INTLIR)=1
          DO 126 IREGIO=2,NREGIO
            CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
            IF(ITYPLU .NE. 1) GO TO 101
            NMERGE=NMERGE+1
            IMERGE(INTLIR)=IREGIO
 126      CONTINUE
        ELSE
          CALL XABORT(NAMSBR//
     >   ': READ ERROR - ILLEGAL TAKE TYPE '//CARLIR)
        ENDIF
      ELSE IF(CARLIR .EQ. 'SAVE') THEN
C----
C  SAVE DIRECTIVE ANALYSIS
```

```
C----
        NSAVES=2
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >  ': READ ERROR - SAVE OPTION MISSING')
        IF(CARLIR .EQ. 'ON') THEN
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU .EQ. 2) THEN
            CALL XABORT(NAMSBR//
     >      ': READ ERROR - SAVE NAME OR NUMBER MISSING')
          ELSE IF(ITYPLU .EQ. 1) THEN
            WRITE(CURNAM,'(8HREF-CASE,I4)') INTLIR
            ICALL=MAX(ICALL,INTLIR)
          ELSE
            CURNAM=CARLIR
          ENDIF
        ELSE
          GO TO 101
        ENDIF
      ELSE IF(CARLIR(1:4) .EQ. 'PERT') THEN
C----
C  SAVE DIRECTIVE ANALYSIS
C----
        NSAVES=3
        NBMICR=-1
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >  ': READ ERROR - PERT OPTION MISSING')
        IF(CARLIR(1:4) .EQ. 'REFE') THEN
          CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
          IF(ITYPLU.EQ.2) THEN
            CALL XABORT(NAMSBR//
     >      ': READ ERROR - PERT NAME OR NUMBER MISSING')
          ELSE IF(ITYPLU .EQ. 1) THEN
            WRITE(CURNAM,'(8HREF-CASE,I4)') INTLIR
          ELSE
            CURNAM=CARLIR
          ENDIF
        ELSE
          GO TO 101
        ENDIF
      ELSE IF(CARLIR(1:4) .EQ. 'STAT') THEN
C----
C  STAT DIRECTIVE ANALYSIS
C----
        CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
        IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >  ': READ ERROR - STAT OPTION MISSING')
        IF(CARLIR .EQ. 'FLUX') THEN
          NSTATS=1
        ELSE IF(CARLIR .EQ. 'RATE') THEN
          NSTATS=2
        ELSE IF(CARLIR .EQ. 'ALL ') THEN
          NSTATS=3
        ELSE IF(CARLIR .EQ. 'DELS') THEN
          NSTATS=-1
```

```
            ELSE
              CALL XABORT(NAMSBR//
     >        ': READ ERROR - ILLEGAL STAT OPTION '//CARLIR)
            ENDIF
            CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
            IF(ITYPLU .NE. 3) CALL XABORT(NAMSBR//
     >      ': READ ERROR - REFERENCE FOR STAT MISSING')
            IF(CARLIR(1:4) .EQ. 'REFE') THEN
              CALL REDGET(ITYPLU,INTLIR,REALIR,CARLIR,DBLLIR)
              IF(ITYPLU .EQ. 2) THEN
                CALL XABORT(NAMSBR//
     >          ': READ ERROR - REFE NAME OR NUMBER MISSING')
              ELSE IF(ITYPLU .EQ. 1) THEN
                WRITE(OLDNAM,'(8HREF-CASE,I4)') INTLIR
              ELSE
                OLDNAM=CARLIR
              ENDIF
            ELSE
              GO TO 101
            ENDIF
          ELSE IF(CARLIR .EQ. 'NBAL') THEN
            IFFAC=1000
            CALL REDGET(ITYPLU,IFFAC,REALIR,CARLIR,DBLLIR)
            IF(ITYPLU .NE. 1) GO TO 101
          ELSE IF(CARLIR(1:4) .EQ. 'MAXR') THEN
            CALL REDGET(ITYPLU,MAXPTS,REALIR,CARLIR,DBLLIR)
            IF(ITYPLU .NE. 1) CALL XABORT(NAMSBR//
     >      ': READ ERROR - MAXR NUMBER MISSING')
          ELSE
            CALL XABORT(NAMSBR//':ILLEGAL KEYWORD '//CARLIR)
          ENDIF
          GO TO 100
C----
C  RETURN
C----
  250 CONTINUE
      IF(IPRINT .GE. 2) NSAVES=MAX(1,NSAVES)
      IF(NSAVES .EQ. 0 .AND.
     >   (NSTATS .NE. 0) .OR. (IFFAC .NE. 0)) NSAVES=1
      IF(NSAVES .GE. 2 .AND. CURNAM .EQ. ' ') THEN
        IF(NSAVES .EQ. 2) THEN
          ICALL=ICALL+1
        ENDIF
        WRITE(CURNAM,'(8HREF-CASE,I4)') ICALL
      ENDIF
      RETURN
C----
C  WARNING FORMAT
C----
 9000 FORMAT(1X,A6,': *****  WARNING  *****'/
     >       ' REQUEST ACTIVATION FOR MATERIAL NUMBER = ',I10/
     >       ' MAXIMUM NUMBER OF MATERIAL PERMITTED   = ',I10/
     >       ' STANDARD ACTION -- DO NOT USE THIS MATERIAL'/
     >       ' ****************************')
      END
```

A.5.3 Subroutine EDIRAT.f

```
*DECK EDIRAT
      SUBROUTINE EDIRAT(IOPERA,NREGIO,NMERGE,IMERGE,MATCOD,
     >                  FLXINT,SIGMAX,RATES )
C
C---------------------------  EDIRAT  ---------------------------------
C
C  1- PROGRAMME STATISTICS:
C      NAME      : EDIRAT
C      USE       : EVALUATE REACTION RATES FROM X-SECTIONS
C      MODIFIED  : 97-02-10 (G.M.)
C                  91-04-08
C      AUTHOR    : G.MARLEAU
C
C  2- ROUTINE PARAMETERS:
C    INPUT
C      IOPERA    : TYPE OF ACTION TAKEN               I
C                  = 2  ADD CROSS SECTION (NO FLUX)
C                  = 1  ADD REACTION RATES
C                  = 0  EVALUATE INTEGRATED FLUX
C                  =-1  SUBTRACT REACTION RATES
C      NREGIO    : NUMBER OF REGIONS                  I
C      NMERGE    : NUMBER OF MERGED REGIONS           I
C      IMERGE    : REGION MERGING MATRIX              I(NREGIO)
C      MATCOD    : MATERIAL PER REGION                I(NREGIO)
C      FLXINT    : INTEGRATED FLUXES                  R(NREGIO)
C      SIGMAX    : CROSS SECTIONS                     R(0:NMERGE)
C                  (NBMIX=MAX(MATCOD(I)))
C    INPUT/OUTPUT
C      RATES     : INITIAL AND FINAL RATES            D(0:NMERGE)
C
C---------------------------   EDIRAT  --------------------------------
C
      IMPLICIT          NONE
      INTEGER           IOUT
      CHARACTER         NAMSBR*6
      PARAMETER        (IOUT=6,NAMSBR='EDIRAT')
C----
C  ROUTINE PARAMETERS
C----
      INTEGER           IOPERA,NREGIO,NMERGE
      INTEGER           IMERGE(NREGIO),MATCOD(NREGIO)
      REAL              FLXINT(NREGIO),SIGMAX(0:NMERGE)
      DOUBLE PRECISION RATES(0:NMERGE)
C----
C  LOCAL PARAMETERS
C----
      INTEGER           IREG,IRATME,MATNUM
C----
C  PROCESS CROSS SECTIONS AND FLUX
C----
      IF(IOPERA .EQ. 0) THEN
C----
C  INTEGRATED FLUXES
```

```
C----
        DO 100 IREG=1,NREGIO
          IRATME=IMERGE(IREG)
          RATES(IRATME)=RATES(IRATME)+DBLE(FLXINT(IREG))
 100    CONTINUE
      ELSE IF(IOPERA .EQ. 1) THEN
C----
C  SUM REACTION RATES
C----
        DO 110 IREG=1,NREGIO
          IRATME=IMERGE(IREG)
          MATNUM=MATCOD(IREG)
          RATES(IRATME)=RATES(IRATME)+DBLE(FLXINT(IREG))
     >                 *DBLE(SIGMAX(MATNUM))
 110    CONTINUE
      ELSE IF(IOPERA .EQ. -1) THEN
C----
C  SUBSTRACT REACTION RATES
C----
        DO 120 IREG=1,NREGIO
          IRATME=IMERGE(IREG)
          MATNUM=MATCOD(IREG)
          RATES(IRATME)=RATES(IRATME)-DBLE(FLXINT(IREG))
     >                 *DBLE(SIGMAX(MATNUM))
 120    CONTINUE
      ELSE
C----
C  ADD CROSS SECTIONS
C----
        DO 130 IREG=1,NREGIO
          IRATME=IMERGE(IREG)
          MATNUM=MATCOD(IREG)
          RATES(IRATME)=RATES(IRATME)+DBLE(SIGMAX(MATNUM))
 130    CONTINUE
      ENDIF
      RETURN
      END
```

A.5.4 Subroutine EDISCT.f

```
*DECK EDISCT
      SUBROUTINE EDISCT(IPMACR,IPRINT,NGROUP,NGCOND,NBMIX ,NREGIO,
     >                  NMERGE,NL    ,NIFISS,NTAUXT,ILEAKS,NWGTH ,
     >                  MATCOD,IGCOND,IMERGE,SPH   ,RATECM,FLXINT,
     >                  SCATTD,B2    ,DIRC  ,
     >                  SIGMA,INGSCT ,IFGSCT,IPOSCT,XSCAT ,DLBDG)
C
C--------------------------  EDISCT  ---------------------------------
C
C  1- PROGRAMME STATISTICS:
C      NAME     : EDISCT
C      USE      : EVALUATE SCATTERING REACTION RATES
C      MODIFIED : 99-02-19 (G.M.)
C                 -> COMPUTE DIRECTIONAL WEIGHTING FACTOR TO
```

```
C                   CORRECT BUCKLING WEIGHTED ANISOTROPIC SCATTERING
C                98-03-09 (G.M. + E.D.)
C                -> CONSISTENT B1 HOMOGENIZATION FOR BUCKLING
C                   WEIGHTED ANISOTROPIC SCATTERING
C      AUTHOR   : G.MARLEAU + E. DEBOS
C
C  2- ROUTINE PARAMETERS:
C      IPMACR   : POINTER TO THE MACROLIB            I
C      IPRINT   : PRINT LEVEL                        I
C                 = 0 NO PRINT
C                 = 1 PRINT FLUXES
C                 = 2 1+PRINT REACTION RATES
C                 = 3 2+PRINT HOMOGENIZED X-S
C      NGROUP   : NUMBER OF GROUPS                   I
C      NGCOND   : NUMBER OF GROUPS CONDENSED         I
C      NBMIX    : NUMBER OF MIXTURES                 I
C      NREGIO   : NUMBER OF REGIONS                  I
C      NMERGE   : NUMBER OF REGIONS MERGED           I
C      NL       : NUMBER OF LEGENDRE ORDERS          I
C      NIFISS   : NUMBER OF FISSILE ISOTOPES         I
C      NTAUXT   : NUMBER OF REACTION RATE EDITS      I
C      MATCOD   : MATERIAL PER REGION                I(NREGIO)
C      IGCOND   : LIMIT CONDENSED GROUPS             I(NGCOND)
C      IMERGE   : INDEX OF MERGED REGION             I(NREGIO)
C      SPH      : SPH HOMOGENIZATION FACTORS         R(NMERGE,NGCOND)
C      B2       : SQUARE BUCKLING                    R(4)
C                 FOR ILEAKS = 2 B2(4) IS HOMOGENEOUS
C                 FOR ILEAKS = 3 B2(1),B2(2),B2(3)
C                 ARE DIRECTIONAL HETEROGENEOUS
C                 AND B2(4) IS HOMOGENEOUS
C      RATECM   : AVERAGED REGION/GROUP X-S          D(0:NMERGE,
C                 = RATECM(*,*,1) = FLUXES             NGCOND,NTAUXT)
C                 = RATECM(*,*,2) = TOTAL
C                 = RATECM(*,*,3) = ABS
C                 = RATECM(*,*,4) = FISSIONS
C                 = RATECM(*,*,5) = PRODUCTIONS
C                 = RATECM(*,*,6) = TOTAL LEAKAGES
C                 = RATECM(*,*,7) = TOTAL OUT OF GROUP SCATTERING
C                 = RATECM(*,*,8) = DIAGONAL SCATTERING X-S
C                 = RATECM(*,*,9) = CHI
C                 = RATECM(*,*,10) = WIMS TYPE TRANSPORT CORRECTION
C                 = RATECM(*,*,11) = X-DIRECTED LEAKAGES
C                 = RATECM(*,*,12) = Y-DIRECTED LEAKAGES
C                 = RATECM(*,*,13) = Z-DIRECTED LEAKAGES
C                 = RATECM(*,*,13+JJ) NUSIGF FOR JJ
C                 = RATECM(*,*,13+NIFISS+JJ) CHI FOR JJ
C                 = RATECM(*,*,13+2*NIFISS+JJ) NFTOT FOR JJ
C                 = RATECM(*,*,13+3*NIFISS+IL) SIGS FOR IL
C                 = RATECM(*,*,13+3*NIFISS+NL+IE) EDIT IE
C                 = RATECM(*,*,NTAUXT)= 1/V MERGE CONDENSED
C      FLXINT   : INTEGRATED FLUX                    R(NREGIO,NGROUP,4)
C      SCATTD   : DOUBLE PRECISION SCATTERING RATES  D(NMERGE,
C                                                      NGCOND,NGCOND,NL)
C      DIRC     : ADDED 99-02-19                     D(0:NMERGE,
C                 DIRECTIONAL CORRECTION               NGCOND,3)
C    WORK
```

```
C       SIGMA    : DUMMY CROSS SECTION VECTOR         R(0:NBMIX)
C       IFGSCT   : FIRST SCATTERING GROUP             I(NBMIX)
C       INGSCT   : NUMBER OF SCATTERING GROUP         I(NBMIX)
C       IPOSCT   : SCATTERING POSITION                I(NBMIX)
C       XSCAT    : COMPRESS SCATTERING MATRIX         R(NBMIX*NGROUP)
C       DLBDG    : GROUP DEPENDENT LAMBDA             D(NGROUP)
C
C---------------------------   EDISCT  --------------------------------
C
      IMPLICIT         NONE
      INTEGER          IUNOUT,ILCMUP,ILCMDN,ILCMLN,ITYLCM
      PARAMETER       (IUNOUT=6,ILCMUP=1,ILCMDN=2)
      INTEGER          IPMACR,IPRINT,NGROUP,NGCOND,NBMIX,NREGIO,NMERGE,
     >                 NL,NIFISS,NTAUXT,ILEAKS,NWGTH
      INTEGER          MATCOD(NREGIO),IGCOND(NGCOND),IMERGE(NREGIO),
     >                 IFGSCT(NBMIX),INGSCT(NBMIX),IPOSCT(NBMIX)
      REAL             FLXINT(NREGIO,NGROUP,4),SIGMA(0:NBMIX),
     >                 XSCAT(NBMIX*NGROUP),SPH(NMERGE,NGCOND),B2(4)
      DOUBLE PRECISION SCATTD(NMERGE,NGCOND,NGCOND,NL),
     >                 RATECM(0:NMERGE,NGCOND,NTAUXT),
     >                 DIRC(0:NMERGE,NGCOND,3),DLBDG(NGROUP)
C----
C  VARIABLES LOCALES
C----
      INTEGER          IGR,IGRC,JGR,JGRC,ILSC,IGRDEB,IGRFIN,IL,IDIR,IKK,
     >                 IREGIO,MATNUM,NGSCAT,IGSCAT,IPOSIT,JGRFIN,JGRDEB,
     >                 J2,J1,IPO
      CHARACTER        CGRPNM*12,CM*2
      DOUBLE PRECISION DCOR,DTOTL,DFLUX
      ILSC=13+3*NIFISS
C----
C  SCATTERING NEUTRONS
C  99-02-19
C  COMPUTE DLBDG GROUP DEPENDENT CORRECTION FACTOR
C----
      CALL XDRDBL(DLBDG,NGROUP,0.0D0)
      IF(NWGTH .GT. 1) THEN
        DO 100 IGR=1,NGROUP
          WRITE(CGRPNM,'(5HGROUP,I3,1H/,I3)') IGR,NGROUP
          CALL LCMSIX(IPMACR,CGRPNM,ILCMUP)
          CALL LCMGET(IPMACR,'TOTAL',SIGMA(1))
          DFLUX=0.0D0
          DTOTL=0.0D0
          DO 101 IREGIO=1,NREGIO
            MATNUM=MATCOD(IREGIO)
            IKK=IMERGE(IREGIO)
            DFLUX=DFLUX+FLXINT(IREGIO,IGR,1)
            DTOTL=DTOTL+FLXINT(IREGIO,IGR,1)
     >                 *SIGMA(MATNUM)
 101      CONTINUE
          IF(DFLUX .NE. 0.0D0) THEN
            DTOTL=DTOTL/DFLUX
            DLBDG(IGR)=DTOTL
            CALL EDILBD(1,DLBDG(IGR),B2(4))
            DLBDG(IGR)=DTOTL*(1.0D0-1.0D0/DLBDG(IGR))
          ENDIF
```

```
          CALL LCMSIX(IPMACR,CGRPNM,ILCMDN)
 100    CONTINUE
      ENDIF
C----
C  SCATTERING NEUTRONS
C  99-02-19
C  INITIALIZE DOUBLE PRECISION VECTOR "DIRC" FOR DIRECTIONAL
C  ANISOTROPIC SCATTERING CORRECTION
C----
      CALL XDRDBL(DIRC,(NMERGE+1)*NGCOND*3,0.0D0)
      CALL XDRDBL(SCATTD,NMERGE*NGCOND*NGCOND*NL,0.0D0)
      IGRFIN=0
      DO 110 IGRC=1,NGCOND
        IGRDEB=IGRFIN+1
        IGRFIN=IGCOND(IGRC)
        DO 120 IGR=IGRDEB,IGRFIN
          WRITE(CGRPNM,'(5HGROUP,I3,1H/,I3)') IGR,NGROUP
          CALL LCMSIX(IPMACR,CGRPNM,ILCMUP)
          CALL LCMGET(IPMACR,'TOTAL',SIGMA(1))
          DO 130 IL=1,NL
            WRITE (CM,'(I2)') IL-1
            CALL LCMLEN(IPMACR,'NJJD'//CM,ILCMLN,ITYLCM)
            IF(ILCMLN.GT.0) THEN
              CALL LCMGET(IPMACR,'NJJD'//CM,INGSCT)
              CALL LCMGET(IPMACR,'IJJD'//CM,IFGSCT)
              CALL LCMGET(IPMACR,'IPOD'//CM,IPOSCT)
              CALL LCMGET(IPMACR,'SCAD'//CM,XSCAT)
              IF( (IL.EQ.2).AND.(NWGTH.GE.1)) THEN
                DO 140 IDIR=1,3
                  DO 141 IREGIO=1,NREGIO
                    MATNUM=MATCOD(IREGIO)
                    IKK=IMERGE(IREGIO)
                    IF((IKK.GT.0).AND.(MATNUM.GT.0)) THEN
                      NGSCAT=INGSCT(MATNUM)
                      IGSCAT=IFGSCT(MATNUM)
                      IPOSIT=IPOSCT(MATNUM)
                      JGRFIN=0
                      DO 142 JGRC=1,NGCOND
                        JGRDEB=JGRFIN+1
                        JGRFIN=IGCOND(JGRC)
                        J2=MIN(JGRFIN,IGSCAT)
                        J1=MAX(JGRDEB,IGSCAT-NGSCAT+1)
                        IPO=IPOSIT+IGSCAT-J2
                        DO 143 JGR=J2,J1,-1
C----
C  99-02-19
C  CONTRIBUTION FROM NON-VOID REGIONS
C  COMPUTE DIRC WHICH IS TOTAL SCATTERING FOR EACH DIRECTION
C  CHANGE EXPRESSIONS FOR RATECM AND SCATT TO INCLUDE B2(K)
C  WHICH IS NO LONGUER IN FLXINT.
C  ADD LAMBDA CORRECTION ( CROSS SECTION AND FLUX )
C----
                          IF(NWGTH.GT.1) THEN
                            IF(JGR.EQ.IGR) THEN
                              DCOR=( XSCAT(IPO)-SIGMA(MATNUM)
     >                              + DLBDG(JGR) )*SPH(IKK,JGRC)
```

```
     >                             *FLXINT(IREGIO,JGR,1+IDIR)
                            ELSE
                              DCOR=XSCAT(IPO)
     >                            *FLXINT(IREGIO,JGR,1+IDIR)
     >                            *SPH(IKK,JGRC)
                            ENDIF
                          ELSE
                            DCOR=XSCAT(IPO)
     >                          *FLXINT(IREGIO,JGR,1+IDIR)
                          ENDIF
                          DIRC(IKK,IGRC,IDIR)=DCOR
     >                        +DIRC(IKK,IGRC,IDIR)
                          IF(ILEAKS.EQ.3) THEN
                            DCOR=DCOR*B2(IDIR)
                          ELSE
                            DCOR=DCOR*B2(4)
                          ENDIF
                          SCATTD(IKK,IGRC,JGRC,IL)=DCOR
     >                       +SCATTD(IKK,IGRC,JGRC,IL)
                          RATECM(IKK,JGRC,ILSC+IL)=DCOR
     >                       +RATECM(IKK,JGRC,ILSC+IL)
                          IPO=IPO+1
 143                    CONTINUE
 142                  CONTINUE
                    ELSE IF((IKK.GT.0).AND.(MATNUM.EQ.0)) THEN
                      JGRFIN=0
                      DO 144 JGRC=1,NGCOND
                        JGRDEB=JGRFIN+1
                        JGRFIN=IGCOND(JGRC)
                        J2=MIN(JGRFIN,IGR)
                        J1=MAX(JGRDEB,IGR)
                        IF(J1.LE.J2) THEN
C----
C  99-02-19
C  CONTRIBUTION FROM VOID REGIONS
C  ONLY DIAGONAL ELEMENT IN SCATTERING MATRIX
C  CONTRIBUTION IN LAMBDA FROM FLUX
C----
                          IF(NWGTH.GT.1) THEN
                            DCOR=DLBDG(IGR)*SPH(IKK,JGRC)
     >                          *FLXINT(IREGIO,IGR,1+IDIR)
                            DIRC(IKK,IGRC,IDIR)=DCOR
     >                        +DIRC(IKK,IGRC,IDIR)
                            IF(ILEAKS.EQ.3) THEN
                              DCOR=DCOR*B2(IDIR)
                            ELSE
                              DCOR=DCOR*B2(4)
                            ENDIF
                            SCATTD(IKK,IGRC,JGRC,IL)=DCOR
     >                       +SCATTD(IKK,IGRC,JGRC,IL)
                            RATECM(IKK,JGRC,ILSC+IL)=DCOR
     >                       +RATECM(IKK,JGRC,ILSC+IL)
                          ENDIF
                        ENDIF
 144                  CONTINUE
                    ENDIF
```

```
 141              CONTINUE
 140            CONTINUE
C----
C  DANS SCATTD ON N'A PAS LE TAUX DE REACTION DE DIFFUSION
C  SCATTD(1,H) ATTENDU, MAIS SCATTD(1,H) - SIGMA(H,H) (AVEC
C  SIGMA(H,H)=RATECM(*,*,2)/RATECM(*,*,1) LA SECTION
C  EFFICACE TOTALE HOMOGENEISEE.)
C  POUR L'OBTENTION DU SCATTD(1,H) ATTENDU, VOIRE ROUTINE
C  EDIPXS
C----
              ELSE
                DO 150 IREGIO=1,NREGIO
                  MATNUM=MATCOD(IREGIO)
                  IKK=IMERGE(IREGIO)
                  IF((IKK.GT.0).AND.(MATNUM.GT.0)) THEN
                    NGSCAT=INGSCT(MATNUM)
                    IGSCAT=IFGSCT(MATNUM)
                    IPOSIT=IPOSCT(MATNUM)
                    JGRFIN=0
                    DO 151 JGRC=1,NGCOND
                      JGRDEB=JGRFIN+1
                      JGRFIN=IGCOND(JGRC)
                      J2=MIN(JGRFIN,IGSCAT)
                      J1=MAX(JGRDEB,IGSCAT-NGSCAT+1)
                      IPO=IPOSIT+IGSCAT-J2
                      DO 152 JGR=J2,J1,-1
                        DCOR=XSCAT(IPO)*FLXINT(IREGIO,JGR,1)
                        SCATTD(IKK,IGRC,JGRC,IL)=DCOR
     >                      +SCATTD(IKK,IGRC,JGRC,IL)
                        RATECM(IKK,JGRC,ILSC+IL)=DCOR
     >                      +RATECM(IKK,JGRC,ILSC+IL)
                        IPO=IPO+1
 152                  CONTINUE
 151                CONTINUE
                  ENDIF
 150            CONTINUE
              ENDIF
            ENDIF
 130      CONTINUE
          CALL LCMSIX(IPMACR,CGRPNM,ILCMDN)
 120    CONTINUE
 110  CONTINUE
      RETURN
      END
```

Appendix B

DRAGON Files

B.1 Test case G21F2DZ1

B.1.1 Geometry description in DRAGON

Contents of file `Geo/G21F2DZ1.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*DECK GeoRef1F
*----
*  2-D model 1/Coarse mesh
*----
TMPGEO  := GEO:  :: CARCEL 5 1 1
  EDIT 1
  X- REFL MESHX 0.0 28.575 X+ REFL
  Y- REFL MESHY 0.0 28.575 Y+ REFL
  RADIUS 0.000000 0.722163 2.160325
         3.600682 5.168875 6.587482
  MIX    10  11  12  13  14   1
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G21F2DZ1'
  EDIT  2
  MAXR  6
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
psp := PSP: TMPVOL  :: ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
```

```
QUIT "LIST" .
```

B.1.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G21F2DZ1.did+gds`

```
      1  'MESHX        '       2       2
  0.00000000E+00  2.85750008E+01
      1  'MESHY        '       2       2
  0.00000000E+00  2.85750008E+01
      1  'RADIUS       '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
      1  'MIX          '       1       6
        10         11         12         13         14          1
      1  'SIGNATURE    '       3      12
L_GEOM
      1  'STATE-VECTOR'        1      20
        20          5          1          1          0          6         14          0
         0          0          0          0          0          0          0          0
         0          0          0          0
      1  'NCODE        '       1       6
         2          2          2          2          0          0
      1  'ZCODE        '       2       6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
  0.00000000E+00
      1  'ICODE        '       1       6
         0          0          0          0          0          0
```

B.1.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G21F2DZ1.did+tds`

```
      1  'SIGNATURE    '       3      12
L_TRACK
      1  'TRACK-TYPE   '       3      12
EXCELL
      1  'TITLE        '       3      72
Verification model : G21F2DZ1
      1  'EXCELL       '       0      -1
      2  'MINDIM       '       1       4
         1          3          5          9
      2  'MAXDIM       '       1       4
         2          4          6         13
      2  'ICORD        '       1       4
         1          2          3          3
      2  'INDEX        '       1      44
         1          4          5          0          2          3          5          0
```

```
         0          3          5          0          1          2          5          0
         0          0          0          0          1          3          5          8
         1          3          5          9          1          3          5         10
         1          3          5         11          1          3          5         12
         1          3          5          0
     2  'REMESH      '        2       13
 0.00000000E+00  2.85750008E+01  0.00000000E+00  2.85750008E+01  0.00000000E+00
 1.00000000E+00  1.42875004E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00
 1.29649115E+01  2.67172718E+01  4.33949203E+01
     2  'KEYMRG      '        1       11
        -4         -3         -2         -1          0          1          2          3
         4          5          6
     2  'MATALB      '        1       11
        -4         -2         -1         -3          0         10         11         12
        13         14          1
     2  'VOLSUR      '        2       11
 7.14375019E+00  7.14375019E+00  7.14375019E+00  7.14375019E+00  0.00000000E+00
 1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01
 6.80201477E+02
     2  'STATE-VECTOR'        1       20
         2          4          6          4         13         11          0          0
         0          0          0          0          0          0          0          0
         0          0          0          0
     1  'BC-REFL+TRAN'        1        4
         1          2          3          4
     1  'STATE-VECTOR'        1       20
         6          6          1         14          4          1          1          0
         0          0          2          1          0          0          0          0
         0          0          0          0
     1  'EXCELTRACKOP'        2        3
 0.00000000E+00  3.98404884E+00  0.00000000E+00
     1  'MATCOD      '        1        6
        10         11         12         13         14          1
     1  'VOLUME      '        2        6
 1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01
 6.80201477E+02
     1  'KEYFLX      '        1        6
         1          2          3          4          5          6
     1  'ALBEDO      '        2        6
 1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
 1.00000000E+00
```

B.2 Test case G21F2DZ2

B.2.1 Geometry description in DRAGON

Contents of file `Geo/G21F2DZ2.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
```

```
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*DECK GeoRef1F
*----
*  2-D model 2/Uniform fine mesh by split
*----
TMPGEOR := GEO:  :: CARCEL 5 1 1
  EDIT 1
  X- REFL MESHX 0.0 28.575 X+ REFL
  Y- REFL MESHY 0.0 28.575 Y+ REFL
  RADIUS 0.000000 0.722163 2.160325
         3.600682 5.168875 6.587482
  MIX    10  11  12  13  14   1
  ;
TMPGEO := GEO: TMPGEOR ::
  EDIT 1
  SPLITX 3
  SPLITY 4
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G21F2DZ2'
  EDIT  2
  MAXR  72
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
psp := PSP: TMPVOL  :: ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.2.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G21F2DZ2.did+gds`

```
     1  'MESHX       '       2       2
  0.00000000E+00  2.85750008E+01
     1  'MESHY       '       2       2
  0.00000000E+00  2.85750008E+01
     1  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     1  'MIX         '       1       6
        10         11         12         13         14          1
     1  'SIGNATURE   '       3      12
L_GEOM
     1  'STATE-VECTOR'       1      20
        20          5          1          1          0          6         14          0
         0          0          1          0          0          0          0          0
         0          0          0          0
     1  'NCODE       '       1       6
         2          2          2          2          0          0
     1  'ZCODE       '       2       6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
  0.00000000E+00
     1  'ICODE       '       1       6
         0          0          0          0          0          0
     1  'SPLITX      '       1       1
         3
     1  'SPLITY      '       1       1
         4
```

B.2.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G21F2DZ2.did+tds`

```
     1  'SIGNATURE   '       3      12
L_TRACK
     1  'TRACK-TYPE  '       3      12
EXCELL
     1  'TITLE       '       3      72
Verification model : G21F2DZ2
     1  'EXCELL      '       0      -1
     2  'MINDIM      '       1       4
         1          5         10         14
     2  'MAXDIM      '       1       4
         4          9         11         18
     2  'ICORD       '       1       4
         1          2          3          3
     2  'INDEX       '       1     348
         3          9         10          0          2          9         10          0
         1          9         10          0          4          8         10          0
         0          8         10          0          4          7         10          0
         0          7         10          0          4          6         10          0
         0          6         10          0          4          5         10          0
         0          5         10          0          3          4         10          0
         2          4         10          0          1          4         10          0
```

```
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         5        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         2         5        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         3         5        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         6        10        16         1         6        10        17
         1         6        10         0         2         6        10        13
         2         6        10        14         2         6        10        15
         2         6        10        16         2         6        10        17
         2         6        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         3         6        10        16         3         6        10        17
         3         6        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         7        10        16         1         7        10        17
         1         7        10         0         2         7        10        13
         2         7        10        14         2         7        10        15
         2         7        10        16         2         7        10        17
         2         7        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         3         7        10        16         3         7        10        17
         3         7        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         8        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         2         8        10         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         3         8        10         0
    2  'REMESH      '        2       18
0.00000000E+00  9.52500057E+00  1.90500011E+01  2.85750008E+01  0.00000000E+00
7.14375019E+00  1.42875004E+01  2.14312515E+01  2.85750008E+01  0.00000000E+00
1.00000000E+00  1.42875004E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00
1.29649115E+01  2.67172718E+01  4.33949203E+01
    2  'KEYMRG      '        1       87
       -14       -13       -12       -11       -10        -9        -8        -7
        -6        -5        -4        -3        -2        -1         0         0
         0         0         0         0         1         0         0         0
         0         0         2         0         0         0         0         0
         3         0         0         0         4         5         6         7
         8         9        10        11        12         0         0         0
        13        14        15         0         0         0        16        17
        18        19        20        21        22        23        24         0
         0         0        25        26        27         0         0         0
         0         0        28         0         0         0         0         0
        29         0         0         0         0         0        30
    2  'MATALB      '        1       87
        -4        -4        -4        -2        -1        -2        -1        -2
```

```
      -1          -2          -1          -3          -3          -3           0           0
       0           0           0           0           1           0           0           0
       0           0           1           0           0           0           0           0
       1           0           0           0          13          14           1          10
      11          12          13          14           1           0           0           0
      13          14           1           0           0           0          13          14
       1          10          11          12          13          14           1           0
       0           0          13          14           1           0           0           0
       0           0           1           0           0           0           0           0
       1           0           0           0           0           0           1
   2  'VOLSUR      '        2       87
 2.38124990E+00  2.38125014E+00  2.38125014E+00  1.78593731E+00  1.78593731E+00
 1.78593779E+00  1.78593779E+00  1.78593755E+00  1.78593755E+00  1.78593755E+00
 1.78593755E+00  2.38124990E+00  2.38125014E+00  2.38125014E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 6.80442276E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  6.80442276E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  6.80442200E+01  0.00000000E+00  0.00000000E+00
 0.00000000E+00  5.48686981E-01  5.16275024E+00  6.23327904E+01  8.19200814E-01
 6.51171207E+00  1.30343227E+01  2.05047817E+01  1.58716965E+01  1.13025131E+01
 0.00000000E+00  0.00000000E+00  0.00000000E+00  5.48686981E-01  5.16274261E+00
 6.23327904E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  5.48686981E-01
 5.16275024E+00  6.23327980E+01  8.19200814E-01  6.51171207E+00  1.30343227E+01
 2.05047817E+01  1.58716965E+01  1.13025208E+01  0.00000000E+00  0.00000000E+00
 0.00000000E+00  5.48686981E-01  5.16274261E+00  6.23327980E+01  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  6.80442123E+01
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 6.80442123E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  6.80442123E+01
   2  'STATE-VECTOR'        1       20
       2          14          72           4          18          87           0           0
       0           0           0           0           0           0           0           0
       0           0           0           0
   1  'BC-REFL+TRAN'        1       14
       1           2           3           4           5           6           7           8
       9          10          11          12          13          14
   1  'STATE-VECTOR'        1       20
      30          30           1          14          14           1           1           0
       0           0           2           1           0           0           0           0
       0           0           0           0
   1  'EXCELTRACKOP'        2        3
 0.00000000E+00  3.98404884E+00  0.00000000E+00
   1  'MATCOD      '        1       30
       1           1           1          13          14           1          10          11
      12          13          14           1          13          14           1          13
      14           1          10          11          12          13          14           1
      13          14           1           1           1           1
   1  'VOLUME      '        2       30
 6.80442276E+01  6.80442276E+01  6.80442200E+01  5.48686981E-01  5.16275024E+00
 6.23327904E+01  8.19200814E-01  6.51171207E+00  1.30343227E+01  2.05047817E+01
 1.58716965E+01  1.13025131E+01  5.48686981E-01  5.16274261E+00  6.23327904E+01
 5.48686981E-01  5.16275024E+00  6.23327980E+01  8.19200814E-01  6.51171207E+00
 1.30343227E+01  2.05047817E+01  1.58716965E+01  1.13025208E+01  5.48686981E-01
 5.16274261E+00  6.23327980E+01  6.80442123E+01  6.80442123E+01  6.80442123E+01
   1  'KEYFLX      '        1       30
       1           2           3           4           5           6           7           8
```

```
         9          10          11          12          13          14          15          16
        17          18          19          20          21          22          23          24
        25          26          27          28          29          30
     1  'ALBEDO      '        2        6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
  1.00000000E+00
```

B.3 Test case G21F2DZ3

B.3.1 Geometry description in DRAGON

Contents of file `Geo/G21F2DZ3.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  2-D model 3/Irregular manual fine mesh
*----
TMPGEO  := GEO:  :: CARCEL 5 4 4
  EDIT 1
  X- REFL MESHX 0.0 7.0 14.2875 21.575 28.575 X+ REFL
  Y- REFL MESHY 0.0 7.0 14.2875 21.575 28.575 Y+ REFL
  RADIUS 0.000000 0.722163 2.160325
         3.600682 5.168875 6.587482
  MIX    10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
```

```
         10  11  12  13  14   1
         10  11  12  13  14   1

  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G21F2DZ3'
  EDIT  2
  MAXR  96
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
psp := PSP: TMPVOL  :: ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.3.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G21F2DZ3.did+gds`

```
     1  'MESHX       '       2       5
  0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     1  'MESHY       '       2       5
  0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     1  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     1  'MIX         '       1      96
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
     1  'SIGNATURE   '       3      12
L_GEOM
     1  'STATE-VECTOR'       1      20
        20          5          4          4          0         96         14          0
         0          0          0          0          0          0          0          0
```

```
       0          0          0          0
   1  'NCODE       '       1       6
       2          2          2          2          0          0
   1  'ZCODE       '       2       6
 1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
 0.00000000E+00
   1  'ICODE       '       1       6
       0          0          0          0          0          0
```

B.3.3 Associated TRACKING data structure generated by the `EXCELT:` module

Contents of file `Geo/G21F2DZ3.did+tds`

```
     1  'SIGNATURE   '       3      12
L_TRACK
     1  'TRACK-TYPE  '       3      12
EXCELL
     1  'TITLE       '       3      72
Verification model : G21F2DZ3
     1  'EXCELL      '       0      -1
     2  'MINDIM      '       1       4
         1         6        11        15
     2  'MAXDIM      '       1       4
         5        10        12        19
     2  'ICORD       '       1       4
         1         2         3         3
     2  'INDEX       '       1     452
         4        10        11         0         3        10        11         0
         2        10        11         0         1        10        11         0
         5         9        11         0         0         9        11         0
         5         8        11         0         0         8        11         0
         5         7        11         0         0         7        11         0
         5         6        11         0         0         6        11         0
         4         5        11         0         3         5        11         0
         2         5        11         0         1         5        11         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         6        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         2         6        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         3         6        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         4         6        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         7        11         0         2         7        11        14
         2         7        11        15         2         7        11        16
         2         7        11        17         2         7        11        18
         2         7        11         0         3         7        11        14
```

```
         3         7        11        15         3         7        11        16
         3         7        11        17         3         7        11        18
         3         7        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         4         7        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         8        11         0         2         8        11        14
         2         8        11        15         2         8        11        16
         2         8        11        17         2         8        11        18
         2         8        11         0         3         8        11        14
         3         8        11        15         3         8        11        16
         3         8        11        17         3         8        11        18
         3         8        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         4         8        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1         9        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         2         9        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         3         9        11         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         4         9        11         0
    2  'REMESH      '       2      19
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  1.00000000E+00  1.42875004E+01  1.42875004E+01  5.21519423E-01
4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
    2  'KEYMRG      '       1     113
       -16       -15       -14       -13       -12       -11       -10        -9
        -8        -7        -6        -5        -4        -3        -2        -1
         0         0         0         0         0         0         1         0
         0         0         0         0         2         0         0         0
         0         0         3         0         0         0         0         0
         4         0         0         0         0         0         5         6
         7         8         9        10        11        12        13        14
        15        16        17         0         0         0         0         0
        18         0         0         0         0         0        19        20
        21        22        23        24        25        26        27        28
        29        30        31         0         0         0         0         0
        32         0         0         0         0         0        33         0
         0         0         0         0        34         0         0         0
         0         0        35         0         0         0         0         0
        36
    2  'MATALB      '       1     113
        -4        -4        -4        -4        -2        -1        -2        -1
        -2        -1        -2        -1        -3        -3        -3        -3
         0         0         0         0         0         0         1         0
         0         0         0         0         1         0         0         0
```

```
         0           0           1           0           0           0           0           0
         1           0           0           0           0           0           1          10
        11          12          13          14           1          10          11          12
        13          14           1           0           0           0           0           0
         1           0           0           0           0           0           1          10
        11          12          13          14           1          10          11          12
        13          14           1           0           0           0           0           0
         1           0           0           0           0           0           1           0
         0           0           0           0           1           0           0           0
         0           0           1           0           0           0           0           0
         1
     2  'VOLSUR      '        2      113
 1.75000000E+00  1.82187510E+00  1.82187510E+00  1.75000000E+00  1.75000000E+00
 1.75000000E+00  1.82187510E+00  1.82187510E+00  1.82187510E+00  1.82187510E+00
 1.75000000E+00  1.75000000E+00  1.75000000E+00  1.82187510E+00  1.82187510E+00
 1.75000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  4.90000000E+01  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  5.10125046E+01  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  5.10125046E+01
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 4.90000000E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  5.10125046E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00
 1.08010778E+01  1.30985947E+01  1.90253716E+01  4.09600407E-01  3.25585604E+00
 6.51716137E+00  1.08010778E+01  1.30985947E+01  1.90253716E+01  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  5.10125046E+01
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 5.10125046E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01
 1.30985947E+01  1.90253716E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00
 1.08010778E+01  1.30985947E+01  1.90253716E+01  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  5.10125046E+01  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.90000000E+01
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 5.10125046E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  5.10125046E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  4.90000000E+01
     2  'STATE-VECTOR'        1       20
         2          16          96           4          19         113           0           0
         0           0           0           0           0           0           0           0
         0           0           0           0
     1  'BC-REFL+TRAN'        1       16
         1           2           3           4           5           6           7           8
         9          10          11          12          13          14          15          16
     1  'STATE-VECTOR'        1       20
        36          36           1          14          16           1           1           0
         0           0           2           1           0           0           0           0
         0           0           0           0
     1  'EXCELTRACKOP'        2        3
 0.00000000E+00  3.98404884E+00  0.00000000E+00
     1  'MATCOD      '        1       36
         1           1           1           1           1          10          11          12
        13          14           1          10          11          12          13          14
         1           1           1          10          11          12          13          14
         1          10          11          12          13          14           1           1
         1           1           1           1
     1  'VOLUME      '        2       36
 4.90000000E+01  5.10125046E+01  5.10125046E+01  4.90000000E+01  5.10125046E+01
```

```
4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01
1.90253716E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01
1.30985947E+01  1.90253716E+01  5.10125046E+01  5.10125046E+01  4.09600407E-01
3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01  1.90253716E+01
4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01
1.90253716E+01  5.10125046E+01  4.90000000E+01  5.10125046E+01  5.10125046E+01
4.90000000E+01
   1  'KEYFLX      '        1       36
       1          2          3          4          5          6          7          8
       9         10         11         12         13         14         15         16
      17         18         19         20         21         22         23         24
      25         26         27         28         29         30         31         32
      33         34         35         36
   1  'ALBEDO      '        2        6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.4 Test case G21F2DZ4

B.4.1 Geometry description in DRAGON

Contents of file `Geo/G21F2DZ4.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  2-D model 4/Irregular manual fine mesh with CELL
*----
TMPGEO  := GEO:  :: CAR2D 3 2
  EDIT 1
  CELL c1 c2 c3
       c4 c5 c6
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  ::: c1 := GEO: CAR2D 1 1
    MESHX 0.0 7.0
    MESHY 0.0 7.0
    MIX 1
    ;
  ::: c2 := GEO: CAR2D 2 1
    MESHX 7.0 14.2875 21.575
```

```
    MESHY 0.0 7.0
    MIX 1   1
    ;
  ::: c3 := GEO: CAR2D 1 1
    MESHX 21.575 28.575
    MESHY 0.0 7.0
    MIX 1
    ;
  ::: c4 := GEO: CAR2D 1 3
    MESHX 0.0 7.0
    MESHY 7.0 14.2875 21.575 28.575
    MIX 1   1   1
    ;
  ::: c5 := GEO: CARCEL 5 2 3
    MESHX 7.0 14.2875 21.575
    MESHY 7.0 14.2875 21.575 28.575
    OFFCENTER 0.0 -3.5
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX 10  11  12  13  14   1
        10  11  12  13  14   1

        10  11  12  13  14   1
        10  11  12  13  14   1

        10  11  12  13  14   1
        10  11  12  13  14   1
    ;
  ::: c6 := GEO: CAR2D 1 3
    MESHX 21.575 28.575
    MESHY 7.0 14.2875 21.575 28.575
    MIX 1   1   1
    ;
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G21F2DZ4'
  EDIT  2
  MAXR  46
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
psp := PSP: TMPVOL  :: ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.4.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G21F2DZ4.did+gds`

```
      1  'CELL        '       3       72
c1           c2           c3           c4           c5           c6
      1  'GENERATING  '       1        6
          1          2          3          4          5          6
      1  'c1          '       0       -1
      2  'MESHX       '       2        2
  0.00000000E+00  7.00000000E+00
      2  'MESHY       '       2        2
  0.00000000E+00  7.00000000E+00
      2  'MIX         '       1        1
          1
      2  'SIGNATURE   '       3       12
L_GEOM
      2  'STATE-VECTOR'       1       20
          5          0          1          1          0          1          1          0
          0          0          0          0          0          0          0          0
          0          0          0          0
      2  'NCODE       '       1        6
          0          0          0          0          0          0
      2  'ZCODE       '       2        6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
      2  'ICODE       '       1        6
          0          0          0          0          0          0
      1  'c2          '       0       -1
      2  'MESHX       '       2        3
  7.00000000E+00  1.42875004E+01  2.15750008E+01
      2  'MESHY       '       2        2
  0.00000000E+00  7.00000000E+00
      2  'MIX         '       1        2
          1          1
      2  'SIGNATURE   '       3       12
L_GEOM
      2  'STATE-VECTOR'       1       20
          5          0          2          1          0          2          1          0
          0          0          0          0          0          0          0          0
          0          0          0          0
      2  'NCODE       '       1        6
          0          0          0          0          0          0
      2  'ZCODE       '       2        6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
      2  'ICODE       '       1        6
          0          0          0          0          0          0
      1  'c3          '       0       -1
      2  'MESHX       '       2        2
  2.15750008E+01  2.85750008E+01
      2  'MESHY       '       2        2
  0.00000000E+00  7.00000000E+00
      2  'MIX         '       1        1
          1
```

```
     2  'SIGNATURE   '       3      12
  L_GEOM
     2  'STATE-VECTOR'       1      20
         5         0         1         1         0         1         1         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     2  'NCODE       '       1       6
         0         0         0         0         0         0
     2  'ZCODE       '       2       6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
     2  'ICODE       '       1       6
         0         0         0         0         0         0
     1  'c4          '       0      -1
     2  'MESHX       '       2       2
    0.00000000E+00  7.00000000E+00
     2  'MESHY       '       2       4
    7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     2  'MIX         '       1       3
         1         1         1
     2  'SIGNATURE   '       3      12
  L_GEOM
     2  'STATE-VECTOR'       1      20
         5         0         1         3         0         3         1         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     2  'NCODE       '       1       6
         0         0         0         0         0         0
     2  'ZCODE       '       2       6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
     2  'ICODE       '       1       6
         0         0         0         0         0         0
     1  'c5          '       0      -1
     2  'MESHX       '       2       3
    7.00000000E+00  1.42875004E+01  2.15750008E+01
     2  'MESHY       '       2       4
    7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     2  'OFFCENTER   '       2       3
    0.00000000E+00 -3.50000000E+00  0.00000000E+00
     2  'RADIUS      '       2       6
    0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
    6.58748198E+00
     2  'MIX         '       1      36
        10        11        12        13        14         1        10        11
        12        13        14         1        10        11        12        13
        14         1        10        11        12        13        14         1
        10        11        12        13        14         1        10        11
        12        13        14         1
     2  'SIGNATURE   '       3      12
  L_GEOM
     2  'STATE-VECTOR'       1      20
        20         5         2         3         0        36        14         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     2  'NCODE       '       1       6
```

```
         0          0          0          0          0          0
     2  'ZCODE       '        2        6
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00
     2  'ICODE       '        1        6
         0          0          0          0          0          0
     1  'c6          '        0       -1
     2  'MESHX       '        2        2
   2.15750008E+01  2.85750008E+01
     2  'MESHY       '        2        4
   7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     2  'MIX         '        1        3
         1          1          1
     2  'SIGNATURE   '        3       12
 L_GEOM
     2  'STATE-VECTOR'        1       20
         5          0          1          3          0          3          1          0
         0          0          0          0          0          0          0          0
         0          0          0          0
     2  'NCODE       '        1        6
         0          0          0          0          0          0
     2  'ZCODE       '        2        6
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00
     2  'ICODE       '        1        6
         0          0          0          0          0          0
     1  'SIGNATURE   '        3       12
 L_GEOM
     1  'STATE-VECTOR'        1       20
         5          0          3          2          0          6         14          1
         6          0          0          0          0          0          0          0
         0          0          0          0
     1  'NCODE       '        1        6
         2          2          2          2          0          0
     1  'ZCODE       '        2        6
   1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
   0.00000000E+00
     1  'ICODE       '        1        6
         0          0          0          0          0          0
```

B.4.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G21F2DZ4.did+tds`

```
     1  'SIGNATURE   '        3       12
 L_TRACK
     1  'TRACK-TYPE  '        3       12
 EXCELL
     1  'TITLE       '        3       72
 Verification model : G21F2DZ4
     1  'EXCELL      '        0       -1
     2  'MINDIM      '        1        4
         1          6         11         15
     2  'MAXDIM      '        1        4
```

```
       5         10          12          19
   2  'ICORD        '         1        4
       1          2           3           3
   2  'INDEX        '         1      252
       4         10          11           0           5           9          11           0
       5          8          11           0           5           7          11           0
       3         10          11           0           2          10          11           0
       1         10          11           0           0           9          11           0
       0          8          11           0           0           7          11           0
       5          6          11           0           4           5          11           0
       3          5          11           0           2           5          11           0
       0          6          11           0           1           5          11           0
       0          0           0           0           1           6          11           0
       2          6          11           0           3           6          11           0
       4          6          11           0           1           7          11           0
       1          8          11           0           1           9          11           0
       2          7          11          14           2           7          11          15
       2          7          11          16           2           7          11          17
       2          7          11          18           2           7          11           0
       3          7          11          14           3           7          11          15
       3          7          11          16           3           7          11          17
       3          7          11          18           3           7          11           0
       2          8          11          14           2           8          11          15
       2          8          11          16           2           8          11          17
       2          8          11          18           2           8          11           0
       3          8          11          14           3           8          11          15
       3          8          11          16           3           8          11          17
       3          8          11          18           3           8          11           0
       0          0           0           0           0           0           0           0
       0          0           0           0           0           0           0           0
       0          0           0           0           2           9          11           0
       0          0           0           0           0           0           0           0
       0          0           0           0           0           0           0           0
       0          0           0           0           3           9          11           0
       4          7          11           0           4           8          11           0
       4          9          11           0
   2  'REMESH       '         2       19
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  1.00000000E+00  1.42875004E+01  1.42875004E+01  5.21519423E-01
4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
   2  'KEYMRG       '         1       63
     -16        -15         -14         -13         -12         -11         -10          -9
      -8         -7          -6          -5          -4          -3          -2          -1
       0          1           2           3           4           5           6           7
       8          9          10          11          12          13          14          15
      16         17          18          19          20          21          22          23
      24         25          26          27          28          29          30          31
       0          0           0           0           0          32           0           0
       0          0           0          33          34          35          36
   2  'MATALB       '         1       63
      -4         -2          -2          -2          -4          -4          -4          -1
      -1         -1          -2          -3          -3          -3          -1          -3
       0          1           1           1           1           1           1           1
      10         11          12          13          14           1          10          11
      12         13          14           1          10          11          12          13
```

```
      14          1         10         11         12         13         14          1
       0          0          0          0          0          1          0          0
       0          0          0          1          1          1          1
   2  'VOLSUR      '        2       63
1.75000000E+00  1.75000000E+00  1.82187510E+00  1.82187510E+00  1.82187510E+00
1.82187510E+00  1.75000000E+00  1.75000000E+00  1.82187510E+00  1.82187510E+00
1.75000000E+00  1.75000000E+00  1.82187510E+00  1.82187510E+00  1.75000000E+00
1.75000000E+00  0.00000000E+00  4.90000000E+01  5.10125046E+01  5.10125046E+01
4.90000000E+01  5.10125046E+01  5.10125046E+01  4.90000000E+01  4.09600407E-01
3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01  1.90253716E+01
4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01
1.90253716E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01
1.30985947E+01  1.90253716E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00
1.08010778E+01  1.30985947E+01  1.90253716E+01  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  5.10125046E+01  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  5.10125046E+01
5.10125046E+01  5.10125046E+01  4.90000000E+01
   2  'STATE-VECTOR'        1       20
       2         16         46          4         19         63          0          0
       0          0          0          0          0          0          0          0
       0          0          0          0
   1  'BC-REFL+TRAN'        1       16
       1          2          3          4          5          6          7          8
       9         10         11         12         13         14         15         16
   1  'STATE-VECTOR'        1       20
      36         36          1         14         16          1          1          0
       0          0          2          1          0          0          0          0
       0          0          0          0
   1  'EXCELTRACKOP'        2        3
0.00000000E+00  3.98404884E+00  0.00000000E+00
   1  'MATCOD      '        1       36
       1          1          1          1          1          1          1         10
      11         12         13         14          1         10         11         12
      13         14          1         10         11         12         13         14
       1         10         11         12         13         14          1          1
       1          1          1          1
   1  'VOLUME      '        2       36
4.90000000E+01  5.10125046E+01  5.10125046E+01  4.90000000E+01  5.10125046E+01
5.10125046E+01  4.90000000E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00
1.08010778E+01  1.30985947E+01  1.90253716E+01  4.09600407E-01  3.25585604E+00
6.51716137E+00  1.08010778E+01  1.30985947E+01  1.90253716E+01  4.09600407E-01
3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01  1.90253716E+01
4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01
1.90253716E+01  5.10125046E+01  5.10125046E+01  5.10125046E+01  5.10125046E+01
4.90000000E+01
   1  'KEYFLX      '        1       36
       1          2          3          4          5          6          7          8
       9         10         11         12         13         14         15         16
      17         18         19         20         21         22         23         24
      25         26         27         28         29         30         31         32
      33         34         35         36
   1  'ALBEDO      '        2        6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.5 Test case G21F3D1

B.5.1 Geometry description in DRAGON

Contents of file `Geo/G21F3D1.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  3-D model 1/Coarse mesh
*----
TMPGEO  := GEO:  :: CARCELZ 5 1 1 1
  EDIT 1
  X- REFL MESHX 0.0 28.575 X+ REFL
  Y- REFL MESHY 0.0 28.575 Y+ REFL
  Z- REFL MESHZ 0.0 49.53  Z+ REFL
  RADIUS 0.000000 0.722163 2.160325
         3.600682 5.168875 6.587482
  MIX    10  11  12  13  14   1
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G21F3D1'
  EDIT  2
  MAXR  6
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.5.2 Associated GEOMETRY data structure generated by the `GEO:` module

Contents of file `Geo/G21F3D1.did+gds`

```
      1   'MESHX        '        2       2
   0.00000000E+00  2.85750008E+01
      1   'MESHY        '        2       2
   0.00000000E+00  2.85750008E+01
      1   'MESHZ        '        2       2
   0.00000000E+00  4.95299988E+01
      1   'RADIUS       '        2       6
   0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
   6.58748198E+00
      1   'MIX          '        1       6
         10         11         12         13         14          1
      1   'SIGNATURE    '        3      12
 L_GEOM
      1   'STATE-VECTOR'        1      20
         23          5          1          1          1          6         14          0
          0          0          0          0          0          0          0          0
          0          0          0          0
      1   'NCODE        '        1       6
          2          2          2          2          2          2
      1   'ZCODE        '        2       6
   1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
   1.00000000E+00
      1   'ICODE        '        1       6
          0          0          0          0          0          0
```

B.5.3 Associated TRACKING data structure generated by the `EXCELT:` module

Contents of file `Geo/G21F3D1.did+tds`

```
      1   'SIGNATURE    '        3      12
 L_TRACK
      1   'TRACK-TYPE   '        3      12
 EXCELL
      1   'TITLE        '        3      72
 Verification model : G21F3D1
      1   'EXCELL       '        0      -1
      2   'MINDIM       '        1       4
          1          3          5          9
      2   'MAXDIM       '        1       4
          2          4          6         13
      2   'ICORD        '        1       4
          1          2          3          3
      2   'INDEX        '        1      92
          1          3          6          0          1          3          6         12
          1          3          6         11          1          3          6         10
          1          3          6          9          1          3          6          8
          1          4          5          0          2          3          5          0
          0          3          5          0          1          2          5          0
```

```
         1         3         4         0         1         3         4        12
         1         3         4        11         1         3         4        10
         1         3         4         9         1         3         4         8
         0         0         0         0         1         3         5         8
         1         3         5         9         1         3         5        10
         1         3         5        11         1         3         5        12
         1         3         5         0
     2  'REMESH      '        2       13
 0.00000000E+00  2.85750008E+01  0.00000000E+00  2.85750008E+01  0.00000000E+00
 4.95299988E+01  1.42875004E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00
 1.29649115E+01  2.67172718E+01  4.33949203E+01
     2  'KEYMRG      '        1       23
       -16       -15       -14       -13       -12       -11       -10        -9
        -8        -7        -6        -5        -4        -3        -2        -1
         0         1         2         3         4         5         6
     2  'MATALB      '        1       23
        -6        -6        -6        -6        -6        -6        -4        -2
        -1        -3        -5        -5        -5        -5        -5        -5
         0        10        11        12        13        14         1
     2  'VOLSUR      '        2       23
 1.70050369E+02  1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00
 4.09600407E-01  3.53829926E+02  3.53829926E+02  3.53829926E+02  3.53829926E+02
 1.70050369E+02  1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00
 4.09600407E-01  0.00000000E+00  8.11500320E+01  6.45050232E+02  1.29117993E+03
 2.13990918E+03  2.59509375E+03  3.36903789E+04
     2  'STATE-VECTOR'        1       20
         3        16         6         4        13        23         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     1  'BC-REFL+TRAN'        1       16
         1         2         3         4         5         6         7         8
         9        10        11        12        13        14        15        16
     1  'STATE-VECTOR'        1       20
         6         6         1        14        16         1         1         0
         0         0         4         1         0         0         0         0
         0         0         0         0
     1  'EXCELTRACKOP'        2        3
 0.00000000E+00  3.94710827E+00  0.00000000E+00
     1  'MATCOD      '        1        6
        10        11        12        13        14         1
     1  'VOLUME      '        2        6
 8.11500320E+01  6.45050232E+02  1.29117993E+03  2.13990918E+03  2.59509375E+03
 3.36903789E+04
     1  'KEYFLX      '        1        6
         1         2         3         4         5         6
     1  'ALBEDO      '        2        6
 1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
 1.00000000E+00
```

B.6 Test case G21F3D2

B.6.1 Geometry description in DRAGON

Contents of file Geo/G21F3D2.did

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  3-D model 2/Uniform fine mesh by split
*----
TMPGEOR := GEO:  :: CARCELZ 5 1 1 1
  EDIT 1
  X- REFL MESHX 0.0 28.575 X+ REFL
  Y- REFL MESHY 0.0 28.575 Y+ REFL
  Z- REFL MESHZ 0.0 49.53  Z+ REFL
  RADIUS 0.000000 0.722163 2.160325
         3.600682 5.168875 6.587482
  MIX    10  11  12  13  14   1
  ;
TMPGEO := GEO: TMPGEOR ::
  EDIT 1
  SPLITX 3
  SPLITY 4
  SPLITZ 2
  ;
TMPGEOR := DELETE: TMPGEOR ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G21F3D2'
  EDIT  2
  MAXR  144
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.6.2 Associated GEOMETRY data structure generated by the `GEO:` module

Contents of file `Geo/G21F3D2.did+gds`

```
      1  'MESHX       '       2       2
   0.00000000E+00  2.85750008E+01
      1  'MESHY       '       2       2
   0.00000000E+00  2.85750008E+01
      1  'MESHZ       '       2       2
   0.00000000E+00  4.95299988E+01
      1  'RADIUS      '       2       6
   0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
   6.58748198E+00
      1  'MIX         '       1       6
         10         11         12         13         14          1
      1  'SIGNATURE   '       3      12
 L_GEOM
      1  'STATE-VECTOR'       1      20
         23          5          1          1          1          6         14          0
          0          0          1          0          0          0          0          0
          0          0          0          0
      1  'NCODE       '       1       6
          2          2          2          2          2          2
      1  'ZCODE       '       2       6
   1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
   1.00000000E+00
      1  'ICODE       '       1       6
          0          0          0          0          0          0
      1  'SPLITX      '       1       1
          3
      1  'SPLITY      '       1       1
          4
      1  'SPLITZ      '       1       1
          2
```

B.6.3 Associated TRACKING data structure generated by the `EXCELT:` module

Contents of file `Geo/G21F3D2.did+tds`

```
      1  'SIGNATURE   '       3      12
 L_TRACK
      1  'TRACK-TYPE  '       3      12
 EXCELL
      1  'TITLE       '       3      72
 Verification model : G21F3D2
      1  'EXCELL      '       0      -1
      2  'MINDIM      '       1       4
          1          5         10         15
      2  'MAXDIM      '       1       4
          4          9         12         19
      2  'ICORD       '       1       4
          1          2          3          3
```

```
  2  'INDEX       '       1    1268
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       3         8        12         0         2         8        12         0
       1         8        12         0         3         7        12         0
       3         7        12        18         3         7        12        17
       2         7        12         0         2         7        12        18
       2         7        12        17         2         7        12        16
       2         7        12        15         2         7        12        14
       1         7        12         0         1         7        12        18
       1         7        12        17         3         6        12         0
       3         6        12        18         3         6        12        17
       2         6        12         0         2         6        12        18
       2         6        12        17         2         6        12        16
       2         6        12        15         2         6        12        14
       1         6        12         0         1         6        12        18
```

1	6	12	17	3	5	12	0
2	5	12	0	1	5	12	0
3	9	11	0	2	9	11	0
1	9	11	0	4	8	11	0
0	8	11	0	4	7	11	0
0	7	11	0	4	6	11	0
0	6	11	0	4	5	11	0
0	5	11	0	3	4	11	0
2	4	11	0	1	4	11	0
3	9	10	0	2	9	10	0
1	9	10	0	4	8	10	0
0	8	10	0	4	7	10	0
0	7	10	0	4	6	10	0
0	6	10	0	4	5	10	0
0	5	10	0	3	4	10	0
2	4	10	0	1	4	10	0
3	8	9	0	2	8	9	0
1	8	9	0	3	7	9	0
3	7	9	18	3	7	9	17
2	7	9	0	2	7	9	18
2	7	9	17	2	7	9	16
2	7	9	15	2	7	9	14
1	7	9	0	1	7	9	18
1	7	9	17	3	6	9	0
3	6	9	18	3	6	9	17
2	6	9	0	2	6	9	18
2	6	9	17	2	6	9	16
2	6	9	15	2	6	9	14
1	6	9	0	1	6	9	18
1	6	9	17	3	5	9	0
2	5	9	0	1	5	9	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	5	10	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
2	5	10	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	5	10	0	0	0	0	0
0	0	0	0	0	0	0	0
1	6	10	17	1	6	10	18
1	6	10	0	2	6	10	14
2	6	10	15	2	6	10	16
2	6	10	17	2	6	10	18
2	6	10	0	0	0	0	0
0	0	0	0	0	0	0	0
3	6	10	17	3	6	10	18
3	6	10	0	0	0	0	0
0	0	0	0	0	0	0	0
1	7	10	17	1	7	10	18
1	7	10	0	2	7	10	14
2	7	10	15	2	7	10	16
2	7	10	17	2	7	10	18
2	7	10	0	0	0	0	0

```
       0         0         0         0         0         0         0         0
       3         7        10        17         3         7        10        18
       3         7        10         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       1         8        10         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       2         8        10         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       3         8        10         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       1         5        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       2         5        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       3         5        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       1         6        11        17         1         6        11        18
       1         6        11         0         2         6        11        14
       2         6        11        15         2         6        11        16
       2         6        11        17         2         6        11        18
       2         6        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       3         6        11        17         3         6        11        18
       3         6        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       1         7        11        17         1         7        11        18
       1         7        11         0         2         7        11        14
       2         7        11        15         2         7        11        16
       2         7        11        17         2         7        11        18
       2         7        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       3         7        11        17         3         7        11        18
       3         7        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       1         8        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       2         8        11         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       3         8        11         0
   2  'REMESH      '       2      19
0.00000000E+00  9.52500057E+00  1.90500011E+01  2.85750008E+01  0.00000000E+00
7.14375019E+00  1.42875004E+01  2.14312515E+01  2.85750008E+01  0.00000000E+00
2.47649994E+01  4.95299988E+01  1.42875004E+01  1.42875004E+01  5.21519423E-01
4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
   2  'KEYMRG      '       1     317
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
```

```
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0     -88     -87     -86     -85
     -84     -83     -82     -81     -80     -79     -78     -77
     -76     -75     -74     -73     -72     -71     -70     -69
     -68     -67     -66     -65     -64     -63     -62     -61
     -60     -59     -58     -57     -56     -55     -54     -53
     -52     -51     -50     -49     -48     -47     -46     -45
     -44     -43     -42     -41     -40     -39     -38     -37
     -36     -35     -34     -33     -32     -31     -30     -29
     -28     -27     -26     -25     -24     -23     -22     -21
     -20     -19     -18     -17     -16     -15     -14     -13
     -12     -11     -10      -9      -8      -7      -6      -5
      -4      -3      -2      -1       0       0       0       0
       0       0       1       0       0       0       0       0
       2       0       0       0       0       0       3       0
       0       0       4       5       6       7       8       9
      10      11      12       0       0       0      13      14
      15       0       0       0      16      17      18      19
      20      21      22      23      24       0       0       0
      25      26      27       0       0       0       0       0
      28       0       0       0       0       0      29       0
       0       0       0       0      30       0       0       0
       0       0      31       0       0       0       0       0
      32       0       0       0       0       0      33       0
       0       0      34      35      36      37      38      39
      40      41      42       0       0       0      43      44
      45       0       0       0      46      47      48      49
      50      51      52      53      54       0       0       0
      55      56      57       0       0       0       0       0
      58       0       0       0       0       0      59       0
       0       0       0       0      60
 2  'MATALB      '       1     317
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0      -6      -6      -6      -6
      -6      -6      -6      -6      -6      -6      -6      -6
      -6      -6      -6      -6      -6      -6      -6      -6
      -6      -6      -6      -6      -6      -6      -6      -6
      -6      -6      -4      -4      -4      -2      -1      -2
      -1      -2      -1      -2      -1      -3      -3      -3
      -4      -4      -4      -2      -1      -2      -1      -2
```

```
      -1        -2        -1        -3        -3        -3        -5        -5
      -5        -5        -5        -5        -5        -5        -5        -5
      -5        -5        -5        -5        -5        -5        -5        -5
      -5        -5        -5        -5        -5        -5        -5        -5
      -5        -5        -5        -5         0         0         0         0
       0         0         1         0         0         0         0         0
       1         0         0         0         0         0         1         0
       0         0        13        14         1        10        11        12
      13        14         1         0         0         0        13        14
       1         0         0         0        13        14         1        10
      11        12        13        14         1         0         0         0
      13        14         1         0         0         0         0         0
       1         0         0         0         0         0         1         0
       0         0         0         0         1         0         0         0
       0         0         1         0         0         0         0         0
       1         0         0         0         0         0         1         0
       0         0        13        14         1        10        11        12
      13        14         1         0         0         0        13        14
       1         0         0         0        13        14         1        10
      11        12        13        14         1         0         0         0
      13        14         1         0         0         0         0         0
       1         0         0         0         0         0         1         0
       0         0         0         0         1
   2  'VOLSUR      '        2      317
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.70110531E+01
  1.70110531E+01  1.70110531E+01  1.55831995E+01  1.29068565E+00  1.37171745E-01
  2.82563019E+00  3.96792412E+00  5.12619543E+00  3.25858068E+00  1.62792802E+00
  2.04800203E-01  1.55831995E+01  1.29068756E+00  1.37171745E-01  1.55831976E+01
  1.29068565E+00  1.37171745E-01  2.82562828E+00  3.96792412E+00  5.12619543E+00
  3.25858068E+00  1.62792802E+00  2.04800203E-01  1.55831976E+01  1.29068756E+00
  1.37171745E-01  1.70110550E+01  1.70110569E+01  1.70110569E+01  5.89716530E+01
  5.89716568E+01  5.89716568E+01  4.42287369E+01  4.42287369E+01  4.42287483E+01
  4.42287483E+01  4.42287407E+01  4.42287407E+01  4.42287407E+01  4.42287407E+01
  5.89716530E+01  5.89716568E+01  5.89716568E+01  5.89716530E+01  5.89716568E+01
  5.89716568E+01  4.42287369E+01  4.42287369E+01  4.42287483E+01  4.42287483E+01
  4.42287407E+01  4.42287407E+01  4.42287407E+01  4.42287407E+01  5.89716530E+01
  5.89716568E+01  5.89716568E+01  1.70110531E+01  1.70110531E+01  1.70110531E+01
  1.55831995E+01  1.29068565E+00  1.37171745E-01  2.82563019E+00  3.96792412E+00
  5.12619543E+00  3.25858068E+00  1.62792802E+00  2.04800203E-01  1.55831995E+01
  1.29068756E+00  1.37171745E-01  1.55831976E+01  1.29068565E+00  1.37171745E-01
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2.82562828E+00  3.96792412E+00  5.12619543E+00  3.25858068E+00  1.62792802E+00
2.04800203E-01  1.55831976E+01  1.29068756E+00  1.37171745E-01  1.70110550E+01
1.70110569E+01  1.70110569E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.68511523E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.68511523E+03
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
1.68511499E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.35882330E+01
1.27855507E+02  1.54367151E+03  2.02875080E+01  1.61262558E+02  3.22794983E+02
5.07800934E+02  3.93062500E+02  2.79906738E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.35882330E+01  1.27855324E+02  1.54367139E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.35882330E+01  1.27855507E+02  1.54367163E+03
2.02875080E+01  1.61262558E+02  3.22794983E+02  5.07800934E+02  3.93062500E+02
2.79906860E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.35882330E+01
1.27855324E+02  1.54367163E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.68511499E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.68511499E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.68511475E+03
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
1.68511523E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.68511523E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.68511499E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.35882330E+01  1.27855507E+02  1.54367151E+03  2.02875080E+01
1.61262558E+02  3.22794983E+02  5.07800934E+02  3.93062500E+02  2.79906738E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.35882330E+01  1.27855324E+02
1.54367139E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.35882330E+01
1.27855507E+02  1.54367163E+03  2.02875080E+01  1.61262558E+02  3.22794983E+02
5.07800934E+02  3.93062500E+02  2.79906860E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.35882330E+01  1.27855324E+02  1.54367163E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.68511499E+03
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
1.68511499E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.68511475E+03
   2  'STATE-VECTOR'       1       20
       3       172       144         4        19       317         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0
   1  'BC-REFL+TRAN'       1       88
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15        16
      17        18        19        20        21        22        23        24
      25        26        27        28        29        30        31        32
      33        34        35        36        37        38        39        40
      41        42        43        44        45        46        47        48
      49        50        51        52        53        54        55        56
      57        58        59        60        61        62        63        64
      65        66        67        68        69        70        71        72
      73        74        75        76        77        78        79        80
      81        82        83        84        85        86        87        88
   1  'STATE-VECTOR'       1       20
      60        60         1        14        88         1         1         0
       0         0         4         1         0         0         0         0
       0         0         0         0
   1  'EXCELTRACKOP'       2        3
0.00000000E+00  3.94710827E+00  0.00000000E+00
   1  'MATCOD      '       1       60
       1         1         1        13        14         1        10        11
```

```
        12         13         14          1         13         14          1         13
        14          1         10         11         12         13         14          1
        13         14          1          1          1          1          1          1
         1         13         14          1         10         11         12         13
        14          1         13         14          1         13         14          1
        10         11         12         13         14          1         13         14
         1          1          1          1
    1  'VOLUME      '        2       60
  1.68511523E+03  1.68511523E+03  1.68511499E+03  1.35882330E+01  1.27855507E+02
  1.54367151E+03  2.02875080E+01  1.61262558E+02  3.22794983E+02  5.07800934E+02
  3.93062500E+02  2.79906738E+02  1.35882330E+01  1.27855324E+02  1.54367139E+03
  1.35882330E+01  1.27855507E+02  1.54367163E+03  2.02875080E+01  1.61262558E+02
  3.22794983E+02  5.07800934E+02  3.93062500E+02  2.79906860E+02  1.35882330E+01
  1.27855324E+02  1.54367163E+03  1.68511499E+03  1.68511499E+03  1.68511475E+03
  1.68511523E+03  1.68511523E+03  1.68511499E+03  1.35882330E+01  1.27855507E+02
  1.54367151E+03  2.02875080E+01  1.61262558E+02  3.22794983E+02  5.07800934E+02
  3.93062500E+02  2.79906738E+02  1.35882330E+01  1.27855324E+02  1.54367139E+03
  1.35882330E+01  1.27855507E+02  1.54367163E+03  2.02875080E+01  1.61262558E+02
  3.22794983E+02  5.07800934E+02  3.93062500E+02  2.79906860E+02  1.35882330E+01
  1.27855324E+02  1.54367163E+03  1.68511499E+03  1.68511499E+03  1.68511475E+03
    1  'KEYFLX      '        1       60
         1          2          3          4          5          6          7          8
         9         10         11         12         13         14         15         16
        17         18         19         20         21         22         23         24
        25         26         27         28         29         30         31         32
        33         34         35         36         37         38         39         40
        41         42         43         44         45         46         47         48
        49         50         51         52         53         54         55         56
        57         58         59         60
    1  'ALBEDO      '        2        6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
  1.00000000E+00
```

B.7 Test case G21F3D3

B.7.1 Geometry description in DRAGON

Contents of file `Geo/G21F3D3.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
```

```
*  3-D model 3/Irregular manual fine mesh
*----
TMPGEO  := GEO:  :: CARCELZ 5 4 4 2
  EDIT 1
  X- REFL MESHX 0.0 7.0 14.2875 21.575 28.575 X+ REFL
  Y- REFL MESHY 0.0 7.0 14.2875 21.575 28.575 Y+ REFL
  Z- REFL MESHZ 0.0     24.765          49.53  Z+ REFL
  RADIUS 0.000000 0.722163 2.160325
         3.600682 5.168875 6.587482
  MIX    10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1
         10  11  12  13  14   1

  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G21F3D3'
  EDIT  2
  MAXR  192
  TRAK TISO 2 4.0
```

```
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.7.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G21F3D3.did+gds`

```
     1  'MESHX       '       2       5
   0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     1  'MESHY       '       2       5
   0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     1  'MESHZ       '       2       3
   0.00000000E+00  2.47649994E+01  4.95299988E+01
     1  'RADIUS      '       2       6
   0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
   6.58748198E+00
     1  'MIX         '       1     192
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
     1  'SIGNATURE   '       3      12
L_GEOM
```

```
      1  'STATE-VECTOR'       1      20
         23         5         4         4         2       192        14         0
          0         0         0         0         0         0         0         0
          0         0         0         0
      1  'NCODE       '       1       6
          2         2         2         2         2         2
      1  'ZCODE       '       2       6
   1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
   1.00000000E+00
      1  'ICODE       '       1       6
          0         0         0         0         0         0
```

B.7.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G21F3D3.did+tds`

```
      1  'SIGNATURE   '       3      12
L_TRACK
      1  'TRACK-TYPE  '       3      12
EXCELL
      1  'TITLE       '       3      72
Verification model : G21F3D3
      1  'EXCELL      '       0      -1
      2  'MINDIM      '       1       4
          1         6        11        16
      2  'MAXDIM      '       1       4
          5        10        13        20
      2  'ICORD       '       1       4
          1         2         3         3
      2  'INDEX       '       1    1668
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
          0         0         0         0         0         0         0         0
```

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
4	9	13	0	3	9	13	0
2	9	13	0	1	9	13	0
4	8	13	0	3	8	13	0
3	8	13	19	3	8	13	18
3	8	13	17	3	8	13	16
3	8	13	15	2	8	13	0
2	8	13	19	2	8	13	18
2	8	13	17	2	8	13	16
2	8	13	15	1	8	13	0
4	7	13	0	3	7	13	0
3	7	13	19	3	7	13	18
3	7	13	17	3	7	13	16
3	7	13	15	2	7	13	0
2	7	13	19	2	7	13	18
2	7	13	17	2	7	13	16
2	7	13	15	1	7	13	0
4	6	13	0	3	6	13	0
2	6	13	0	1	6	13	0
4	10	12	0	3	10	12	0
2	10	12	0	1	10	12	0

5	9	12	0	0	9	12	0
5	8	12	0	0	8	12	0
5	7	12	0	0	7	12	0
5	6	12	0	0	6	12	0
4	5	12	0	3	5	12	0
2	5	12	0	1	5	12	0
4	10	11	0	3	10	11	0
2	10	11	0	1	10	11	0
5	9	11	0	0	9	11	0
5	8	11	0	0	8	11	0
5	7	11	0	0	7	11	0
5	6	11	0	0	6	11	0
4	5	11	0	3	5	11	0
2	5	11	0	1	5	11	0
4	9	10	0	3	9	10	0
2	9	10	0	1	9	10	0
4	8	10	0	3	8	10	0
3	8	10	19	3	8	10	18
3	8	10	17	3	8	10	16
3	8	10	15	2	8	10	0
2	8	10	19	2	8	10	18
2	8	10	17	2	8	10	16
2	8	10	15	1	8	10	0
4	7	10	0	3	7	10	0
3	7	10	19	3	7	10	18
3	7	10	17	3	7	10	16
3	7	10	15	2	7	10	0
2	7	10	19	2	7	10	18
2	7	10	17	2	7	10	16
2	7	10	15	1	7	10	0
4	6	10	0	3	6	10	0
2	6	10	0	1	6	10	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	6	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
2	6	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	6	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
4	6	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	7	11	0	2	7	11	15
2	7	11	16	2	7	11	17
2	7	11	18	2	7	11	19
2	7	11	0	3	7	11	15
3	7	11	16	3	7	11	17
3	7	11	18	3	7	11	19
3	7	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

4	7	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	8	11	0	2	8	11	15
2	8	11	16	2	8	11	17
2	8	11	18	2	8	11	19
2	8	11	0	3	8	11	15
3	8	11	16	3	8	11	17
3	8	11	18	3	8	11	19
3	8	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
4	8	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	9	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
2	9	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	9	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
4	9	11	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	6	12	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
2	6	12	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	6	12	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
4	6	12	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	7	12	0	2	7	12	15
2	7	12	16	2	7	12	17
2	7	12	18	2	7	12	19
2	7	12	0	3	7	12	15
3	7	12	16	3	7	12	17
3	7	12	18	3	7	12	19
3	7	12	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
4	7	12	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	8	12	0	2	8	12	15
2	8	12	16	2	8	12	17
2	8	12	18	2	8	12	19
2	8	12	0	3	8	12	15
3	8	12	16	3	8	12	17

```
           3           8          12          18           3           8          12          19
           3           8          12           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           4           8          12           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           1           9          12           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           2           9          12           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           3           9          12           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           4           9          12           0
   2  'REMESH      '       2      20
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  2.47649994E+01  4.95299988E+01  1.42875004E+01  1.42875004E+01
5.21519423E-01  4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
   2  'KEYMRG      '       1     417
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
           0           0           0           0           0           0           0           0
        -104        -103        -102        -101        -100         -99         -98         -97
         -96         -95         -94         -93         -92         -91         -90         -89
         -88         -87         -86         -85         -84         -83         -82         -81
         -80         -79         -78         -77         -76         -75         -74         -73
         -72         -71         -70         -69         -68         -67         -66         -65
         -64         -63         -62         -61         -60         -59         -58         -57
         -56         -55         -54         -53         -52         -51         -50         -49
         -48         -47         -46         -45         -44         -43         -42         -41
         -40         -39         -38         -37         -36         -35         -34         -33
         -32         -31         -30         -29         -28         -27         -26         -25
         -24         -23         -22         -21         -20         -19         -18         -17
         -16         -15         -14         -13         -12         -11         -10          -9
          -8          -7          -6          -5          -4          -3          -2          -1
           0           0           0           0           0           0           1           0
           0           0           0           0           2           0           0           0
           0           0           3           0           0           0           0           0
           4           0           0           0           0           0           5           6
           7           8           9          10          11          12          13          14
```

```
     15        16        17         0         0         0         0         0
     18         0         0         0         0         0        19        20
     21        22        23        24        25        26        27        28
     29        30        31         0         0         0         0         0
     32         0         0         0         0         0        33         0
      0         0         0         0        34         0         0         0
      0         0        35         0         0         0         0         0
     36         0         0         0         0         0        37         0
      0         0         0         0        38         0         0         0
      0         0        39         0         0         0         0         0
     40         0         0         0         0         0        41        42
     43        44        45        46        47        48        49        50
     51        52        53         0         0         0         0         0
     54         0         0         0         0         0        55        56
     57        58        59        60        61        62        63        64
     65        66        67         0         0         0         0         0
     68         0         0         0         0         0        69         0
      0         0         0         0        70         0         0         0
      0         0        71         0         0         0         0         0
     72
  2  'MATALB      '       1       417
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
      0         0         0         0         0         0         0         0
     -6        -6        -6        -6        -6        -6        -6        -6
     -6        -6        -6        -6        -6        -6        -6        -6
     -6        -6        -6        -6        -6        -6        -6        -6
     -6        -6        -6        -6        -6        -6        -6        -6
     -6        -6        -6        -6        -4        -4        -4        -4
     -2        -1        -2        -1        -2        -1        -2        -1
     -3        -3        -3        -3        -4        -4        -4        -4
     -2        -1        -2        -1        -2        -1        -2        -1
     -3        -3        -3        -3        -5        -5        -5        -5
     -5        -5        -5        -5        -5        -5        -5        -5
     -5        -5        -5        -5        -5        -5        -5        -5
     -5        -5        -5        -5        -5        -5        -5        -5
     -5        -5        -5        -5        -5        -5        -5        -5
      0         0         0         0         0         0         1         0
      0         0         0         0         1         0         0         0
      0         0         1         0         0         0         0         0
      1         0         0         0         0         0         1        10
     11        12        13        14         1        10        11        12
     13        14         1         0         0         0         0         0
      1         0         0         0         0         0         1        10
```

```
          11          12          13          14           1          10          11          12
          13          14           1           0           0           0           0           0
           1           0           0           0           0           0           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1           0           0           0           0           0           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1           0           0           0           0           0           1          10
          11          12          13          14           1          10          11          12
          13          14           1           0           0           0           0           0
           1           0           0           0           0           0           1          10
          11          12          13          14           1          10          11          12
          13          14           1           0           0           0           0           0
           1           0           0           0           0           0           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1
     2  'VOLSUR      '       2      417
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   1.22500000E+01  1.27531261E+01  1.27531261E+01  1.22500000E+01  1.27531261E+01
   4.75634289E+00  3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01
   1.02400102E-01  4.75634289E+00  3.27464867E+00  2.70026946E+00  1.62929034E+00
   8.13964009E-01  1.02400102E-01  1.27531261E+01  1.27531261E+01  4.75634289E+00
   3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01  1.02400102E-01
   4.75634289E+00  3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01
   1.02400102E-01  1.27531261E+01  1.22500000E+01  1.27531261E+01  1.27531261E+01
   1.22500000E+01  4.33387489E+01  4.51187363E+01  4.51187363E+01  4.33387489E+01
   4.33387489E+01  4.33387489E+01  4.51187363E+01  4.51187363E+01  4.51187363E+01
   4.51187363E+01  4.33387489E+01  4.33387489E+01  4.33387489E+01  4.51187363E+01
   4.51187363E+01  4.33387489E+01  4.33387489E+01  4.51187363E+01  4.51187363E+01
   4.33387489E+01  4.33387489E+01  4.33387489E+01  4.51187363E+01  4.51187363E+01
   4.51187363E+01  4.51187363E+01  4.33387489E+01  4.33387489E+01  4.33387489E+01
```

```
4.51187363E+01  4.51187363E+01  4.33387489E+01  1.22500000E+01  1.27531261E+01
1.27531261E+01  1.22500000E+01  1.27531261E+01  4.75634289E+00  3.27464867E+00
2.70026946E+00  1.62929034E+00  8.13964009E-01  1.02400102E-01  4.75634289E+00
3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01  1.02400102E-01
1.27531261E+01  1.27531261E+01  4.75634289E+00  3.27464867E+00  2.70026946E+00
1.62929034E+00  8.13964009E-01  1.02400102E-01  4.75634289E+00  3.27464867E+00
2.70026946E+00  1.62929034E+00  8.13964009E-01  1.02400102E-01  1.27531261E+01
1.22500000E+01  1.27531261E+01  1.27531261E+01  1.22500000E+01  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
1.21348499E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.21348499E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03  1.01437540E+01
8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.21348499E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
1.21348499E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.21348499E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.21348499E+03
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
1.26332458E+03  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02
2.67488647E+02  3.24386719E+02  4.71163269E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.21348499E+03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
1.26332458E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.21348499E+03
   2  'STATE-VECTOR'        1       20
       3       224       192         4        20       417         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0
   1  'BC-REFL+TRAN'        1      104
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15        16
      17        18        19        20        21        22        23        24
      25        26        27        28        29        30        31        32
```

```
      33         34         35         36         37         38         39         40
      41         42         43         44         45         46         47         48
      49         50         51         52         53         54         55         56
      57         58         59         60         61         62         63         64
      65         66         67         68         69         70         71         72
      73         74         75         76         77         78         79         80
      81         82         83         84         85         86         87         88
      89         90         91         92         93         94         95         96
      97         98         99        100        101        102        103        104
   1  'STATE-VECTOR'        1      20
      72         72          1         14        104          1          1          0
       0          0          4          1          0          0          0          0
       0          0          0          0
   1  'EXCELTRACKOP'        2       3
0.00000000E+00  3.94710827E+00  0.00000000E+00
   1  'MATCOD      '        1      72
       1          1          1          1          1         10         11         12
      13         14          1         10         11         12         13         14
       1          1          1         10         11         12         13         14
       1         10         11         12         13         14          1          1
       1          1          1          1          1          1          1          1
       1         10         11         12         13         14          1         10
      11         12         13         14          1          1          1         10
      11         12         13         14          1         10         11         12
      13         14          1          1          1          1          1          1
   1  'VOLUME      '        2      72
1.21348499E+03  1.26332458E+03  1.26332458E+03  1.21348499E+03  1.26332458E+03
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  1.26332458E+03  1.26332458E+03  1.01437540E+01
8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.26332458E+03  1.21348499E+03  1.26332458E+03  1.26332458E+03
1.21348499E+03  1.21348499E+03  1.26332458E+03  1.26332458E+03  1.21348499E+03
1.26332458E+03  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02
2.67488647E+02  3.24386719E+02  4.71163269E+02  1.26332458E+03  1.26332458E+03
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  1.26332458E+03  1.21348499E+03  1.26332458E+03
1.26332458E+03  1.21348499E+03
   1  'KEYFLX      '        1      72
       1          2          3          4          5          6          7          8
       9         10         11         12         13         14         15         16
      17         18         19         20         21         22         23         24
      25         26         27         28         29         30         31         32
      33         34         35         36         37         38         39         40
      41         42         43         44         45         46         47         48
      49         50         51         52         53         54         55         56
      57         58         59         60         61         62         63         64
      65         66         67         68         69         70         71         72
   1  'ALBEDO      '        2       6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.8 Test case G21F3D4

B.8.1 Geometry description in DRAGON

Contents of file `Geo/G21F3D4.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  3-D model 4/Irregular manual fine mesh with CELL
*----
TMPGEO  := GEO:  :: CAR3D 3 2 2
  EDIT 1
  CELL c1 c2 c3
       c4 c5 c6
       c1 c2 c3
       c4 c5 c6
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  Z- REFL Z+ REFL
  ::: c1 := GEO: CAR3D 1 1 1
    MESHX 0.0 7.0
    MESHY 0.0 7.0
    MESHZ 0.0 24.765
    MIX 1
    ;
  ::: c2 := GEO: CAR3D 2 1 1
    MESHX 7.0 14.2875 21.575
    MESHY 0.0 7.0
    MESHZ 0.0 24.765
    MIX 1   1
    ;
  ::: c3 := GEO: CAR3D 1 1 1
    MESHX 21.575 28.575
    MESHY 0.0 7.0
    MESHZ 0.0 24.765
    MIX 1
    ;
  ::: c4 := GEO: CAR3D 1 3 1
    MESHX 0.0 7.0
    MESHY 7.0 14.2875 21.575 28.575
```

```
      MESHZ 0.0 24.765
      MIX 1   1   1
      ;
    ::: c5 := GEO: CARCELZ 5 2 3 1
      MESHX 7.0 14.2875 21.575
      MESHY 7.0 14.2875 21.575 28.575
      MESHZ 0.0 24.765
      OFFCENTER 0.0 -3.5 0.0
      RADIUS 0.000000 0.722163 2.160325
             3.600682 5.168875 6.587482
      MIX 10  11  12  13  14   1
          10  11  12  13  14   1

          10  11  12  13  14   1
          10  11  12  13  14   1

          10  11  12  13  14   1
          10  11  12  13  14   1
      ;
    ::: c6 := GEO: CAR3D 1 3 1
      MESHX 21.575 28.575
      MESHY 7.0 14.2875 21.575 28.575
      MESHZ 0.0 24.765
      MIX 1   1   1
      ;
    ;
  gds := TMPGEO ;
  TMPVOL TMPTRK := EXCELT: TMPGEO ::
    TITLE  'Verification model : G21F3D4'
    EDIT  2
    MAXR  92
    TRAK TISO 2 4.0
    ;
  tds := TMPVOL ;
  mth := TST: TMPVOL  ::
    EDIT 1  VERIFY MTH   ;
  TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
  *----
  *  END, QUIT
  *----
  END: ;
  QUIT "LIST" .
```

B.8.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G21F3D4.did+gds`

```
       1  'CELL        '        3       72
  c1          c2          c3          c4          c5          c6
       1  'GENERATING  '        1       12
           1           2           3           4           5           6           1           2
```

```
         3         4         5         6
     1  'c1          '       0      -1
     2  'MESHX       '       2       2
  0.00000000E+00  7.00000000E+00
     2  'MESHY       '       2       2
  0.00000000E+00  7.00000000E+00
     2  'MESHZ       '       2       2
  0.00000000E+00  2.47649994E+01
     2  'MIX         '       1       1
         1
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
         7         0         1         1         1         1         1         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     2  'NCODE       '       1       6
         0         0         0         0         0         0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '       1       6
         0         0         0         0         0         0
     1  'c2          '       0      -1
     2  'MESHX       '       2       3
  7.00000000E+00  1.42875004E+01  2.15750008E+01
     2  'MESHY       '       2       2
  0.00000000E+00  7.00000000E+00
     2  'MESHZ       '       2       2
  0.00000000E+00  2.47649994E+01
     2  'MIX         '       1       2
         1         1
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
         7         0         2         1         1         2         1         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     2  'NCODE       '       1       6
         0         0         0         0         0         0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '       1       6
         0         0         0         0         0         0
     1  'c3          '       0      -1
     2  'MESHX       '       2       2
  2.15750008E+01  2.85750008E+01
     2  'MESHY       '       2       2
  0.00000000E+00  7.00000000E+00
     2  'MESHZ       '       2       2
  0.00000000E+00  2.47649994E+01
     2  'MIX         '       1       1
         1
     2  'SIGNATURE   '       3      12
L_GEOM
```

```
    2  'STATE-VECTOR'       1      20
        7         0         1         1         1         1         1         0
        0         0         0         0         0         0         0         0
        0         0         0         0
    2  'NCODE       '       1       6
        0         0         0         0         0         0
    2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
    2  'ICODE       '       1       6
        0         0         0         0         0         0
    1  'c4          '       0      -1
    2  'MESHX       '       2       2
  0.00000000E+00  7.00000000E+00
    2  'MESHY       '       2       4
  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
    2  'MESHZ       '       2       2
  0.00000000E+00  2.47649994E+01
    2  'MIX         '       1       3
        1         1         1
    2  'SIGNATURE   '       3      12
 L_GEOM
    2  'STATE-VECTOR'       1      20
        7         0         1         3         1         3         1         0
        0         0         0         0         0         0         0         0
        0         0         0         0
    2  'NCODE       '       1       6
        0         0         0         0         0         0
    2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
    2  'ICODE       '       1       6
        0         0         0         0         0         0
    1  'c5          '       0      -1
    2  'MESHX       '       2       3
  7.00000000E+00  1.42875004E+01  2.15750008E+01
    2  'MESHY       '       2       4
  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
    2  'MESHZ       '       2       2
  0.00000000E+00  2.47649994E+01
    2  'OFFCENTER   '       2       3
  0.00000000E+00 -3.50000000E+00  0.00000000E+00
    2  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
    2  'MIX         '       1      36
       10        11        12        13        14         1        10        11
       12        13        14         1        10        11        12        13
       14         1        10        11        12        13        14         1
       10        11        12        13        14         1        10        11
       12        13        14         1
    2  'SIGNATURE   '       3      12
 L_GEOM
    2  'STATE-VECTOR'       1      20
       23         5         2         3         1        36        14         0
        0         0         0         0         0         0         0         0
```

```
          0          0          0          0
     2  'NCODE       '        1        6
          0          0          0          0          0          0
     2  'ZCODE       '        2        6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '        1        6
          0          0          0          0          0          0
     1  'c6          '        0       -1
     2  'MESHX       '        2        2
  2.15750008E+01  2.85750008E+01
     2  'MESHY       '        2        4
  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
     2  'MESHZ       '        2        2
  0.00000000E+00  2.47649994E+01
     2  'MIX         '        1        3
          1          1          1
     2  'SIGNATURE   '        3       12
L_GEOM
     2  'STATE-VECTOR'        1       20
          7          0          1          3          1          3          1          0
          0          0          0          0          0          0          0          0
          0          0          0          0
     2  'NCODE       '        1        6
          0          0          0          0          0          0
     2  'ZCODE       '        2        6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '        1        6
          0          0          0          0          0          0
     1  'SIGNATURE   '        3       12
L_GEOM
     1  'STATE-VECTOR'        1       20
          7          0          3          2          2         12         14          1
          6          0          0          0          0          0          0          0
          0          0          0          0
     1  'NCODE       '        1        6
          2          2          2          2          2          2
     1  'ZCODE       '        2        6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
  1.00000000E+00
     1  'ICODE       '        1        6
          0          0          0          0          0          0
```

B.8.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G21F3D4.did+tds`

```
     1  'SIGNATURE   '        3       12
L_TRACK
     1  'TRACK-TYPE  '        3       12
EXCELL
     1  'TITLE       '        3       72
Verification model : G21F3D4
```

```
1  'EXCELL      '       0      -1
2  'MINDIM      '       1       4
    1         6        11        16
2  'MAXDIM      '       1       4
    5        10        13        20
2  'ICORD       '       1       4
    1         2         3         3
2  'INDEX       '       1     948
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    0         0         0         0         0         0         0         0
    4         9        13         0         4         8        13         0
    4         7        13         0         4        10        12         0
    5         9        12         0         5         8        12         0
    5         7        12         0         3         9        13         0
    2         9        13         0         3         8        13         0
    3         8        13        19         3         8        13        18
    3         8        13        17         3         8        13        16
    3         8        13        15         2         8        13         0
    2         8        13        19         2         8        13        18
    2         8        13        17         2         8        13        16
    2         8        13        15         3         7        13         0
    3         7        13        19         3         7        13        18
    3         7        13        17         3         7        13        16
    3         7        13        15         2         7        13         0
    2         7        13        19         2         7        13        18
    2         7        13        17         2         7        13        16
    2         7        13        15         3        10        12         0
    2        10        12         0         1         9        13         0
    1         8        13         0         1         7        13         0
    1        10        12         0         0         9        12         0
    0         8        12         0         0         7        12         0
    4         6        13         0         5         6        12         0
    4         5        12         0         3         6        13         0
    2         6        13         0         3         5        12         0
    2         5        12         0         1         6        13         0
    0         6        12         0         1         5        12         0
    4        10        11         0         5         9        11         0
    5         8        11         0         5         7        11         0
```

4	9	10	0	4	8	10	0
4	7	10	0	3	10	11	0
2	10	11	0	3	9	10	0
2	9	10	0	3	8	10	0
3	8	10	19	3	8	10	18
3	8	10	17	3	8	10	16
3	8	10	15	2	8	10	0
2	8	10	19	2	8	10	18
2	8	10	17	2	8	10	16
2	8	10	15	3	7	10	0
3	7	10	19	3	7	10	18
3	7	10	17	3	7	10	16
3	7	10	15	2	7	10	0
2	7	10	19	2	7	10	18
2	7	10	17	2	7	10	16
2	7	10	15	1	10	11	0
0	9	11	0	0	8	11	0
0	7	11	0	1	9	10	0
1	8	10	0	1	7	10	0
5	6	11	0	4	5	11	0
4	6	10	0	3	5	11	0
2	5	11	0	3	6	10	0
2	6	10	0	0	6	11	0
1	5	11	0	1	6	10	0
0	0	0	0	1	6	11	0
2	6	11	0	3	6	11	0
4	6	11	0	1	7	11	0
1	8	11	0	1	9	11	0
2	7	11	15	2	7	11	16
2	7	11	17	2	7	11	18
2	7	11	19	2	7	11	0
3	7	11	15	3	7	11	16
3	7	11	17	3	7	11	18
3	7	11	19	3	7	11	0
2	8	11	15	2	8	11	16
2	8	11	17	2	8	11	18
2	8	11	19	2	8	11	0
3	8	11	15	3	8	11	16
3	8	11	17	3	8	11	18
3	8	11	19	3	8	11	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	2	9	11	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	3	9	11	0
4	7	11	0	4	8	11	0
4	9	11	0	1	6	12	0
2	6	12	0	3	6	12	0
4	6	12	0	1	7	12	0
1	8	12	0	1	9	12	0
2	7	12	15	2	7	12	16
2	7	12	17	2	7	12	18
2	7	12	19	2	7	12	0
3	7	12	15	3	7	12	16
3	7	12	17	3	7	12	18

```
         3         7        12        19         3         7        12         0
         2         8        12        15         2         8        12        16
         2         8        12        17         2         8        12        18
         2         8        12        19         2         8        12         0
         3         8        12        15         3         8        12        16
         3         8        12        17         3         8        12        18
         3         8        12        19         3         8        12         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         2         9        12         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         3         9        12         0
         4         7        12         0         4         8        12         0
         4         9        12         0
    2  'REMESH      '        2      20
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
0.00000000E+00  2.47649994E+01  4.95299988E+01  1.42875004E+01  1.42875004E+01
5.21519423E-01  4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
    2  'KEYMRG      '        1     237
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
      -104      -103      -102      -101      -100       -99       -98       -97
       -96       -95       -94       -93       -92       -91       -90       -89
       -88       -87       -86       -85       -84       -83       -82       -81
       -80       -79       -78       -77       -76       -75       -74       -73
       -72       -71       -70       -69       -68       -67       -66       -65
       -64       -63       -62       -61       -60       -59       -58       -57
       -56       -55       -54       -53       -52       -51       -50       -49
       -48       -47       -46       -45       -44       -43       -42       -41
       -40       -39       -38       -37       -36       -35       -34       -33
       -32       -31       -30       -29       -28       -27       -26       -25
       -24       -23       -22       -21       -20       -19       -18       -17
       -16       -15       -14       -13       -12       -11       -10        -9
        -8        -7        -6        -5        -4        -3        -2        -1
         0         1         2         3         4         5         6         7
         8         9        10        11        12        13        14        15
        16        17        18        19        20        21        22        23
        24        25        26        27        28        29        30        31
         0         0         0         0         0        32         0         0
         0         0         0        33        34        35        36        37
        38        39        40        41        42        43        44        45
        46        47        48        49        50        51        52        53
        54        55        56        57        58        59        60        61
        62        63        64        65        66        67         0         0
         0         0         0        68         0         0         0         0
         0        69        70        71        72
    2  'MATALB      '        1     237
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
```

```
       0       0       0       0       0       0       0       0
      -6      -6      -6      -4      -2      -2      -2      -6
      -6      -6      -6      -6      -6      -6      -6      -6
      -6      -6      -6      -6      -6      -6      -6      -6
      -6      -6      -6      -6      -6      -6      -6      -6
      -6      -4      -4      -6      -6      -6      -4      -1
      -1      -1      -6      -2      -3      -6      -6      -3
      -3      -6      -1      -3      -4      -2      -2      -2
      -5      -5      -5      -4      -4      -5      -5      -5
      -5      -5      -5      -5      -5      -5      -5      -5
      -5      -5      -5      -5      -5      -5      -5      -5
      -5      -5      -5      -5      -5      -5      -5      -4
      -1      -1      -1      -5      -5      -5      -2      -3
      -5      -3      -3      -5      -5      -1      -3      -5
       0       1       1       1       1       1       1       1
      10      11      12      13      14       1      10      11
      12      13      14       1      10      11      12      13
      14       1      10      11      12      13      14       1
       0       0       0       0       0       1       0       0
       0       0       0       1       1       1       1       1
       1       1       1       1       1       1      10      11
      12      13      14       1      10      11      12      13
      14       1      10      11      12      13      14       1
      10      11      12      13      14       1       0       0
       0       0       0       1       0       0       0       0
       0       1       1       1       1
   2  'VOLSUR      '       2     237
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 1.22500000E+01  1.27531261E+01  1.27531261E+01  4.33387489E+01  4.33387489E+01
 4.51187363E+01  4.51187363E+01  1.27531261E+01  1.27531261E+01  4.75634289E+00
 3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01  1.02400102E-01
 4.75634289E+00  3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01
 1.02400102E-01  4.75634289E+00  3.27464867E+00  2.70026946E+00  1.62929034E+00
 8.13964009E-01  1.02400102E-01  4.75634289E+00  3.27464867E+00  2.70026946E+00
 1.62929034E+00  8.13964009E-01  1.02400102E-01  4.51187363E+01  4.51187363E+01
 1.22500000E+01  1.27531261E+01  1.27531261E+01  4.33387489E+01  4.33387489E+01
 4.51187363E+01  4.51187363E+01  1.22500000E+01  4.33387489E+01  4.33387489E+01
 1.27531261E+01  1.27531261E+01  4.51187363E+01  4.51187363E+01  1.22500000E+01
 4.33387489E+01  4.33387489E+01  4.33387489E+01  4.33387489E+01  4.51187363E+01
 4.51187363E+01  1.22500000E+01  1.27531261E+01  1.27531261E+01  4.51187363E+01
 4.51187363E+01  1.27531261E+01  1.27531261E+01  4.75634289E+00  3.27464867E+00
 2.70026946E+00  1.62929034E+00  8.13964009E-01  1.02400102E-01  4.75634289E+00
 3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01  1.02400102E-01
 4.75634289E+00  3.27464867E+00  2.70026946E+00  1.62929034E+00  8.13964009E-01
 1.02400102E-01  4.75634289E+00  3.27464867E+00  2.70026946E+00  1.62929034E+00
 8.13964009E-01  1.02400102E-01  4.33387489E+01  4.33387489E+01  4.51187363E+01
 4.51187363E+01  1.22500000E+01  1.27531261E+01  1.27531261E+01  4.33387489E+01
 4.33387489E+01  1.22500000E+01  4.51187363E+01  4.51187363E+01  1.27531261E+01
 1.27531261E+01  4.33387489E+01  4.33387489E+01  1.22500000E+01  0.00000000E+00
```

```
1.21348499E+03  1.26332458E+03  1.26332458E+03  1.21348499E+03  1.26332458E+03
1.26332458E+03  1.21348499E+03  1.01437540E+01  8.06312790E+01  1.61397491E+02
2.67488647E+02  3.24386719E+02  4.71163269E+02  1.01437540E+01  8.06312790E+01
1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02  1.01437540E+01
8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.26332458E+03  1.26332458E+03  1.26332458E+03
1.21348499E+03  1.21348499E+03  1.26332458E+03  1.26332458E+03  1.21348499E+03
1.26332458E+03  1.26332458E+03  1.21348499E+03  1.01437540E+01  8.06312790E+01
1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02  1.01437540E+01
8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.26332458E+03  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  1.26332458E+03  1.26332458E+03
1.26332458E+03  1.21348499E+03
   2  'STATE-VECTOR'       1      20
       3       144        92         4        20       237         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0
   1  'BC-REFL+TRAN'       1     104
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15        16
      17        18        19        20        21        22        23        24
      25        26        27        28        29        30        31        32
      33        34        35        36        37        38        39        40
      41        42        43        44        45        46        47        48
      49        50        51        52        53        54        55        56
      57        58        59        60        61        62        63        64
      65        66        67        68        69        70        71        72
      73        74        75        76        77        78        79        80
      81        82        83        84        85        86        87        88
      89        90        91        92        93        94        95        96
      97        98        99       100       101       102       103       104
   1  'STATE-VECTOR'       1      20
      72        72         1        14       104         1         1         0
       0         0         4         1         0         0         0         0
       0         0         0         0
   1  'EXCELTRACKOP'       2       3
0.00000000E+00  3.94710827E+00  0.00000000E+00
   1  'MATCOD      '       1      72
       1         1         1         1         1         1         1        10
      11        12        13        14         1        10        11        12
      13        14         1        10        11        12        13        14
       1        10        11        12        13        14         1         1
       1         1         1         1         1         1         1         1
       1         1         1        10        11        12        13        14
       1        10        11        12        13        14         1        10
      11        12        13        14         1        10        11        12
      13        14         1         1         1         1         1         1
   1  'VOLUME      '       2      72
1.21348499E+03  1.26332458E+03  1.26332458E+03  1.21348499E+03  1.26332458E+03
1.26332458E+03  1.21348499E+03  1.01437540E+01  8.06312790E+01  1.61397491E+02
```

```
2.67488647E+02  3.24386719E+02  4.71163269E+02  1.01437540E+01  8.06312790E+01
1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02  1.01437540E+01
8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.26332458E+03  1.26332458E+03  1.26332458E+03  1.26332458E+03
1.21348499E+03  1.21348499E+03  1.26332458E+03  1.26332458E+03  1.21348499E+03
1.26332458E+03  1.26332458E+03  1.21348499E+03  1.01437540E+01  8.06312790E+01
1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02  1.01437540E+01
8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02  4.71163269E+02
1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02  3.24386719E+02
4.71163269E+02  1.01437540E+01  8.06312790E+01  1.61397491E+02  2.67488647E+02
3.24386719E+02  4.71163269E+02  1.26332458E+03  1.26332458E+03  1.26332458E+03
1.26332458E+03  1.21348499E+03
   1  'KEYFLX      '       1      72
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15        16
      17        18        19        20        21        22        23        24
      25        26        27        28        29        30        31        32
      33        34        35        36        37        38        39        40
      41        42        43        44        45        46        47        48
      49        50        51        52        53        54        55        56
      57        58        59        60        61        62        63        64
      65        66        67        68        69        70        71        72
   1  'ALBEDO      '       2       6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.9 Test case G22F2DZ1

B.9.1 Geometry description in DRAGON

Contents of file `Geo/G22F2DZ1.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  2-DZ model 1/Coarse mesh without symmetry
*----
TMPGEO  := GEO:  :: CAR2D 3 1
  EDIT 1
  CELL c1 c2 c3
```

```
    X- REFL X+ REFL
    Y- REFL Y+ REFL
    ::: c1 := GEO: CARCEL 5 1 1
      MESHX -28.575   -7.0
      MESHY -14.2875  14.2875
      OFFCENTER 3.5 0.0
      RADIUS 0.000000 0.722163 2.160325
             3.600682 5.168875 6.587482
      MIX 10  11  12  13  14   1
      ;
    ::: c2 := GEO: CAR2D 1 1
      MESHX  -7.0       7.0
      MESHY -14.2875  14.2875
      MIX 1
      ;
    ::: c3 := GEO: CARCEL 5 1 1
      MESHX   7.0     28.575
      MESHY -14.2875  14.2875
      OFFCENTER -3.5 0.0
      RADIUS 0.000000 0.722163 2.160325
             3.600682 5.168875 6.587482
      MIX 10  11  12  13  14   1
      ;
    ;
  gds := TMPGEO ;
  TMPVOL TMPTRK := EXCELT: TMPGEO ::
    TITLE  'Verification model : G22F2DZ1'
    EDIT  2
    MAXR  18
    TRAK TISO 2 4.0
    ;
  tds := TMPVOL ;
  mth := TST: TMPVOL  ::
    EDIT 1  VERIFY MTH   ;
  psp := PSP: TMPVOL  :: ;
  TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
  *----
  *  END, QUIT
  *----
  END: ;
  QUIT "LIST" .
```

B.9.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F2DZ1.did+gds`

```
        1  'CELL        '       3      36
  c1           c2           c3
        1  'GENERATING  '       1       3
            1          2        3
        1  'c1          '       0      -1
```

```
     2  'MESHX        '        2       2
 -2.85750008E+01 -7.00000000E+00
     2  'MESHY        '        2       2
 -1.42875004E+01  1.42875004E+01
     2  'OFFCENTER    '        2       3
  3.50000000E+00  0.00000000E+00  0.00000000E+00
     2  'RADIUS       '        2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     2  'MIX          '        1       6
        10         11         12          13         14          1
     2  'SIGNATURE    '        3      12
L_GEOM
     2  'STATE-VECTOR'        1      20
        20          5          1           1          0          6         14          0
         0          0          0           0          0          0          0          0
         0          0          0           0
     2  'NCODE        '        1       6
         0          0          0           0          0          0
     2  'ZCODE        '        2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE        '        1       6
         0          0          0           0          0          0
     1  'c2           '        0      -1
     2  'MESHX        '        2       2
 -7.00000000E+00  7.00000000E+00
     2  'MESHY        '        2       2
 -1.42875004E+01  1.42875004E+01
     2  'MIX          '        1       1
         1
     2  'SIGNATURE    '        3      12
L_GEOM
     2  'STATE-VECTOR'        1      20
         5          0          1           1          0          1          1          0
         0          0          0           0          0          0          0          0
         0          0          0           0
     2  'NCODE        '        1       6
         0          0          0           0          0          0
     2  'ZCODE        '        2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE        '        1       6
         0          0          0           0          0          0
     1  'c3           '        0      -1
     2  'MESHX        '        2       2
  7.00000000E+00  2.85750008E+01
     2  'MESHY        '        2       2
 -1.42875004E+01  1.42875004E+01
     2  'OFFCENTER    '        2       3
 -3.50000000E+00  0.00000000E+00  0.00000000E+00
     2  'RADIUS       '        2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     2  'MIX          '        1       6
        10         11         12          13         14          1
```

```
      2  'SIGNATURE   '       3      12
  L_GEOM
      2  'STATE-VECTOR'       1      20
         20         5         1         1         0         6        14         0
          0         0         0         0         0         0         0         0
          0         0         0         0
      2  'NCODE       '       1       6
          0         0         0         0         0         0
      2  'ZCODE       '       2       6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
      2  'ICODE       '       1       6
          0         0         0         0         0         0
      1  'SIGNATURE   '       3      12
  L_GEOM
      1  'STATE-VECTOR'       1      20
          5         0         3         1         0         3        14         1
          3         0         0         0         0         0         0         0
          0         0         0         0
      1  'NCODE       '       1       6
          2         2         2         2         0         0
      1  'ZCODE       '       2       6
    1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
    0.00000000E+00
      1  'ICODE       '       1       6
          0         0         0         0         0         0
```

B.9.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F2DZ1.did+tds`

```
      1  'SIGNATURE   '       3      12
  L_TRACK
      1  'TRACK-TYPE  '       3      12
  EXCELL
      1  'TITLE       '       3      72
  Verification model : G22F2DZ1
      1  'EXCELL      '       0      -1
      2  'MINDIM      '       1       5
          1         5         7        11        18
      2  'MAXDIM      '       1       5
          4         6         8        15        22
      2  'ICORD       '       1       5
          1         2         3         3         3
      2  'INDEX       '       1      88
          3         6         7         0         4         5         7         0
          3         4         7         0         2         6         7         0
          2         4         7         0         1         6         7         0
          0         5         7         0         1         4         7         0
          0         0         0         0         1         5         7        10
          1         5         7        11         1         5         7        12
          1         5         7        13         1         5         7        14
          1         5         7         0         2         5         7         0
          3         5         7        17         3         5         7        18
```

```
       3           5           7          19           3           5           7          20
       3           5           7          21           3           5           7           0
   2  'REMESH      '         2        22
0.00000000E+00  2.15750008E+01  3.55750008E+01  5.71500015E+01  0.00000000E+00
2.85750008E+01  0.00000000E+00  1.00000000E+00  1.42875004E+01  1.42875004E+01
5.21519423E-01  4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
4.28625031E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00  1.29649115E+01
2.67172718E+01  4.33949203E+01
   2  'KEYMRG      '         1        22
      -8          -7          -6          -5          -4          -3          -2          -1
       0           1           2           3           4           5           6           7
       8           9          10          11          12          13
   2  'MATALB      '         1        22
      -4          -2          -3          -4          -3          -4          -1          -3
       0          10          11          12          13          14           1           1
      10          11          12          13          14           1
   2  'VOLSUR      '         2        22
5.39375019E+00  7.14375019E+00  5.39375019E+00  3.50000000E+00  3.50000000E+00
5.39375019E+00  7.14375019E+00  5.39375019E+00  0.00000000E+00  1.63840163E+00
1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01  4.80176514E+02
4.00050018E+02  1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01
5.23943787E+01  4.80176514E+02
   2  'STATE-VECTOR'         1        20
       2           8          13           5          22          22           0           0
       0           0           0           0           0           0           0           0
       0           0           0           0
   1  'BC-REFL+TRAN'         1         8
       1           2           3           4           5           6           7           8
   1  'STATE-VECTOR'         1        20
      13          13           1          14           8           1           1           0
       0           0           2           1           0           0           0           0
       0           0           0           0
   1  'EXCELTRACKOP'         2         3
0.00000000E+00  3.99088216E+00  0.00000000E+00
   1  'MATCOD      '         1        13
      10          11          12          13          14           1           1          10
      11          12          13          14           1
   1  'VOLUME      '         2        13
1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01
4.80176514E+02  4.00050018E+02  1.63840163E+00  1.30234241E+01  2.60686455E+01
4.32043114E+01  5.23943787E+01  4.80176514E+02
   1  'KEYFLX      '         1        13
       1           2           3           4           5           6           7           8
       9          10          11          12          13
   1  'ALBEDO      '         2         6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.10 Test case G22F2DZ2

B.10.1 Geometry description in DRAGON

Contents of file Geo/G22F2DZ2.did

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  2-DZ model 2/Coarse mesh without symmetry
*                using turn
*----
TMPGEO  := GEO:  :: CAR2D 3 1
  EDIT 1
  CELL c1 c2 c1
  TURN  A  A  E
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  ::: c1 := GEO: CARCEL 5 1 1
    MESHX -28.575   -7.0
    MESHY -14.2875  14.2875
    OFFCENTER 3.5 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX 10  11  12  13  14   1
    ;
  ::: c2 := GEO: CAR2D 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MIX 1
    ;
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F2DZ2'
  EDIT  2
  MAXR  18
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
psp := PSP: TMPVOL  :: ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.10.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F2DZ2.did+gds`

```
       1  'CELL        '       3      24
  c1          c2
       1  'GENERATING  '       1       3
           1         2         1
       1  'TURN        '       1       3
           1         1         5
       1  'c1          '       0      -1
       2  'MESHX       '       2       2
   -2.85750008E+01 -7.00000000E+00
       2  'MESHY       '       2       2
   -1.42875004E+01  1.42875004E+01
       2  'OFFCENTER   '       2       3
    3.50000000E+00  0.00000000E+00  0.00000000E+00
       2  'RADIUS      '       2       6
    0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
    6.58748198E+00
       2  'MIX         '       1       6
          10        11        12        13        14         1
       2  'SIGNATURE   '       3      12
  L_GEOM
       2  'STATE-VECTOR'       1      20
          20         5         1         1         0         6        14         0
           0         0         0         0         0         0         0         0
           0         0         0         0
       2  'NCODE       '       1       6
           0         0         0         0         0         0
       2  'ZCODE       '       2       6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
       2  'ICODE       '       1       6
           0         0         0         0         0         0
       1  'c2          '       0      -1
       2  'MESHX       '       2       2
   -7.00000000E+00  7.00000000E+00
       2  'MESHY       '       2       2
   -1.42875004E+01  1.42875004E+01
       2  'MIX         '       1       1
           1
       2  'SIGNATURE   '       3      12
  L_GEOM
       2  'STATE-VECTOR'       1      20
           5         0         1         1         0         1         1         0
           0         0         0         0         0         0         0         0
           0         0         0         0
       2  'NCODE       '       1       6
           0         0         0         0         0         0
```

```
    2  'ZCODE       '       2       6
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00
    2  'ICODE       '       1       6
        0          0          0          0          0          0
    1  'SIGNATURE   '       3      12
L_GEOM
    1  'STATE-VECTOR'       1      20
        5          0          3          1          0          3         14          1
        2          0          0          0          0          0          0          0
        0          0          0          0
    1  'NCODE       '       1       6
        2          2          2          2          0          0
    1  'ZCODE       '       2       6
 1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
 0.00000000E+00
    1  'ICODE       '       1       6
        0          0          0          0          0          0
```

B.10.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F2DZ2.did+tds`

```
    1  'SIGNATURE   '       3      12
L_TRACK
    1  'TRACK-TYPE  '       3      12
EXCELL
    1  'TITLE       '       3      72
Verification model : G22F2DZ2
    1  'EXCELL      '       0      -1
    2  'MINDIM      '       1       5
        1          5          7         11         18
    2  'MAXDIM      '       1       5
        4          6          8         15         22
    2  'ICORD       '       1       5
        1          2          3          3          3
    2  'INDEX       '       1      88
        3          6          7          0          4          5          7          0
        3          4          7          0          2          6          7          0
        2          4          7          0          1          6          7          0
        0          5          7          0          1          4          7          0
        0          0          0          0          1          5          7         10
        1          5          7         11          1          5          7         12
        1          5          7         13          1          5          7         14
        1          5          7          0          2          5          7          0
        3          5          7         17          3          5          7         18
        3          5          7         19          3          5          7         20
        3          5          7         21          3          5          7          0
    2  'REMESH      '       2      22
 0.00000000E+00  2.15750008E+01  3.55750008E+01  5.71500015E+01  0.00000000E+00
 2.85750008E+01  0.00000000E+00  1.00000000E+00  1.42875004E+01  1.42875004E+01
 5.21519423E-01  4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
 4.28625031E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00  1.29649115E+01
 2.67172718E+01  4.33949203E+01
```

```
   2  'KEYMRG      '       1       22
      -8         -7         -6          -5          -4          -3          -2          -1
       0          1          2           3           4           5           6           7
       8          9         10          11          12          13
   2  'MATALB      '       1       22
      -4         -2         -3          -4          -3          -4          -1          -3
       0         10         11          12          13          14           1           1
      10         11         12          13          14           1
   2  'VOLSUR      '       2       22
5.39375019E+00  7.14375019E+00  5.39375019E+00  3.50000000E+00  3.50000000E+00
5.39375019E+00  7.14375019E+00  5.39375019E+00  0.00000000E+00  1.63840163E+00
1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01  4.80176514E+02
4.00050018E+02  1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01
5.23943787E+01  4.80176514E+02
   2  'STATE-VECTOR'       1       20
       2          8         13           5          22          22           0           0
       0          0          0           0           0           0           0           0
       0          0          0           0
   1  'BC-REFL+TRAN'       1        8
       1          2          3           4           5           6           7           8
   1  'STATE-VECTOR'       1       20
      13         13          1          14           8           1           1           0
       0          0          2           1           0           0           0           0
       0          0          0           0
   1  'EXCELTRACKOP'       2        3
0.00000000E+00  3.99088216E+00  0.00000000E+00
   1  'MATCOD      '       1       13
      10         11         12          13          14           1           1          10
      11         12         13          14           1
   1  'VOLUME      '       2       13
1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01
4.80176514E+02  4.00050018E+02  1.63840163E+00  1.30234241E+01  2.60686455E+01
4.32043114E+01  5.23943787E+01  4.80176514E+02
   1  'KEYFLX      '       1       13
       1          2          3           4           5           6           7           8
       9         10         11          12          13
   1  'ALBEDO      '       2        6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.11 Test case G22F2DZ3

B.11.1 Geometry description in DRAGON

Contents of file `Geo/G22F2DZ3.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
```

```
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  2-DZ model 3/Coarse mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR2D 2 1
  EDIT 1
  CELL c1 c2
  X- REFL X+ SYME
  Y- REFL Y+ SYME
  ::: c1 := GEO: CARCEL 5 1 1
    MESHX -28.575   -7.0
    MESHY -14.2875  14.2875
    OFFCENTER 3.5 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX 10  11  12  13  14   1
    ;
  ::: c2 := GEO: CAR2D 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MIX   1
    ;
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F2DZ3'
  EDIT  2
  MAXR  12
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
psp := PSP: TMPVOL  :: ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.11.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F2DZ3.did+gds`

```
      1  'CELL        '       3      24
  c1          c2
      1  'GENERATING  '       1       2
          1         2
      1  'c1          '       0      -1
      2  'MESHX       '       2       2
   -2.85750008E+01 -7.00000000E+00
      2  'MESHY       '       2       2
   -1.42875004E+01  1.42875004E+01
      2  'OFFCENTER   '       2       3
    3.50000000E+00  0.00000000E+00  0.00000000E+00
      2  'RADIUS      '       2       6
    0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
    6.58748198E+00
      2  'MIX         '       1       6
         10        11        12        13        14         1
      2  'SIGNATURE   '       3      12
  L_GEOM
      2  'STATE-VECTOR'       1      20
         20         5         1         1         0         6        14         0
          0         0         0         0         0         0         0         0
          0         0         0         0
      2  'NCODE       '       1       6
          0         0         0         0         0         0
      2  'ZCODE       '       2       6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
      2  'ICODE       '       1       6
          0         0         0         0         0         0
      1  'c2          '       0      -1
      2  'MESHX       '       2       2
   -7.00000000E+00  7.00000000E+00
      2  'MESHY       '       2       2
   -1.42875004E+01  1.42875004E+01
      2  'MIX         '       1       1
          1
      2  'SIGNATURE   '       3      12
  L_GEOM
      2  'STATE-VECTOR'       1      20
          5         0         1         1         0         1         1         0
          0         0         0         0         0         0         0         0
          0         0         0         0
      2  'NCODE       '       1       6
          0         0         0         0         0         0
      2  'ZCODE       '       2       6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
      2  'ICODE       '       1       6
          0         0         0         0         0         0
      1  'SIGNATURE   '       3      12
  L_GEOM
      1  'STATE-VECTOR'       1      20
          5         0         2         1         0         2        14         1
          2         0         0         0         0         0         0         0
          0         0         0         0
```

```
     1  'NCODE       '       1       6
         2         5         2         5         0         0
     1  'ZCODE       '       2       6
  1.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     1  'ICODE       '       1       6
         0         0         0         0         0         0
```

B.11.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F2DZ3.did+tds`

```
     1  'SIGNATURE   '       3      12
 L_TRACK
     1  'TRACK-TYPE  '       3      12
 EXCELL
     1  'TITLE       '       3      72
 Verification model : G22F2DZ3
     1  'EXCELL      '       0      -1
     2  'MINDIM      '       1       5
         1         5         7        11        18
     2  'MAXDIM      '       1       5
         4         6         8        15        22
     2  'ICORD       '       1       5
         1         2         3         3         3
     2  'INDEX       '       1      88
         3         6         7         0         4         5         7         0
         3         4         7         0         2         6         7         0
         2         4         7         0         1         6         7         0
         0         5         7         0         1         4         7         0
         3         5         7         0         1         5         7        10
         1         5         7        11         1         5         7        12
         1         5         7        13         1         5         7        14
         1         5         7         0         2         5         7         0
         3         5         7        17         3         5         7        18
         3         5         7        19         3         5         7        20
         3         5         7        21         3         5         7         0
     2  'REMESH      '       2      22
  0.00000000E+00  2.15750008E+01  3.55750008E+01  5.71500015E+01  0.00000000E+00
  2.85750008E+01  0.00000000E+00  1.00000000E+00  1.42875004E+01  1.42875004E+01
  5.21519423E-01  4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
  4.28625031E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00  1.29649115E+01
  2.67172718E+01  4.33949203E+01
     2  'KEYMRG      '       1      22
        -3        -2        -3        -1        -1        -3        -2        -3
         0         1         2         3         4         5         6         7
         1         2         3         4         5         6
     2  'MATALB      '       1      22
        -4        -2        -3        -4        -3        -4        -1        -3
         0        10        11        12        13        14         1         1
        10        11        12        13        14         1
     2  'VOLSUR      '       2      22
  5.39375019E+00  7.14375019E+00  5.39375019E+00  3.50000000E+00  3.50000000E+00
  5.39375019E+00  7.14375019E+00  5.39375019E+00  0.00000000E+00  1.63840163E+00
```

```
1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01  4.80176514E+02
4.00050018E+02  1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01
5.23943787E+01  4.80176514E+02
   2  'STATE-VECTOR'       1      20
       2         8        13         5        22        22         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0
   1  'BC-REFL+TRAN'       1       3
       1         2         3
   1  'STATE-VECTOR'       1      20
       7         7         1        14         3         1         1         0
       0         0         2         1         0         0         0         0
       0         0         0         0
   1  'EXCELTRACKOP'       2       3
0.00000000E+00  3.99088216E+00  0.00000000E+00
   1  'MATCOD      '       1       7
      10        11        12        13        14         1         1
   1  'VOLUME      '       2       7
3.27680326E+00  2.60468483E+01  5.21372910E+01  8.64086227E+01  1.04788757E+02
9.60353027E+02  4.00050018E+02
   1  'KEYFLX      '       1       7
       1         2         3         4         5         6         7
   1  'ALBEDO      '       2       6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.12 Test case G22F2DZ4

B.12.1 Geometry description in DRAGON

Contents of file `Geo/G22F2DZ4.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  2-DZ model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR2D 2 1
  EDIT 1
  CELL c1 c2
  X- REFL X+ SYME
```

```
  Y- REFL Y+ SYME
  ::: c1 := GEO: CARCEL 5 3 1
    MESHX -28.575  -21.575 -14.2875 -7.0
    MESHY -14.2875  14.2875
    SPLITY 4
    OFFCENTER 3.5 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX
       10  11  12  13  14   1
       10  11  12  13  14   1
       10  11  12  13  14   1
    ;
  ::: c2 := GEO: CAR2D 1 1
    MESHX  -7.0       7.0
    SPLITX  2
    MESHY -14.2875  14.2875
    SPLITY  4
    MIX     1
    ;
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F2DZ4'
  EDIT  2
  MAXR  100
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
psp := PSP: TMPVOL  :: ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.12.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F2DZ4.did+gds`

```
      1  'CELL        '       3      24
c1           c2
      1  'GENERATING  '       1       2
         1         2
      1  'c1          '       0      -1
      2  'MESHX       '       2       4
 -2.85750008E+01 -2.15750008E+01 -1.42875004E+01 -7.00000000E+00
      2  'MESHY       '       2       2
```

```
 -1.42875004E+01  1.42875004E+01
     2  'SPLITY      '       1       1
        4
     2  'OFFCENTER   '       2       3
  3.50000000E+00  0.00000000E+00  0.00000000E+00
     2  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     2  'MIX         '       1      18
       10         11         12         13         14          1         10         11
       12         13         14          1         10         11         12         13
       14          1
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
       20          5          3          1          0         18         14          0
        0          0          1          0          0          0          0          0
        0          0          0          0
     2  'NCODE       '       1       6
        0          0          0          0          0          0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '       1       6
        0          0          0          0          0          0
     1  'c2          '       0      -1
     2  'MESHX       '       2       2
 -7.00000000E+00  7.00000000E+00
     2  'SPLITX      '       1       1
        2
     2  'MESHY       '       2       2
 -1.42875004E+01  1.42875004E+01
     2  'SPLITY      '       1       1
        4
     2  'MIX         '       1       1
        1
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
        5          0          1          1          0          1          1          0
        0          0          1          0          0          0          0          0
        0          0          0          0
     2  'NCODE       '       1       6
        0          0          0          0          0          0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '       1       6
        0          0          0          0          0          0
     1  'SIGNATURE   '       3      12
L_GEOM
     1  'STATE-VECTOR'       1      20
        5          0          2          1          0          2         14          1
        2          0          0          0          0          0          0          0
        0          0          0          0
     1  'NCODE       '       1       6
```

```
         2         5         2         5         0         0
     1  'ZCODE       '       2       6
  1.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     1  'ICODE       '       1       6
         0         0         0         0         0         0
```

B.12.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F2DZ4.did+tds`

```
     1  'SIGNATURE   '       3      12
L_TRACK
     1  'TRACK-TYPE  '       3      12
EXCELL
     1  'TITLE       '       3      72
Verification model : G22F2DZ4
     1  'EXCELL      '       0      -1
     2  'MINDIM      '       1       5
         1        10        15        19        26
     2  'MAXDIM      '       1       5
         9        14        16        23        30
     2  'ICORD       '       1       5
         1         2         3         3         3
     2  'INDEX       '       1     708
         6        14        15         0         7        14        15         0
         8        14        15         0         9        13        15         0
         9        12        15         0         9        11        15         0
         9        10        15         0         6         9        15         0
         7         9        15         0         8         9        15         0
         5        14        15         0         4        14        15         0
         5         9        15         0         4         9        15         0
         3        14        15         0         2        14        15         0
         1        14        15         0         0        13        15         0
         0        12        15         0         0        11        15         0
         0        10        15         0         3         9        15         0
         2         9        15         0         1         9        15         0
         6        10        15         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1        10        15         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         2        10        15         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         3        10        15         0         0         0         0         0
         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0
         1        11        15         0         2        11        15        18
         2        11        15        19         2        11        15        20
         2        11        15        21         2        11        15        22
         2        11        15         0         3        11        15        18
         3        11        15        19         3        11        15        20
```

3	11	15	21	3	11	15	22
3	11	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	12	15	0	2	12	15	18
2	12	15	19	2	12	15	20
2	12	15	21	2	12	15	22
2	12	15	0	3	12	15	18
3	12	15	19	3	12	15	20
3	12	15	21	3	12	15	22
3	12	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	13	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
2	13	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	13	15	0	4	10	15	0
5	10	15	0	4	11	15	0
5	11	15	0	4	12	15	0
5	12	15	0	4	13	15	0
5	13	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
8	10	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
7	10	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
6	10	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
8	11	15	0	7	11	15	25
7	11	15	26	7	11	15	27
7	11	15	28	7	11	15	29
7	11	15	0	6	11	15	25
6	11	15	26	6	11	15	27
6	11	15	28	6	11	15	29
6	11	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
8	12	15	0	7	12	15	25
7	12	15	26	7	12	15	27
7	12	15	28	7	12	15	29
7	12	15	0	6	12	15	25
6	12	15	26	6	12	15	27
6	12	15	28	6	12	15	29
6	12	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
8	13	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

```
       7        13        15         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       6        13        15         0
   2  'REMESH      '       2      30
0.00000000E+00  7.00000000E+00  1.42875004E+01  2.15750008E+01  2.85750008E+01
3.55750008E+01  4.28625031E+01  5.01500015E+01  5.71500015E+01  0.00000000E+00
7.14375019E+00  1.42875004E+01  2.14312515E+01  2.85750008E+01  0.00000000E+00
1.00000000E+00  1.42875004E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00
1.29649115E+01  2.67172718E+01  4.33949203E+01  4.28625031E+01  1.42875004E+01
5.21519423E-01  4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
   2  'KEYMRG      '       1     177
      -6        -5        -4        -3        -2        -2        -3        -6
      -5        -4        -1        -1        -1        -1        -6        -5
      -4        -3        -2        -2        -3        -6        -5        -4
       0         0         0         0         0         0         1         0
       0         0         0         0         2         0         0         0
       0         0         3         0         0         0         0         0
       4         5         6         7         8         9        10        11
      12        13        14        15        16         0         0         0
       0         0         4         5         6         7         8         9
      10        11        12        13        14        15        16         0
       0         0         0         0         1         0         0         0
       0         0         2         0         0         0         0         0
       3        17        17        18        18        18        18        17
      17         0         0         0         0         0         1         0
       0         0         0         0         2         0         0         0
       0         0         3         0         0         0         0         0
       4         5         6         7         8         9        10        11
      12        13        14        15        16         0         0         0
       0         0         4         5         6         7         8         9
      10        11        12        13        14        15        16         0
       0         0         0         0         1         0         0         0
       0         0         2         0         0         0         0         0
       3
   2  'MATALB      '       1     177
      -4        -4        -4        -2        -2        -2        -2        -3
      -3        -3        -4        -4        -3        -3        -4        -4
      -4        -1        -1        -1        -1        -3        -3        -3
       0         0         0         0         0         0         1         0
       0         0         0         0         1         0         0         0
       0         0         1         0         0         0         0         0
       1        10        11        12        13        14         1        10
      11        12        13        14         1         0         0         0
       0         0         1        10        11        12        13        14
       1        10        11        12        13        14         1         0
       0         0         0         0         1         0         0         0
       0         0         1         0         0         0         0         0
       1         1         1         1         1         1         1         1
       1         0         0         0         0         0         1         0
       0         0         0         0         1         0         0         0
       0         0         1         0         0         0         0         0
       1        10        11        12        13        14         1        10
      11        12        13        14         1         0         0         0
       0         0         1        10        11        12        13        14
       1        10        11        12        13        14         1         0
```

```
       0         0         0         0         1         0         0         0
       0         0         1         0         0         0         0         0
       1
   2  'VOLSUR      '       2      177
1.82187510E+00  1.82187510E+00  1.75000000E+00  1.78593755E+00  1.78593755E+00
1.78593755E+00  1.78593755E+00  1.82187510E+00  1.82187510E+00  1.75000000E+00
1.75000000E+00  1.75000000E+00  1.75000000E+00  1.75000000E+00  1.82187510E+00
1.82187510E+00  1.75000000E+00  1.78593755E+00  1.78593755E+00  1.78593755E+00
1.78593755E+00  1.82187510E+00  1.82187510E+00  1.75000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
5.00062523E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  5.20600815E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  5.20600815E+01  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  5.00062523E+01  4.09600407E-01
3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01  1.79777908E+01
4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01
1.79777908E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  5.00062523E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00
1.08010778E+01  1.30985947E+01  1.79777908E+01  4.09600407E-01  3.25585604E+00
6.51716137E+00  1.08010778E+01  1.30985947E+01  1.79777908E+01  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  5.00062523E+01
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
5.20600815E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  5.20600815E+01  5.00062523E+01  5.00062523E+01  5.00062523E+01
5.00062523E+01  5.00062523E+01  5.00062523E+01  5.00062523E+01  5.00062523E+01
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
5.00062523E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  5.20600815E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  5.20600815E+01  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  5.00062523E+01  4.09600407E-01
3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01  1.79777908E+01
4.09600407E-01  3.25585604E+00  6.51716137E+00  1.08010778E+01  1.30985947E+01
1.79777908E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  5.00062523E+01  4.09600407E-01  3.25585604E+00  6.51716137E+00
1.08010778E+01  1.30985947E+01  1.79777908E+01  4.09600407E-01  3.25585604E+00
6.51716137E+00  1.08010778E+01  1.30985947E+01  1.79777908E+01  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  5.00062523E+01
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
5.20600815E+01  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  5.20600815E+01
   2  'STATE-VECTOR'       1       20
       2        24       152         5        30       177         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0
   1  'BC-REFL+TRAN'       1        6
       1         2         3         4         5         6
   1  'STATE-VECTOR'       1       20
      18        18         1        14         6         1         1         0
       0         0         2         1         0         0         0         0
       0         0         0         0
   1  'EXCELTRACKOP'       2        3
0.00000000E+00  3.99088216E+00  0.00000000E+00
   1  'MATCOD      '       1       18
       1         1         1         1        10        11        12        13
      14         1        10        11        12        13        14         1
       1         1
```

```
   1  'VOLUME      '       2      18
2.00025009E+02  2.08240326E+02  2.08240326E+02  2.00025009E+02  1.63840163E+00
1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01  7.19111633E+01
1.63840163E+00  1.30234241E+01  2.60686455E+01  4.32043114E+01  5.23943787E+01
7.19111633E+01  2.00025009E+02  2.00025009E+02
   1  'KEYFLX      '       1      18
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15        16
      17        18
   1  'ALBEDO      '       2       6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.13 Test case G22F2DZ5

B.13.1 Geometry description in DRAGON

Contents of file `Geo/G22F2DZ5.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  mth
  ;
*----
*  2-DZ model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR2D 2 1
  EDIT 1
  CELL c1 c2
  X- REFL X+ SYME
  Y- REFL Y+ REFL
  ::: c1 := GEO: CARCEL 2 2 2
    MESHX -28.575  -16.2875 -7.0
    MESHY -14.2875  2.0     14.2875
    OFFCENTER 3.5 0.0
    RADIUS 0.000000 3.600682 6.587482
    MIX
       10  11   1
       10  11   1
       10  11   1
       10  11   1
    ;
  ::: c2 := GEO: CAR2D 1 2
```

```
    MESHX  -7.0       7.0
    MESHY -14.2875  2.0 14.2875
    MIX     1  1
    ;
  ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F2DZ5'
  EDIT  2
  MAXR  100
  TRAK TISO 15 30.0
  ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
TMPVOL TMPTRK := DELETE: TMPVOL TMPTRK ;
*
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F2DZ5'
  EDIT  2
  MAXR  100
  TRAK TISO 7 3.0
  ;
TMPVOL TMPTRK := DELETE: TMPVOL TMPTRK ;
*
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F2DZ5'
  EDIT  1000000
  MAXR  100
  TRAK TISO 2 0.3
  ;
TMPVOL TMPTRK := DELETE: TMPVOL TMPTRK ;
TMPGEO := DELETE: TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.14 Test case G22F3D1

B.14.1 Geometry description in DRAGON

Contents of file `Geo/G22F3D1.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
```

```
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  3-D model 1/Coarse mesh without symmetry
*----
TMPGEO  := GEO:  :: CAR3D 3 1 1
  EDIT 1
  CELL c1 c2 c3
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  Z- REFL Z+ REFL
  ::: c1 := GEO: CARCELZ 5 1 1 1
    MESHX -28.575   -7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX 10  11  12  13  14   1
    ;
  ::: c2 := GEO: CARCELY 5 1 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    RADIUS 0.000000 1.06900 3.62458
           3.81000  4.44500 4.75200
    MIX 2    3   4   6   6   1
    ;
  ::: c3 := GEO: CARCELZ 5 1 1 1
    MESHX   7.0     28.575
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER -3.5 0.0 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX 10  11  12  13  14   1
    ;
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D1'
  EDIT  2
  MAXR  18
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
```

```
*----
END: ;
QUIT "LIST" .
```

B.14.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F3D1.did+gds`

```
     1  'CELL        '       3      36
c1           c2           c3
     1  'GENERATING  '       1       3
         1          2          3
     1  'c1          '       0      -1
     2  'MESHX       '       2       2
 -2.85750008E+01 -7.00000000E+00
     2  'MESHY       '       2       2
 -1.42875004E+01  1.42875004E+01
     2  'MESHZ       '       2       2
 -2.47649994E+01  2.47649994E+01
     2  'OFFCENTER   '       2       3
  3.50000000E+00  0.00000000E+00  0.00000000E+00
     2  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     2  'MIX         '       1       6
        10         11         12         13         14          1
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
        23          5          1          1          1          6         14          0
         0          0          0          0          0          0          0          0
         0          0          0          0
     2  'NCODE       '       1       6
         0          0          0          0          0          0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '       1       6
         0          0          0          0          0          0
     1  'c2          '       0      -1
     2  'MESHX       '       2       2
 -7.00000000E+00  7.00000000E+00
     2  'MESHY       '       2       2
 -1.42875004E+01  1.42875004E+01
     2  'MESHZ       '       2       2
 -2.47649994E+01  2.47649994E+01
     2  'RADIUS      '       2       6
  0.00000000E+00  1.06900001E+00  3.62457991E+00  3.80999994E+00  4.44500017E+00
  4.75199986E+00
     2  'MIX         '       1       6
         2          3          4          6          6          1
```

```
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
        22         5         1         1         1         6         6         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     2  'NCODE       '       1       6
         0         0         0         0         0         0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '       1       6
         0         0         0         0         0         0
     1  'c3          '       0      -1
     2  'MESHX       '       2       2
  7.00000000E+00  2.85750008E+01
     2  'MESHY       '       2       2
 -1.42875004E+01  1.42875004E+01
     2  'MESHZ       '       2       2
 -2.47649994E+01  2.47649994E+01
     2  'OFFCENTER   '       2       3
 -3.50000000E+00  0.00000000E+00  0.00000000E+00
     2  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     2  'MIX         '       1       6
        10        11        12        13        14         1
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
        23         5         1         1         1         6        14         0
         0         0         0         0         0         0         0         0
         0         0         0         0
     2  'NCODE       '       1       6
         0         0         0         0         0         0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
     2  'ICODE       '       1       6
         0         0         0         0         0         0
     1  'SIGNATURE   '       3      12
L_GEOM
     1  'STATE-VECTOR'       1      20
         7         0         3         1         1         3        14         1
         3         0         0         0         0         0         0         0
         0         0         0         0
     1  'NCODE       '       1       6
         2         2         2         2         2         2
     1  'ZCODE       '       2       6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
  1.00000000E+00
     1  'ICODE       '       1       6
         0         0         0         0         0         0
```

B.14.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F3D1.did+tds`

```
      1  'SIGNATURE   '       3      12
L_TRACK
      1  'TRACK-TYPE  '       3      12
EXCELL
      1  'TITLE       '       3      72
Verification model : G22F3D1
      1  'EXCELL      '       0      -1
      2  'MINDIM      '       1       6
          1          5          7          11         18         25
      2  'MAXDIM      '       1       6
          4          6          8          15         22         29
      2  'ICORD       '       1       6
          1          2          3           2          3          3
      2  'INDEX       '       1     252
          3          5          8           0          3          5          8         28
          3          5          8          27          3          5          8         26
          3          5          8          25          3          5          8         24
          3          6          7           0          4          5          7          0
          3          4          7           0          3          5          6          0
          3          5          6          28          3          5          6         27
          3          5          6          26          3          5          6         25
          3          5          6          24          2          6          7          0
          2          6          7          14          2          6          7         13
          2          6          7          12          2          6          7         11
          2          6          7          10          2          5          8          0
          2          5          6           0          2          4          7          0
          2          4          7          14          2          4          7         13
          2          4          7          12          2          4          7         11
          2          4          7          10          1          5          8          0
          1          5          8          21          1          5          8         20
          1          5          8          19          1          5          8         18
          1          5          8          17          1          6          7          0
          0          5          7           0          1          4          7          0
          1          5          6           0          1          5          6         21
          1          5          6          20          1          5          6         19
          1          5          6          18          1          5          6         17
          0          0          0           0          1          5          7         17
          1          5          7          18          1          5          7         19
          1          5          7          20          1          5          7         21
          1          5          7           0          2          5          7         10
          2          5          7          11          2          5          7         12
          2          5          7          13          2          5          7         14
          2          5          7           0          3          5          7         24
          3          5          7          25          3          5          7         26
          3          5          7          27          3          5          7         28
          3          5          7           0
      2  'REMESH      '       2      29
  0.00000000E+00  2.15750008E+01  3.55750008E+01  5.71500015E+01  0.00000000E+00
  2.85750008E+01  0.00000000E+00  4.95299988E+01  2.47649994E+01  2.85750008E+01
  1.14276099E+00  1.31375799E+01  1.45160999E+01  1.97580261E+01  2.25815029E+01
  1.42875004E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00  1.29649115E+01
```

```
2.67172718E+01  4.33949203E+01  4.28625031E+01  1.42875004E+01  5.21519423E-01
4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
   2  'KEYMRG       '       1      63
     -44       -43       -42       -41       -40       -39       -38       -37
     -36       -35       -34       -33       -32       -31       -30       -29
     -28       -27       -26       -25       -24       -23       -22       -21
     -20       -19       -18       -17       -16       -15       -14       -13
     -12       -11       -10        -9        -8        -7        -6        -5
      -4        -3        -2        -1         0         1         2         3
       4         5         6         7         8         9        10        11
      12        13        14        15        16        17        18
   2  'MATALB       '       1      63
      -6        -6        -6        -6        -6        -6        -4        -2
      -3        -5        -5        -5        -5        -5        -5        -4
      -4        -4        -4        -4        -4        -6        -5        -3
      -3        -3        -3        -3        -3        -6        -6        -6
      -6        -6        -6        -4        -1        -3        -5        -5
      -5        -5        -5        -5         0        10        11        12
      13        14         1         2         3         4         6         6
       1        10        11        12        13        14         1
   2  'VOLSUR       '       2      63
1.20044128E+02  1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00
4.09600407E-01  2.67152435E+02  3.53829926E+02  2.67152435E+02  1.20044128E+02
1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01
1.55619522E+02  2.21755409E+00  4.11699867E+00  1.08268738E+00  9.42070961E+00
8.97522390E-01  1.00012505E+02  1.00012505E+02  1.55619522E+02  2.21755409E+00
4.11699867E+00  1.08268738E+00  9.42070961E+00  8.97522390E-01  1.20044128E+02
1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01
2.67152435E+02  3.53829926E+02  2.67152435E+02  1.20044128E+02  1.30985947E+01
1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01  0.00000000E+00
8.11500320E+01  6.45050232E+02  1.29117993E+03  2.13990918E+03  2.59509375E+03
2.37831426E+04  1.02586815E+02  1.07678711E+03  1.23751221E+02  4.70572876E+02
2.53466431E+02  1.77873125E+04  8.11500320E+01  6.45050232E+02  1.29117993E+03
2.13990918E+03  2.59509375E+03  2.37831426E+04
   2  'STATE-VECTOR'       1      20
       3        44        18         6        29        63         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0
   1  'BC-REFL+TRAN'       1      44
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15        16
      17        18        19        20        21        22        23        24
      25        26        27        28        29        30        31        32
      33        34        35        36        37        38        39        40
      41        42        43        44
   1  'STATE-VECTOR'       1      20
      18        18         1        14        44         1         1         0
       0         0         4         1         0         0         0         0
       0         0         0         0
   1  'EXCELTRACKOP'       2       3
0.00000000E+00  3.96595788E+00  0.00000000E+00
   1  'MATCOD       '       1      18
      10        11        12        13        14         1         2         3
       4         6         6         1        10        11        12        13
      14         1
   1  'VOLUME       '       2      18
```

```
8.11500320E+01  6.45050232E+02  1.29117993E+03  2.13990918E+03  2.59509375E+03
2.37831426E+04  1.02586815E+02  1.07678711E+03  1.23751221E+02  4.70572876E+02
2.53466431E+02  1.77873125E+04  8.11500320E+01  6.45050232E+02  1.29117993E+03
2.13990918E+03  2.59509375E+03  2.37831426E+04
   1  'KEYFLX      '       1      18
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15        16
      17        18
   1  'ALBEDO      '       2       6
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
1.00000000E+00
```

B.15 Test case G22F3D2

B.15.1 Geometry description in DRAGON

Contents of file `Geo/G22F3D2.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  3-D model 2/Coarse mesh without symmetry
*              using turn
*----
TMPGEO  := GEO:  :: CAR3D 3 1 1
  EDIT 1
  CELL c1 c2 c1
  TURN A A E
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  Z- REFL Z+ REFL
  ::: c1 := GEO: CARCELZ 5 1 1 1
    MESHX -28.575   -7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX 10  11  12  13  14   1
    ;
  ::: c2 := GEO: CARCELY 5 1 1 1
```

```
      MESHX  -7.0       7.0
      MESHY -14.2875  14.2875
      MESHZ -24.765   24.765
      RADIUS 0.000000 1.06900 3.62458
             3.81000  4.44500 4.75200
      MIX 2    3   4   6   6   1
      ;
    ;
  gds := TMPGEO ;
  TMPVOL TMPTRK := EXCELT: TMPGEO ::
    TITLE  'Verification model : G22F3D2'
    EDIT  2
    MAXR  18
    TRAK TISO 2 4.0
    ;
  tds := TMPVOL ;
  mth := TST: TMPVOL  ::
    EDIT 1  VERIFY MTH   ;
  TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
  *----
  *  END, QUIT
  *----
  END: ;
  QUIT "LIST" .
```

B.15.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F3D2.did+gds`

```
       1  'CELL        '       3      24
  c1           c2
       1  'GENERATING  '       1       3
           1         2         1
       1  'TURN        '       1       3
           1         1         5
       1  'c1          '       0      -1
       2  'MESHX       '       2       2
   -2.85750008E+01 -7.00000000E+00
       2  'MESHY       '       2       2
   -1.42875004E+01  1.42875004E+01
       2  'MESHZ       '       2       2
   -2.47649994E+01  2.47649994E+01
       2  'OFFCENTER   '       2       3
    3.50000000E+00  0.00000000E+00  0.00000000E+00
       2  'RADIUS      '       2       6
    0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
    6.58748198E+00
       2  'MIX         '       1       6
          10         11         12         13         14          1
       2  'SIGNATURE   '       3      12
  L_GEOM
```

```
    2  'STATE-VECTOR'       1       20
       23          5          1          1          1          6         14          0
        0          0          0          0          0          0          0          0
        0          0          0          0
    2  'NCODE       '       1        6
        0          0          0          0          0          0
    2  'ZCODE       '       2        6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
    2  'ICODE       '       1        6
        0          0          0          0          0          0
    1  'c2          '       0       -1
    2  'MESHX       '       2        2
 -7.00000000E+00  7.00000000E+00
    2  'MESHY       '       2        2
 -1.42875004E+01  1.42875004E+01
    2  'MESHZ       '       2        2
 -2.47649994E+01  2.47649994E+01
    2  'RADIUS      '       2        6
  0.00000000E+00  1.06900001E+00  3.62457991E+00  3.80999994E+00  4.44500017E+00
  4.75199986E+00
    2  'MIX         '       1        6
        2          3          4          6          6          1
    2  'SIGNATURE   '       3       12
L_GEOM
    2  'STATE-VECTOR'       1       20
       22          5          1          1          1          6          6          0
        0          0          0          0          0          0          0          0
        0          0          0          0
    2  'NCODE       '       1        6
        0          0          0          0          0          0
    2  'ZCODE       '       2        6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
    2  'ICODE       '       1        6
        0          0          0          0          0          0
    1  'SIGNATURE   '       3       12
L_GEOM
    1  'STATE-VECTOR'       1       20
        7          0          3          1          1          3         14          1
        2          0          0          0          0          0          0          0
        0          0          0          0
    1  'NCODE       '       1        6
        2          2          2          2          2          2
    1  'ZCODE       '       2        6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
  1.00000000E+00
    1  'ICODE       '       1        6
        0          0          0          0          0          0
```

B.15.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F3D2.did+tds`

```
      1  'SIGNATURE   '       3      12
  L_TRACK
      1  'TRACK-TYPE  '       3      12
  EXCELL
      1  'TITLE       '       3      72
  Verification model : G22F3D2
      1  'EXCELL      '       0      -1
      2  'MINDIM      '       1       6
          1          5          7          11         18         25
      2  'MAXDIM      '       1       6
          4          6          8          15         22         29
      2  'ICORD       '       1       6
          1          2          3           2          3          3
      2  'INDEX       '       1     252
          3          5          8           0          3          5          8         28
          3          5          8          27          3          5          8         26
          3          5          8          25          3          5          8         24
          3          6          7           0          4          5          7          0
          3          4          7           0          3          5          6          0
          3          5          6          28          3          5          6         27
          3          5          6          26          3          5          6         25
          3          5          6          24          2          6          7          0
          2          6          7          14          2          6          7         13
          2          6          7          12          2          6          7         11
          2          6          7          10          2          5          8          0
          2          5          6           0          2          4          7          0
          2          4          7          14          2          4          7         13
          2          4          7          12          2          4          7         11
          2          4          7          10          1          5          8          0
          1          5          8          21          1          5          8         20
          1          5          8          19          1          5          8         18
          1          5          8          17          1          6          7          0
          0          5          7           0          1          4          7          0
          1          5          6           0          1          5          6         21
          1          5          6          20          1          5          6         19
          1          5          6          18          1          5          6         17
          0          0          0           0          1          5          7         17
          1          5          7          18          1          5          7         19
          1          5          7          20          1          5          7         21
          1          5          7           0          2          5          7         10
          2          5          7          11          2          5          7         12
          2          5          7          13          2          5          7         14
          2          5          7           0          3          5          7         24
          3          5          7          25          3          5          7         26
          3          5          7          27          3          5          7         28
          3          5          7           0
      2  'REMESH      '       2      29
    0.00000000E+00  2.15750008E+01  3.55750008E+01  5.71500015E+01  0.00000000E+00
    2.85750008E+01  0.00000000E+00  4.95299988E+01  2.47649994E+01  2.85750008E+01
    1.14276099E+00  1.31375799E+01  1.45160999E+01  1.97580261E+01  2.25815029E+01
    1.42875004E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00  1.29649115E+01
    2.67172718E+01  4.33949203E+01  4.28625031E+01  1.42875004E+01  5.21519423E-01
    4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
      2  'KEYMRG      '       1      63
        -44        -43        -42        -41        -40        -39        -38        -37
```

```
      -36       -35       -34       -33       -32       -31       -30       -29
      -28       -27       -26       -25       -24       -23       -22       -21
      -20       -19       -18       -17       -16       -15       -14       -13
      -12       -11       -10        -9        -8        -7        -6        -5
       -4        -3        -2        -1         0         1         2         3
        4         5         6         7         8         9        10        11
       12        13        14        15        16        17        18
    2  'MATALB      '      1       63
       -6        -6        -6        -6        -6        -6        -4        -2
       -3        -5        -5        -5        -5        -5        -5        -4
       -4        -4        -4        -4        -4        -6        -5        -3
       -3        -3        -3        -3        -3        -6        -6        -6
       -6        -6        -6        -4        -1        -3        -5        -5
       -5        -5        -5        -5         0        10        11        12
       13        14         1         2         3         4         6         6
        1        10        11        12        13        14         1
    2  'VOLSUR      '      2       63
 1.20044128E+02  1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00
 4.09600407E-01  2.67152435E+02  3.53829926E+02  2.67152435E+02  1.20044128E+02
 1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01
 1.55619522E+02  2.21755409E+00  4.11699867E+00  1.08268738E+00  9.42070961E+00
 8.97522390E-01  1.00012505E+02  1.00012505E+02  1.55619522E+02  2.21755409E+00
 4.11699867E+00  1.08268738E+00  9.42070961E+00  8.97522390E-01  1.20044128E+02
 1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01
 2.67152435E+02  3.53829926E+02  2.67152435E+02  1.20044128E+02  1.30985947E+01
 1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01  0.00000000E+00
 8.11500320E+01  6.45050232E+02  1.29117993E+03  2.13990918E+03  2.59509375E+03
 2.37831426E+04  1.02586815E+02  1.07678711E+03  1.23751221E+02  4.70572876E+02
 2.53466431E+02  1.77873125E+04  8.11500320E+01  6.45050232E+02  1.29117993E+03
 2.13990918E+03  2.59509375E+03  2.37831426E+04
    2  'STATE-VECTOR'      1       20
        3        44        18         6        29        63         0         0
        0         0         0         0         0         0         0         0
        0         0         0         0
    1  'BC-REFL+TRAN'      1       44
        1         2         3         4         5         6         7         8
        9        10        11        12        13        14        15        16
       17        18        19        20        21        22        23        24
       25        26        27        28        29        30        31        32
       33        34        35        36        37        38        39        40
       41        42        43        44
    1  'STATE-VECTOR'      1       20
       18        18         1        14        44         1         1         0
        0         0         4         1         0         0         0         0
        0         0         0         0
    1  'EXCELTRACKOP'      2        3
 0.00000000E+00  3.96595788E+00  0.00000000E+00
    1  'MATCOD      '      1       18
       10        11        12        13        14         1         2         3
        4         6         6         1        10        11        12        13
       14         1
    1  'VOLUME      '      2       18
 8.11500320E+01  6.45050232E+02  1.29117993E+03  2.13990918E+03  2.59509375E+03
 2.37831426E+04  1.02586815E+02  1.07678711E+03  1.23751221E+02  4.70572876E+02
 2.53466431E+02  1.77873125E+04  8.11500320E+01  6.45050232E+02  1.29117993E+03
 2.13990918E+03  2.59509375E+03  2.37831426E+04
```

```
     1  'KEYFLX       '        1       18
         1          2          3          4          5          6          7          8
         9         10         11         12         13         14         15         16
        17         18
     1  'ALBEDO       '        2        6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
  1.00000000E+00
```

B.16 Test case G22F3D3

B.16.1 Geometry description in DRAGON

Contents of file `Geo/G22F3D3.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  3-D model 3/Coarse mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR3D 2 1 1
  EDIT 1
  CELL c1 c2
  X- REFL X+ SYME
  Y- REFL Y+ SYME
  Z- REFL Z+ SYME
  ::: c1 := GEO: CARCELZ 5 1 1 1
    MESHX -28.575   -7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX 10  11  12  13  14   1
    ;
  ::: c2 := GEO: CARCELY 5 1 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    RADIUS 0.000000 1.06900 3.62458
           3.81000  4.44500 4.75200
    MIX 2    3   4   6   6   1
```

```
    ;
  ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D3'
  EDIT  2
  MAXR  12
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.16.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F3D3.did+gds`

```
     1  'CELL        '       3      24
c1           c2
     1  'GENERATING  '       1       2
         1          2
     1  'c1          '       0      -1
     2  'MESHX       '       2       2
 -2.85750008E+01 -7.00000000E+00
     2  'MESHY       '       2       2
 -1.42875004E+01  1.42875004E+01
     2  'MESHZ       '       2       2
 -2.47649994E+01  2.47649994E+01
     2  'OFFCENTER   '       2       3
  3.50000000E+00  0.00000000E+00  0.00000000E+00
     2  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     2  'MIX         '       1       6
        10         11         12          13         14          1
     2  'SIGNATURE   '       3      12
L_GEOM
     2  'STATE-VECTOR'       1      20
        23          5          1           1          1          6         14          0
         0          0          0           0          0          0          0          0
         0          0          0           0
     2  'NCODE       '       1       6
         0          0          0           0          0          0
     2  'ZCODE       '       2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
```

```
  0.00000000E+00
      2  'ICODE       '        1       6
         0          0          0          0          0          0
      1  'c2          '        0      -1
      2  'MESHX       '        2       2
 -7.00000000E+00  7.00000000E+00
      2  'MESHY       '        2       2
 -1.42875004E+01  1.42875004E+01
      2  'MESHZ       '        2       2
 -2.47649994E+01  2.47649994E+01
      2  'RADIUS      '        2       6
  0.00000000E+00  1.06900001E+00  3.62457991E+00  3.80999994E+00  4.44500017E+00
  4.75199986E+00
      2  'MIX         '        1       6
         2          3          4          6          6          1
      2  'SIGNATURE   '        3      12
L_GEOM
      2  'STATE-VECTOR'        1      20
        22          5          1          1          1          6          6          0
         0          0          0          0          0          0          0          0
         0          0          0          0
      2  'NCODE       '        1       6
         0          0          0          0          0          0
      2  'ZCODE       '        2       6
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00
      2  'ICODE       '        1       6
         0          0          0          0          0          0
      1  'SIGNATURE   '        3      12
L_GEOM
      1  'STATE-VECTOR'        1      20
         7          0          2          1          1          2         14          1
         2          0          0          0          0          0          0          0
         0          0          0          0
      1  'NCODE       '        1       6
         2          5          2          5          2          5
      1  'ZCODE       '        2       6
  1.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  1.00000000E+00
  0.00000000E+00
      1  'ICODE       '        1       6
         0          0          0          0          0          0
```

B.16.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F3D3.did+tds`

```
      1  'SIGNATURE   '        3      12
L_TRACK
      1  'TRACK-TYPE  '        3      12
EXCELL
      1  'TITLE       '        3      72
Verification model : G22F3D3
      1  'EXCELL      '        0      -1
      2  'MINDIM      '        1       6
```

```
        1         5         7        11        18        25
   2  'MAXDIM      '         1        6
        4         6         8        15        22        29
   2  'ICORD       '         1        6
        1         2         3         2         3         3
   2  'INDEX       '         1      252
        3         5         8         0         3         5         8        28
        3         5         8        27         3         5         8        26
        3         5         8        25         3         5         8        24
        3         6         7         0         4         5         7         0
        3         4         7         0         3         5         6         0
        3         5         6        28         3         5         6        27
        3         5         6        26         3         5         6        25
        3         5         6        24         2         6         7         0
        2         6         7        14         2         6         7        13
        2         6         7        12         2         6         7        11
        2         6         7        10         2         5         8         0
        2         5         6         0         2         4         7         0
        2         4         7        14         2         4         7        13
        2         4         7        12         2         4         7        11
        2         4         7        10         1         5         8         0
        1         5         8        21         1         5         8        20
        1         5         8        19         1         5         8        18
        1         5         8        17         1         6         7         0
        0         5         7         0         1         4         7         0
        1         5         6         0         1         5         6        21
        1         5         6        20         1         5         6        19
        1         5         6        18         1         5         6        17
        3         5         7         0         1         5         7        17
        1         5         7        18         1         5         7        19
        1         5         7        20         1         5         7        21
        1         5         7         0         2         5         7        10
        2         5         7        11         2         5         7        12
        2         5         7        13         2         5         7        14
        2         5         7         0         3         5         7        24
        3         5         7        25         3         5         7        26
        3         5         7        27         3         5         7        28
        3         5         7         0
   2  'REMESH      '         2        29
0.00000000E+00  2.15750008E+01  3.55750008E+01  5.71500015E+01  0.00000000E+00
2.85750008E+01  0.00000000E+00  4.95299988E+01  2.47649994E+01  2.85750008E+01
1.14276099E+00  1.31375799E+01  1.45160999E+01  1.97580261E+01  2.25815029E+01
1.42875004E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00  1.29649115E+01
2.67172718E+01  4.33949203E+01  4.28625031E+01  1.42875004E+01  5.21519423E-01
4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
   2  'KEYMRG      '         1        63
      -15       -14       -13       -12       -11       -10        -9        -8
       -9       -15       -14       -13       -12       -11       -10        -7
       -6        -5        -4        -3        -2        -1        -1        -7
       -6        -5        -4        -3        -2       -15       -14       -13
      -12       -11       -10        -9        -8        -9       -15       -14
      -13       -12       -11       -10         0         1         2         3
        4         5         6         7         8         9        10        11
       12         1         2         3         4         5         6
   2  'MATALB      '         1        63
       -6        -6        -6        -6        -6        -6        -4        -2
```

```
         -3          -5          -5          -5          -5          -5          -5          -4
         -4          -4          -4          -4          -4          -6          -5          -3
         -3          -3          -3          -3          -3          -6          -6          -6
         -6          -6          -6          -4          -1          -3          -5          -5
         -5          -5          -5          -5           0          10          11          12
         13          14           1           2           3           4           6           6
          1          10          11          12          13          14           1
      2  'VOLSUR      '        2         63
 1.20044128E+02  1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00
 4.09600407E-01  2.67152435E+02  3.53829926E+02  2.67152435E+02  1.20044128E+02
 1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01
 1.55619522E+02  2.21755409E+00  4.11699867E+00  1.08268738E+00  9.42070961E+00
 8.97522390E-01  1.00012505E+02  1.00012505E+02  1.55619522E+02  2.21755409E+00
 4.11699867E+00  1.08268738E+00  9.42070961E+00  8.97522390E-01  1.20044128E+02
 1.30985947E+01  1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01
 2.67152435E+02  3.53829926E+02  2.67152435E+02  1.20044128E+02  1.30985947E+01
 1.08010778E+01  6.51716137E+00  3.25585604E+00  4.09600407E-01  0.00000000E+00
 8.11500320E+01  6.45050232E+02  1.29117993E+03  2.13990918E+03  2.59509375E+03
 2.37831426E+04  1.02586815E+02  1.07678711E+03  1.23751221E+02  4.70572876E+02
 2.53466431E+02  1.77873125E+04  8.11500320E+01  6.45050232E+02  1.29117993E+03
 2.13990918E+03  2.59509375E+03  2.37831426E+04
      2  'STATE-VECTOR'        1         20
          3          44          18           6          29          63           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0
      1  'BC-REFL+TRAN'        1         15
          1           2           3           4           5           6           7           8
          9          10          11          12          13          14          15
      1  'STATE-VECTOR'        1         20
         12          12           1          14          15           1           1           0
          0           0           4           1           0           0           0           0
          0           0           0           0
      1  'EXCELTRACKOP'        2          3
 0.00000000E+00  3.96595788E+00  0.00000000E+00
      1  'MATCOD      '        1         12
         10          11          12          13          14           1           2           3
          4           6           6           1
      1  'VOLUME      '        2         12
 1.62300064E+02  1.29010046E+03  2.58235986E+03  4.27981836E+03  5.19018750E+03
 4.75662852E+04  1.02586815E+02  1.07678711E+03  1.23751221E+02  4.70572876E+02
 2.53466431E+02  1.77873125E+04
      1  'KEYFLX      '        1         12
          1           2           3           4           5           6           7           8
          9          10          11          12
      1  'ALBEDO      '        2          6
 1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
 1.00000000E+00
```

B.17 Test case G22F3D4

B.17.1 Geometry description in DRAGON

Contents of file `Geo/G22F3D4.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  gds tds mth psp
  ;
*----
*  3-D model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR3D 2 1 1
  EDIT 1
  CELL c1 c2
  X- REFL X+ SYME
  Y- REFL Y+ SYME
  Z- REFL Z+ SYME
  ::: c1 := GEO: CARCELZ 5 3 1 3
    MESHX -28.575  -21.575 -14.2875 -7.0
    MESHY -14.2875  14.2875
    SPLITY 4
    MESHZ -24.765  -7.0 7.0 24.765
    SPLITZ 2 2 2
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 0.722163 2.160325
           3.600682 5.168875 6.587482
    MIX
       10  11  12  13  14   1
       10  11  12  13  14   1
       10  11  12  13  14   1

       10  11  12  13  14   1
       10  11  12  13  14   1
       10  11  12  13  14   1

       10  11  12  13  14   1
       10  11  12  13  14   1
       10  11  12  13  14   1
    ;
  ::: c2 := GEO: CARCELY 5 1 1 3
    MESHX  -7.0       7.0
    SPLITX  2
    MESHY -14.2875  14.2875
    SPLITY  4
    MESHZ -24.765  -7.0 7.0 24.765
    SPLITZ 2 2 2
    RADIUS 0.000000 1.06900 3.62458
           3.81000  4.44500 4.75200
    MIX
```

```
        2    3   4   6   6   1
        2    3   4   6   6   1
        2    3   4   6   6   1
     ;
   ;
gds := TMPGEO ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D4'
  EDIT  2
  MAXR  1500
  TRAK TISO 2 4.0
  ;
tds := TMPVOL ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
TMPVOL TMPTRK TMPGEO := DELETE: TMPVOL TMPTRK TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.17.2 Associated GEOMETRY *data structure generated by the* `GEO:` *module*

Contents of file `Geo/G22F3D4.did+gds`

```
     1  'CELL        '       3      24
c1           c2
     1  'GENERATING  '       1       2
         1          2
     1  'c1          '       0      -1
     2  'MESHX       '       2       4
 -2.85750008E+01 -2.15750008E+01 -1.42875004E+01 -7.00000000E+00
     2  'MESHY       '       2       2
 -1.42875004E+01  1.42875004E+01
     2  'SPLITY      '       1       1
         4
     2  'MESHZ       '       2       4
 -2.47649994E+01 -7.00000000E+00  7.00000000E+00  2.47649994E+01
     2  'SPLITZ      '       1       3
         2          2          2
     2  'OFFCENTER   '       2       3
  3.50000000E+00  0.00000000E+00  0.00000000E+00
     2  'RADIUS      '       2       6
  0.00000000E+00  7.22163022E-01  2.16032505E+00  3.60068202E+00  5.16887522E+00
  6.58748198E+00
     2  'MIX         '       1      54
        10         11         12         13         14          1         10         11
        12         13         14          1         10         11         12         13
        14          1         10         11         12         13         14          1
        10         11         12         13         14          1         10         11
```

```
          12          13          14           1          10          11          12          13
          14           1          10          11          12          13          14           1
          10          11          12          13          14           1
      2  'SIGNATURE   '        3       12
  L_GEOM
      2  'STATE-VECTOR'        1       20
          23           5           3           1           3          54          14           0
           0           0           1           0           0           0           0           0
           0           0           0           0
      2  'NCODE       '        1        6
           0           0           0           0           0           0
      2  'ZCODE       '        2        6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
      2  'ICODE       '        1        6
           0           0           0           0           0           0
      1  'c2          '        0       -1
      2  'MESHX       '        2        2
   -7.00000000E+00  7.00000000E+00
      2  'SPLITX      '        1        1
           2
      2  'MESHY       '        2        2
   -1.42875004E+01  1.42875004E+01
      2  'SPLITY      '        1        1
           4
      2  'MESHZ       '        2        4
   -2.47649994E+01 -7.00000000E+00  7.00000000E+00  2.47649994E+01
      2  'SPLITZ      '        1        3
           2           2           2
      2  'RADIUS      '        2        6
    0.00000000E+00  1.06900001E+00  3.62457991E+00  3.80999994E+00  4.44500017E+00
    4.75199986E+00
      2  'MIX         '        1       18
           2           3           4           6           6           1           2           3
           4           6           6           1           2           3           4           6
           6           1
      2  'SIGNATURE   '        3       12
  L_GEOM
      2  'STATE-VECTOR'        1       20
          22           5           1           1           3          18           6           0
           0           0           1           0           0           0           0           0
           0           0           0           0
      2  'NCODE       '        1        6
           0           0           0           0           0           0
      2  'ZCODE       '        2        6
    0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    0.00000000E+00
      2  'ICODE       '        1        6
           0           0           0           0           0           0
      1  'SIGNATURE   '        3       12
  L_GEOM
      1  'STATE-VECTOR'        1       20
           7           0           2           1           1           2          14           1
           2           0           0           0           0           0           0           0
           0           0           0           0
      1  'NCODE       '        1        6
```

```
          2           5           2           5           2           5
      1  'ZCODE       '         2        6
   1.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  1.00000000E+00
   0.00000000E+00
      1  'ICODE       '         1        6
          0           0           0           0           0           0
```

B.17.3 Associated TRACKING *data structure generated by the* `EXCELT:` *module*

Contents of file `Geo/G22F3D4.did+tds`

```
      1  'SIGNATURE   '         3       12
 L_TRACK
      1  'TRACK-TYPE  '         3       12
 EXCELL
      1  'TITLE       '         3       72
 Verification model : G22F3D4
      1  'EXCELL      '         0       -1
      2  'MINDIM      '         1        6
          1          10          15          24          31          38
      2  'MAXDIM      '         1        6
          9          14          21          28          35          42
      2  'ICORD       '         1        6
          1           2           3           2           3           3
      2  'INDEX       '         1     6884
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
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          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
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          0           0           0           0           0           0           0           0
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          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
          0           0           0           0           0           0           0           0
```

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8	13	21	0	6	12	21	0
6	12	21	41	6	12	21	40
6	12	21	39	6	12	21	38
6	12	21	37	7	12	21	0
7	12	21	41	7	12	21	40
7	12	21	39	7	12	21	38
7	12	21	37	8	12	21	0
6	11	21	0	6	11	21	41
6	11	21	40	6	11	21	39
6	11	21	38	6	11	21	37
7	11	21	0	7	11	21	41
7	11	21	40	7	11	21	39
7	11	21	38	7	11	21	37
8	11	21	0	6	10	21	0
7	10	21	0	8	10	21	0
6	14	20	0	7	14	20	0
8	14	20	0	9	13	20	0
9	12	20	0	9	11	20	0
9	10	20	0	6	9	20	0
7	9	20	0	8	9	20	0

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8	14	19	0	9	13	19	0
9	12	19	0	9	11	19	0
9	10	19	0	6	9	19	0
7	9	19	0	8	9	19	0
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9	10	18	0	6	9	18	0
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6	14	17	0	7	14	17	0
8	14	17	0	9	13	17	0
9	12	17	0	9	11	17	0
9	10	17	0	6	9	17	0
7	9	17	0	8	9	17	0
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9	10	15	0	6	9	15	0
7	9	15	0	8	9	15	0
6	13	14	0	7	13	14	0
8	13	14	0	6	12	14	0
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6	12	14	39	6	12	14	38
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7	12	14	41	7	12	14	40
7	12	14	39	7	12	14	38
7	12	14	37	8	12	14	0
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6	11	14	40	6	11	14	39
6	11	14	38	6	11	14	37
7	11	14	0	7	11	14	41
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7	11	14	38	7	11	14	37
8	11	14	0	6	10	14	0
7	10	14	0	8	10	14	0
5	14	20	0	5	14	19	0
5	14	18	0	5	14	18	27
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5	14	18	24	5	14	18	23
5	14	17	0	5	14	17	27
5	14	17	26	5	14	17	25
5	14	17	24	5	14	17	23
5	14	16	0	5	14	15	0
4	14	20	0	4	14	19	0
4	14	18	0	4	14	18	27
4	14	18	26	4	14	18	25
4	14	18	24	4	14	18	23
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4	14	17	26	4	14	17	25
4	14	17	24	4	14	17	23

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4	13	21	0	4	13	14	0
5	12	21	0	5	12	14	0
4	12	21	0	4	12	14	0
5	11	21	0	5	11	14	0
4	11	21	0	4	11	14	0
5	10	21	0	5	10	14	0
4	10	21	0	4	10	14	0
5	9	20	0	5	9	19	0
5	9	18	0	5	9	18	27
5	9	18	26	5	9	18	25
5	9	18	24	5	9	18	23
5	9	17	0	5	9	17	27
5	9	17	26	5	9	17	25
5	9	17	24	5	9	17	23
5	9	16	0	5	9	15	0
4	9	20	0	4	9	19	0
4	9	18	0	4	9	18	27
4	9	18	26	4	9	18	25
4	9	18	24	4	9	18	23
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4	9	17	26	4	9	17	25
4	9	17	24	4	9	17	23
4	9	16	0	4	9	15	0
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1	13	21	0	3	12	21	0
3	12	21	34	3	12	21	33
3	12	21	32	3	12	21	31
3	12	21	30	2	12	21	0
2	12	21	34	2	12	21	33
2	12	21	32	2	12	21	31
2	12	21	30	1	12	21	0
3	11	21	0	3	11	21	34
3	11	21	33	3	11	21	32
3	11	21	31	3	11	21	30
2	11	21	0	2	11	21	34
2	11	21	33	2	11	21	32
2	11	21	31	2	11	21	30
1	11	21	0	3	10	21	0
2	10	21	0	1	10	21	0
3	14	20	0	2	14	20	0
1	14	20	0	0	13	20	0
0	12	20	0	0	11	20	0
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3	14	18	0	2	14	18	0
1	14	18	0	0	13	18	0
0	12	18	0	0	11	18	0
0	10	18	0	3	9	18	0
2	9	18	0	1	9	18	0

3	14	17	0	2	14	17	0
1	14	17	0	0	13	17	0
0	12	17	0	0	11	17	0
0	10	17	0	3	9	17	0
2	9	17	0	1	9	17	0
3	14	16	0	2	14	16	0
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0	10	16	0	3	9	16	0
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3	14	15	0	2	14	15	0
1	14	15	0	0	13	15	0
0	12	15	0	0	11	15	0
0	10	15	0	3	9	15	0
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3	13	14	0	2	13	14	0
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3	12	14	34	3	12	14	33
3	12	14	32	3	12	14	31
3	12	14	30	2	12	14	0
2	12	14	34	2	12	14	33
2	12	14	32	2	12	14	31
2	12	14	30	1	12	14	0
3	11	14	0	3	11	14	34
3	11	14	33	3	11	14	32
3	11	14	31	3	11	14	30
2	11	14	0	2	11	14	34
2	11	14	33	2	11	14	32
2	11	14	31	2	11	14	30
1	11	14	0	3	10	14	0
2	10	14	0	1	10	14	0
6	13	15	0	0	0	0	0
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3	10	15	0	0	0	0	0
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0	0	0	0	0	0	0	0
1	11	15	0	2	11	15	30
2	11	15	31	2	11	15	32
2	11	15	33	2	11	15	34
2	11	15	0	3	11	15	30
3	11	15	31	3	11	15	32
3	11	15	33	3	11	15	34
3	11	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	12	15	0	2	12	15	30
2	12	15	31	2	12	15	32
2	12	15	33	2	12	15	34
2	12	15	0	3	12	15	30

3	12	15	31	3	12	15	32
3	12	15	33	3	12	15	34
3	12	15	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	13	15	0	0	0	0	0
0	0	0	0	0	0	0	0
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3	13	15	0	0	0	0	0
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1	10	16	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
2	10	16	0	0	0	0	0
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3	10	16	0	0	0	0	0
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0	0	0	0	0	0	0	0
1	11	16	0	2	11	16	30
2	11	16	31	2	11	16	32
2	11	16	33	2	11	16	34
2	11	16	0	3	11	16	30
3	11	16	31	3	11	16	32
3	11	16	33	3	11	16	34
3	11	16	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	12	16	0	2	12	16	30
2	12	16	31	2	12	16	32
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3	12	16	31	3	12	16	32
3	12	16	33	3	12	16	34
3	12	16	0	0	0	0	0
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3	13	16	0	0	0	0	0
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1	10	17	0	0	0	0	0
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1	11	17	0	2	11	17	30
2	11	17	31	2	11	17	32
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3	11	17	31	3	11	17	32
3	11	17	33	3	11	17	34
3	11	17	0	0	0	0	0
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3.55750008E+01  4.28625031E+01  5.01500015E+01  5.71500015E+01  0.00000000E+00
7.14375019E+00  1.42875004E+01  2.14312515E+01  2.85750008E+01  0.00000000E+00
8.88249969E+00  1.77649994E+01  2.47649994E+01  3.17649994E+01  4.06474991E+01
4.95299988E+01  2.47649994E+01  2.85750008E+01  1.14276099E+00  1.31375799E+01
1.45160999E+01  1.97580261E+01  2.25815029E+01  1.42875004E+01  1.42875004E+01
5.21519423E-01  4.66700411E+00  1.29649115E+01  2.67172718E+01  4.33949203E+01
```

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4.28625031E+01  1.42875004E+01  5.21519423E-01  4.66700411E+00  1.29649115E+01
2.67172718E+01  4.33949203E+01
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           0           0           1          10          11          12          13          14
           1          10          11          12          13          14           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1           0           0           0           0           0           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1          10          11          12          13          14           1          10
          11          12          13          14           1           0           0           0
           0           0           1          10          11          12          13          14
           1          10          11          12          13          14           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1           0           0           0           0           0           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1          10          11          12          13          14           1          10
          11          12          13          14           1           0           0           0
           0           0           1          10          11          12          13          14
           1          10          11          12          13          14           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1           0           0           0           0           0           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1          10          11          12          13          14           1          10
          11          12          13          14           1           0           0           0
           0           0           1          10          11          12          13          14
           1          10          11          12          13          14           1           0
           0           0           0           0           1           0           0           0
           0           0           1           0           0           0           0           0
           1
   2  'VOLSUR      '       2    1721
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
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  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
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  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
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0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
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0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
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0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
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1.30150204E+01	1.30150204E+01	1.25015631E+01	4.49444771E+00	3.27464867E+00
2.70026946E+00	1.62929034E+00	8.13964009E-01	1.02400102E-01	4.49444771E+00
3.27464867E+00	2.70026946E+00	1.62929034E+00	8.13964009E-01	1.02400102E-01
1.25015631E+01	4.49444771E+00	3.27464867E+00	2.70026946E+00	1.62929034E+00
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1.62929034E+00	8.13964009E-01	1.02400102E-01	1.25015631E+01	1.30150204E+01
1.30150204E+01	1.25015631E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01
1.61828041E+01	1.55443745E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01
1.61828041E+01	1.55443745E+01	1.27531261E+01	1.27531261E+01	1.22500000E+01
1.25015631E+01	1.25015631E+01	1.25015631E+01	1.25015631E+01	1.27531261E+01
1.27531261E+01	1.22500000E+01	1.27531261E+01	1.27531261E+01	1.22500000E+01
1.25015631E+01	1.25015631E+01	1.25015631E+01	1.25015631E+01	1.27531261E+01
1.27531261E+01	1.22500000E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01
1.61828041E+01	1.55443745E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01
1.61828041E+01	1.55443745E+01	1.30150204E+01	1.30150204E+01	1.25015631E+01

4.49444771E+00	3.27464867E+00	2.70026946E+00	1.62929034E+00	8.13964009E-01
1.02400102E-01	4.49444771E+00	3.27464867E+00	2.70026946E+00	1.62929034E+00
8.13964009E-01	1.02400102E-01	1.25015631E+01	4.49444771E+00	3.27464867E+00
2.70026946E+00	1.62929034E+00	8.13964009E-01	1.02400102E-01	4.49444771E+00
3.27464867E+00	2.70026946E+00	1.62929034E+00	8.13964009E-01	1.02400102E-01
1.25015631E+01	1.30150204E+01	1.30150204E+01	1.25015631E+01	1.55443745E+01
1.55443745E+01	7.81613207E+00	5.54388523E-01	1.02924967E+00	2.70671844E-01
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2.70671844E-01	2.35517740E+00	2.24380597E-01	1.55443745E+01	1.55443745E+01
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1.25015631E+01	1.25015631E+01	1.25015631E+01	1.25015631E+01	1.25015631E+01
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1.25015631E+01	1.25015631E+01	1.55443745E+01	1.55443745E+01	7.81613207E+00
5.54388523E-01	1.02924967E+00	2.70671844E-01	2.35517740E+00	2.24380597E-01
7.81613207E+00	5.54388523E-01	1.02924967E+00	2.70671844E-01	2.35517740E+00
2.24380597E-01	1.55443745E+01	1.55443745E+01	1.55443745E+01	1.55443745E+01
7.81613207E+00	5.54388523E-01	1.02924967E+00	2.70671844E-01	2.35517740E+00
2.24380597E-01	7.81613207E+00	5.54388523E-01	1.02924967E+00	2.70671844E-01
2.35517740E+00	2.24380597E-01	1.55443745E+01	1.55443745E+01	1.30150204E+01
1.30150204E+01	1.25015631E+01	4.49444771E+00	3.27464867E+00	2.70026946E+00
1.62929034E+00	8.13964009E-01	1.02400102E-01	4.49444771E+00	3.27464867E+00
2.70026946E+00	1.62929034E+00	8.13964009E-01	1.02400102E-01	1.25015631E+01
4.49444771E+00	3.27464867E+00	2.70026946E+00	1.62929034E+00	8.13964009E-01
1.02400102E-01	4.49444771E+00	3.27464867E+00	2.70026946E+00	1.62929034E+00
8.13964009E-01	1.02400102E-01	1.25015631E+01	1.30150204E+01	1.30150204E+01
1.25015631E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01	1.58635893E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01	1.61828041E+01
1.55443745E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01	1.58635893E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01	1.61828041E+01
1.55443745E+01	1.27531261E+01	1.27531261E+01	1.22500000E+01	1.25015631E+01
1.25015631E+01	1.25015631E+01	1.25015631E+01	1.27531261E+01	1.27531261E+01
1.22500000E+01	1.27531261E+01	1.27531261E+01	1.22500000E+01	1.25015631E+01
1.25015631E+01	1.25015631E+01	1.25015631E+01	1.27531261E+01	1.27531261E+01
1.22500000E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01	1.58635893E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01	1.61828041E+01
1.55443745E+01	1.61828041E+01	1.61828041E+01	1.55443745E+01	1.58635893E+01
1.58635893E+01	1.58635893E+01	1.58635893E+01	1.61828041E+01	1.61828041E+01
1.55443745E+01	1.30150204E+01	1.30150204E+01	1.25015631E+01	4.49444771E+00
3.27464867E+00	2.70026946E+00	1.62929034E+00	8.13964009E-01	1.02400102E-01
4.49444771E+00	3.27464867E+00	2.70026946E+00	1.62929034E+00	8.13964009E-01
1.02400102E-01	1.25015631E+01	4.49444771E+00	3.27464867E+00	2.70026946E+00
1.62929034E+00	8.13964009E-01	1.02400102E-01	4.49444771E+00	3.27464867E+00
2.70026946E+00	1.62929034E+00	8.13964009E-01	1.02400102E-01	1.25015631E+01
1.30150204E+01	1.30150204E+01	1.25015631E+01	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
4.62423676E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	4.62423676E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	4.44180511E+02	3.63827538E+00	2.89201431E+01
5.78886871E+01	9.59405746E+01	1.16348251E+02	1.59687744E+02	3.63827538E+00
2.89201431E+01	5.78886871E+01	9.59405746E+01	1.16348251E+02	1.59687744E+02
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1.16348251E+02  1.59687744E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01
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1.16348251E+02  1.59687744E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
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9.59405746E+01  1.16348251E+02  1.59687744E+02  0.00000000E+00  0.00000000E+00
```

0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02	3.63827538E+00
2.89201431E+01	5.78886871E+01	9.59405746E+01	1.16348251E+02	1.59687744E+02
3.63827538E+00	2.89201431E+01	5.78886871E+01	9.59405746E+01	1.16348251E+02
1.59687744E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	4.44180511E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	4.62423676E+02	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	4.62423676E+02	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
4.62423676E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	4.62423676E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	4.44180511E+02	3.63827538E+00	2.89201431E+01
5.78886871E+01	9.59405746E+01	1.16348251E+02	1.59687744E+02	3.63827538E+00
2.89201431E+01	5.78886871E+01	9.59405746E+01	1.16348251E+02	1.59687744E+02
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
4.44180511E+02	3.63827538E+00	2.89201431E+01	5.78886871E+01	9.59405746E+01
1.16348251E+02	1.59687744E+02	3.63827538E+00	2.89201431E+01	5.78886871E+01
9.59405746E+01	1.16348251E+02	1.59687744E+02	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	4.62423676E+02
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
4.62423676E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	4.44180511E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	4.44180511E+02	6.41167593E+00	6.72991943E+01
7.73445129E+00	2.94108047E+01	1.58416519E+01	2.23345978E+02	6.41167593E+00
6.72991943E+01	7.73445129E+00	2.94108047E+01	1.58416519E+01	2.23345978E+02
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
4.44180511E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	4.44180511E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	4.44180511E+02	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02	6.41167593E+00
6.72991943E+01	7.73445129E+00	2.94108047E+01	1.58416519E+01	2.23345978E+02
6.41167593E+00	6.72991943E+01	7.73445129E+00	2.94108047E+01	1.58416519E+01
2.23345978E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	4.44180511E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	4.44180511E+02	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02
6.41167593E+00	6.72991943E+01	7.73445129E+00	2.94108047E+01	1.58416519E+01
2.23345978E+02	6.41167593E+00	6.72991943E+01	7.73445129E+00	2.94108047E+01
1.58416519E+01	2.23345978E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	4.44180511E+02	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
4.44180511E+02	6.41167593E+00	6.72991943E+01	7.73445129E+00	2.94108047E+01
1.58416519E+01	2.23345978E+02	6.41167593E+00	6.72991943E+01	7.73445129E+00
2.94108047E+01	1.58416519E+01	2.23345978E+02	0.00000000E+00	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
4.44180511E+02	0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00
0.00000000E+00	4.44180511E+02	6.41167593E+00	6.72991943E+01	7.73445129E+00
2.94108047E+01	1.58416519E+01	2.23345978E+02	6.41167593E+00	6.72991943E+01
7.73445129E+00	2.94108047E+01	1.58416519E+01	2.23345978E+02	0.00000000E+00
0.00000000E+00	0.00000000E+00	0.00000000E+00	0.00000000E+00	4.44180511E+02

```
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  6.41167593E+00  6.72991943E+01
7.73445129E+00  2.94108047E+01  1.58416519E+01  2.23345978E+02  6.41167593E+00
6.72991943E+01  7.73445129E+00  2.94108047E+01  1.58416519E+01  2.23345978E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02  6.41167593E+00
6.72991943E+01  7.73445129E+00  2.94108047E+01  1.58416519E+01  2.23345978E+02
6.41167593E+00  6.72991943E+01  7.73445129E+00  2.94108047E+01  1.58416519E+01
2.23345978E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02
6.41167593E+00  6.72991943E+01  7.73445129E+00  2.94108047E+01  1.58416519E+01
2.23345978E+02  6.41167593E+00  6.72991943E+01  7.73445129E+00  2.94108047E+01
1.58416519E+01  2.23345978E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.62423676E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.62423676E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  3.63827538E+00  2.89201431E+01
5.78886871E+01  9.59405746E+01  1.16348251E+02  1.59687744E+02  3.63827538E+00
2.89201431E+01  5.78886871E+01  9.59405746E+01  1.16348251E+02  1.59687744E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.44180511E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01  9.59405746E+01
1.16348251E+02  1.59687744E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01
9.59405746E+01  1.16348251E+02  1.59687744E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.62423676E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.62423676E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.62423676E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.62423676E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02
3.63827538E+00  2.89201431E+01  5.78886871E+01  9.59405746E+01  1.16348251E+02
1.59687744E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01  9.59405746E+01
1.16348251E+02  1.59687744E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  3.63827538E+00  2.89201431E+01
5.78886871E+01  9.59405746E+01  1.16348251E+02  1.59687744E+02  3.63827538E+00
2.89201431E+01  5.78886871E+01  9.59405746E+01  1.16348251E+02  1.59687744E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.62423676E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.62423676E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  3.50043762E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  3.64420563E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
3.64420563E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
```

```
0.00000000E+00  3.50043762E+02  2.86720276E+00  2.27909927E+01  4.56201324E+01
7.56075363E+01  9.16901703E+01  1.25844528E+02  2.86720276E+00  2.27909927E+01
4.56201324E+01  7.56075363E+01  9.16901703E+01  1.25844528E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  3.50043762E+02
2.86720276E+00  2.27909927E+01  4.56201324E+01  7.56075363E+01  9.16901703E+01
1.25844528E+02  2.86720276E+00  2.27909927E+01  4.56201324E+01  7.56075363E+01
9.16901703E+01  1.25844528E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  3.50043762E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  3.64420563E+02  0.00000000E+00
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0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
3.50043762E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  3.64420563E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  3.64420563E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  3.50043762E+02  2.86720276E+00
2.27909927E+01  4.56201324E+01  7.56075363E+01  9.16901703E+01  1.25844528E+02
2.86720276E+00  2.27909927E+01  4.56201324E+01  7.56075363E+01  9.16901703E+01
1.25844528E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  3.50043762E+02  2.86720276E+00  2.27909927E+01  4.56201324E+01
7.56075363E+01  9.16901703E+01  1.25844528E+02  2.86720276E+00  2.27909927E+01
4.56201324E+01  7.56075363E+01  9.16901703E+01  1.25844528E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  3.50043762E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
3.64420563E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  3.64420563E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.62423676E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.62423676E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.44180511E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01  9.59405746E+01
1.16348251E+02  1.59687744E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01
9.59405746E+01  1.16348251E+02  1.59687744E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02  3.63827538E+00
2.89201431E+01  5.78886871E+01  9.59405746E+01  1.16348251E+02  1.59687744E+02
3.63827538E+00  2.89201431E+01  5.78886871E+01  9.59405746E+01  1.16348251E+02
1.59687744E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.44180511E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.62423676E+02  0.00000000E+00  0.00000000E+00
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0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.62423676E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  4.62423676E+02  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.44180511E+02  3.63827538E+00  2.89201431E+01
5.78886871E+01  9.59405746E+01  1.16348251E+02  1.59687744E+02  3.63827538E+00
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0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.44180511E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01  9.59405746E+01
1.16348251E+02  1.59687744E+02  3.63827538E+00  2.89201431E+01  5.78886871E+01
9.59405746E+01  1.16348251E+02  1.59687744E+02  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  4.44180511E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.62423676E+02
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
4.62423676E+02
   2  'STATE-VECTOR'       1      20
       3       568      1152         6        42      1721          0          0
```

```
         0           0           0           0           0           0           0           0
         0           0           0           0
     1  'BC-REFL+TRAN'       1      41
         1           2           3           4           5           6           7           8
         9          10          11          12          13          14          15          16
        17          18          19          20          21          22          23          24
        25          26          27          28          29          30          31          32
        33          34          35          36          37          38          39          40
        41
     1  'STATE-VECTOR'       1      20
        64          64           1          14          41           1           1           0
         0           0           4           1           0           0           0           0
         0           0           0           0
     1  'EXCELTRACKOP'       2       3
 0.00000000E+00  3.96595788E+00  0.00000000E+00
     1  'MATCOD      '       1      64
         1           1           1           1          10          11          12          13
        14           1          10          11          12          13          14           1
         1           1           1           1          10          11          12          13
        14           1          10          11          12          13          14           1
         1           1           1           1          10          11          12          13
        14           1          10          11          12          13          14           1
         1           1           2           3           4           6           6           1
         1           1           2           3           4           6           6           1
     1  'VOLUME      '       2      64
 3.55344385E+03  3.69938916E+03  3.69938916E+03  3.55344385E+03  2.91062031E+01
 2.31361115E+02  4.63109436E+02  7.67524536E+02  9.30786072E+02  1.27750195E+03
 2.91062031E+01  2.31361115E+02  4.63109436E+02  7.67524536E+02  9.30786072E+02
 1.27750195E+03  3.55344385E+03  3.69938916E+03  3.69938916E+03  3.55344385E+03
 2.91062031E+01  2.31361115E+02  4.63109436E+02  7.67524536E+02  9.30786072E+02
 1.27750195E+03  2.91062031E+01  2.31361115E+02  4.63109436E+02  7.67524536E+02
 9.30786072E+02  1.27750195E+03  2.80034985E+03  2.91536475E+03  2.91536475E+03
 2.80034985E+03  2.29376221E+01  1.82327942E+02  3.64961060E+02  6.04860291E+02
 7.33521423E+02  1.00675629E+03  2.29376221E+01  1.82327942E+02  3.64961060E+02
 6.04860291E+02  7.33521423E+02  1.00675629E+03  3.55344385E+03  3.55344385E+03
 5.12934036E+01  5.38393555E+02  6.18756104E+01  2.35286407E+02  1.26733215E+02
 1.78676770E+03  3.55344385E+03  3.55344385E+03  5.12934036E+01  5.38393555E+02
 6.18756104E+01  2.35286407E+02  1.26733215E+02  1.78676770E+03
     1  'KEYFLX      '       1      64
         1           2           3           4           5           6           7           8
         9          10          11          12          13          14          15          16
        17          18          19          20          21          22          23          24
        25          26          27          28          29          30          31          32
        33          34          35          36          37          38          39          40
        41          42          43          44          45          46          47          48
        49          50          51          52          53          54          55          56
        57          58          59          60          61          62          63          64
     1  'ALBEDO      '       2       6
 1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
 1.00000000E+00
```

B.18 Test case G22F3D5

B.18.1 Geometry description in DRAGON

Contents of file `Geo/G22F3D5.did`

```
MODULE
  GEO:  EXCELT:  PSP:
  TST:  DELETE:  END:
  ;
LINKED_LIST
  TMPGEOR
  TMPGEO  TMPVOL
  ;
SEQ_BINARY
  TMPTRK
  ;
SEQ_ASCII
  mth
  ;
*----
*  3-D model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR3D 2 1 1
  EDIT 1
  CELL c1 c2
  X- REFL X+ SYME
  Y- REFL Y+ REFL
  Z- REFL Z+ REFL
  ::: c1 := GEO: CARCELZ 2 2 2 1
    MESHX -28.575  -16.2875 -7.0
    MESHY -14.2875  2.0 14.2875
    MESHZ -24.765   24.765
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 3.600682 6.587482
    MIX
       10  11  1
       10  11  1
       10  11  1
       10  11  1
    ;
  ::: c2 := GEO: CARCELY 2 1 2 1
    MESHX  -7.0       7.0
    MESHY -14.2875  2.0 14.2875
    MESHZ -24.765   24.765
    RADIUS 0.000000 3.62458 4.75200
    MIX
       2    3    1
       2    3    1
    ;
  ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D5'
```

```
  EDIT  2
  MAXR  30
  TRAK TISO 4 25.0
  ;
mth := TST: TMPVOL  ::
  EDIT 1  VERIFY MTH   ;
*
TMPTRK TMPVOL := DELETE: TMPTRK TMPVOL ;
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D5'
  EDIT  2
  MAXR  30
  TRAK TISO 4 10.0
  ;
TMPTRK TMPVOL := DELETE: TMPTRK TMPVOL ;
*
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D5'
  EDIT  2
  MAXR  30
  TRAK TISO 4 1.0
  ;
TMPTRK TMPVOL := DELETE: TMPTRK TMPVOL ;
*
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D5'
  EDIT  2
  MAXR  30
  TRAK TISO 4 0.1
  ;
TMPTRK TMPVOL := DELETE: TMPTRK TMPVOL ;
*
TMPVOL TMPTRK := EXCELT: TMPGEO ::
  TITLE  'Verification model : G22F3D5'
  EDIT  1000000
  MAXR  30
  TRAK TISO 2 0.01
  ;
TMPTRK TMPVOL := DELETE: TMPTRK TMPVOL ;
TMPGEO := DELETE: TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.19 Test case T2D

B.19.1 Geometry description, tracking and CP integration

Contents of file `Geo/T2DT.did`

```
MODULE
  GEO:  EXCELT:  ASM:
  DELETE:  END:
  ;
LINKED_LIST
  TMPGEO TMPVOL TMPMAC TMPPIJ
  ;
SEQ_BINARY
  TRKFIL
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  MAC2G
  ;
*----
*  Files created in this procedure
*----
SEQ_ASCII
  VOLTRK
  PIJMATLEA PIJMATSTD PIJMATSMD
  ;
*----
*  2-DZ model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR2D 3 1
  EDIT 1
  CELL c1 c2 c3
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  ::: c1 := GEO: CARCEL 2 2 1
    MESHX -28.575  -14.2875 -7.0
    MESHY -14.2875  14.2875
    OFFCENTER 3.5 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   5   11
       1   5   11
    ;
  ::: c2 := GEO: CAR2D 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MIX     11
    ;
  ::: c3 := GEO: CARCEL 2 2 1
    MESHX   7.0    14.2875  28.575
    MESHY -14.2875 14.2875
    OFFCENTER -3.5 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   5   11
       1   5   11
    ;
  ;
```

```
TMPVOL TRKFIL := EXCELT: TMPGEO ::
  TITLE  'Verification model : T2D'
  EDIT  2
  MAXR  13
  TRAK TISO 15 30.0
  ;
VOLTRK := TMPVOL ;
*----
*  Restore 'macrolib' structure from MAC2G
*----
TMPMAC :=  MAC2G ;
*----
*  Evaluate 'asmpij' structure
*  option 1: no scattering reduction
*            no normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TRKFIL  ::
  EDIT 100 SKIP PNOR NONE ;
PIJMATLEA :=  TMPPIJ ;
TMPPIJ := DELETE: TMPPIJ  ;
*----
*  Evaluate 'asmpij' structure
*  option 2: no scattering reduction
*            with normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TRKFIL  ::
  EDIT 100 SKIP ;
PIJMATSTD :=  TMPPIJ ;
TMPPIJ := DELETE: TMPPIJ ;
*----
*  Evaluate 'asmpij' structure
*  option 3: with scattering reduction
*            with normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TRKFIL  ::
  EDIT 100 ;
PIJMATSMD :=  TMPPIJ ;
TMPPIJ := DELETE: TMPPIJ ;
*
TMPMAC := DELETE: TMPMAC ;
TMPVOL := DELETE: TMPVOL ;
TRKFIL := DELETE: TRKFIL ;
TMPGEO := DELETE: TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.19.2 Flux Solution

Contents of file `Geo/T2DF.did`

```
MODULE
  FLU:
  DELETE:  END:
  ;
LINKED_LIST
  TMPMAC TMPVOL TMPPIJ TMPFLU
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  MAC2G
  ;
*----
*  Local 'tracking' file from T2DT.did
*----
SEQ_ASCII
  VOLTRK
  ;
*----
*  Local 'asmpij' file from T2DA.did
*----
SEQ_ASCII
  PIJMATSTD PIJMATSMD
  ;
*----
*  Files created in this procedure
*----
SEQ_ASCII
  FLUXSK  FLUXK   FLUXKB0    FLUXKB1
  FLUXB0  FLUXB1  FLUXKB1DB2
  ;
*----
*  Restore 'macrolib' structure from MAC2D
*----
TMPMAC :=  MAC2G ;
*----
*  Restore 'tracking' structure from VOLTRK
*----
TMPVOL := VOLTRK ;
*----
*  Restore 'asmpij' structure from PIJMATSTD
*  option 2: no scattering reduction
*            with normalization
*----
TMPPIJ := PIJMATSTD ;
*----
*  Evaluate 'flux' structure
*  option 1: no scattering reduction
*            type k - no leakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 20 TYPE K THER 40 1.0E-4 ;
FLUXSK := TMPFLU ;
TMPFLU := DELETE: TMPFLU ;
```

```
TMPPIJ := DELETE: TMPPIJ ;
*----
*  Restore 'asmpij' structure from PIJMATSMD
*  option 3: with scattering reduction
*            with normalization
*----
TMPPIJ := PIJMATSMD ;
*----
*  Evaluate 'flux' structure
*  option 2: with scattering reduction
*            type k - no leakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 20 TYPE K  ;
FLUXK := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 3: with scattering reduction
*            type k - B0 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE K B0 PNL BUCK 4.01628E-04 ;
FLUXKB0 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 4: with scattering reduction
*            type k - B1 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE K B1 PNL BUCK 3.40281E-04 ;
FLUXKB1 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 5: with scattering reduction
*            type B - B0 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B0 PNL ;
FLUXB0 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 6: with scattering reduction
*            type B - B1 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL ;
FLUXB1 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 7: with scattering reduction
*            type k - B1 lakage
```

```
*             Leakage from FLUXB1 flux file
*----
TMPFLU := FLUXB1  ;
TMPFLU := FLU: TMPFLU TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE K B1 PNL IDEM DB2 ;
FLUXKB1DB2 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPVOL := DELETE: TMPVOL ;
TMPMAC := DELETE: TMPMAC ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.19.3 Edition

Contents of file `Geo/T2DE.did`

```
MODULE
  EDI:
  DELETE:  END:
  ;
LINKED_LIST
  TMPMAC TMPVOL TMPFLU TMPEDI
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  MAC2G
  ;
*----
*  Local 'tracking' file from T2DT.did
*----
SEQ_ASCII
  VOLTRK
  ;
*----
*  Local 'flxunk' file from T2DF.did
*----
*  Files created in this procedure
*----
SEQ_ASCII
  FLUXB1
  ;
*----
*  Files created in this procedure
*----
SEQ_ASCII
```

```
  EDIRES
  ;
*----
*  Restore 'macrolib' structure from MAC2D
*----
TMPMAC :=  MAC2G ;
*----
*  Restore 'tracking' structure from VOLTRK
*----
TMPVOL := VOLTRK ;
*----
*  Restore 'flxunk' structure from FLUXB1
*----
TMPFLU := FLUXB1 ;
*----
*  CREATE EDIT FILE
*  option 1) no condensed, no merge
*----
TMPEDI := EDI: TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  MERG NONE
  SAVE ON 'MAC1'
  ;
*----
*  option 2) no condensed, merge per mixture
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  TAKE MIX 1 5 11
  SAVE ON 'MAC2'
  ;
*----
*  option 3) no condensed, merge per regions
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  MERG REGI 1 2 3 1 2 3 3 1 2 3 1 2 3
  SAVE ON 'MAC3'
  ;
*----
*  option 4) no condensed, complete merge
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  MERG COMP
  SAVE ON 'MAC4'
  ;
*----
*  option 5) condensed, no merge
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
```

```
  COND 2
  MERG NONE
  SAVE ON 'MAC5'
  ;
*----
*  option 6) condensed, merge per mixture
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND 2
  TAKE MIX 1 5 11
  SAVE ON 'MAC6'
  ;
*----
*  option 7) condensed, merge per regions
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND 2
  MERG REGI 1 2 3 1 2 3 3 1 2 3 1 2 3
  SAVE ON 'MAC7'
  ;
*----
*  option 8) no condensed, complete merge
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND 2
  MERG COMP
  SAVE ON 'MAC8'
  ;
*
EDIRES := TMPEDI ;
TMPEDI := DELETE: TMPEDI ;
TMPFLU := DELETE: TMPFLU ;
TMPVOL := DELETE: TMPVOL ;
TMPMAC := DELETE: TMPMAC ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.19.4 Global verification of EDITION *data structure*

Contents of file `Geo/T2DG.did`

```
MODULE
  GEO: EXCELT: ASM: FLU: EDI:
  UTL: DELETE:  END:
  ;
```

```
LINKED_LIST
  TMPGEO TMPVOL TMPMAC TMPPIJ TMPFLU TMPEDI
  NEWEDI
  ;
SEQ_BINARY
  TMPFIL
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  EDIRES
  ;
TMPEDI := EDIRES ;
NEWEDI := EDIRES ;
*----
*  2-DZ model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR2D 3 1
  EDIT 1
  CELL c1 c2 c3
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  ::: c1 := GEO: CARCEL 2 2 1
    MESHX -28.575  -14.2875 -7.0
    MESHY -14.2875  14.2875
    OFFCENTER 3.5 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   2   3
       4   5   6
    ;
  ::: c2 := GEO: CAR2D 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MIX     7
    ;
  ::: c3 := GEO: CARCEL 2 2 1
    MESHX   7.0    14.2875  28.575
    MESHY -14.2875 14.2875
    OFFCENTER -3.5 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       8   9  10
      11  12  13
    ;
  ;
TMPVOL TMPFIL := EXCELT: TMPGEO ::
  TITLE  'Verification model : T2D'
  EDIT  1
  MAXR  13
  TRAK TISO 15 30.0
  ;
TMPGEO := DELETE: TMPGEO ;
*----
*  Restore 'macrolib' structure from TMPEDI
```

```
*  no merge
*----
TMPEDI :=  UTL:  TMPEDI ::
  STEP UP MAC1 STEP UP MACROLIB ;
TMPMAC :=  TMPEDI ;
TMPEDI :=  UTL:  TMPEDI ::
  STEP DOWN STEP DOWN ;
*----
*  Evaluate 'asmpij' structure
*----
TMPPIJ := ASM: TMPMAC TMPVOL TMPFIL  ::
  EDIT 1 ;
*----
*  Evaluate 'flux' structure
*            type B - B1 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 1 2
  MERGE REGI 1 2 3 4 5 6 7 8 9 10 11 12 13
  SAVE ON MAC9
  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 2
  MERG COMP
  SAVE ON MAC10
  STAT ALL REFE 'MAC8'
  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPMAC := DELETE: TMPMAC ;
TMPVOL := DELETE: TMPVOL ;
TMPFIL := DELETE: TMPFIL ;
*----
*  2-DZ model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR2D 3 1
  EDIT 1
  CELL c1 c2 c3
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  ::: c1 := GEO: CARCEL 2 2 1
    MESHX -28.575  -14.2875 -7.0
    MESHY -14.2875  14.2875
    OFFCENTER 3.5 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   2   3
       1   2   3
    ;
  ::: c2 := GEO: CAR2D 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
```

```
    MIX     3
    ;
  ::: c3 := GEO: CARCEL 2 2 1
    MESHX   7.0    14.2875  28.575
    MESHY -14.2875 14.2875
    OFFCENTER -3.5 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   2   3
       1   2   3
    ;
  ;
TMPVOL TMPFIL := EXCELT: TMPGEO ::
  TITLE  'Verification model : T2D'
  EDIT  1
  MAXR  13
  TRAK TISO 15 30.0
  ;
TMPGEO := DELETE: TMPGEO ;
*----
*  Restore 'macrolib' structure from TMPEDI
*  MERGE PER MIXTURE
*----
TMPEDI :=  UTL:  TMPEDI ::
  STEP UP MAC2 STEP UP MACROLIB ;
TMPMAC :=  TMPEDI ;
TMPEDI :=  UTL:  TMPEDI ::
  STEP DOWN STEP DOWN ;
*----
*  Evaluate 'asmpij' structure
*----
TMPPIJ := ASM: TMPMAC TMPVOL TMPFIL  ::
  EDIT 1 ;
*----
*  Evaluate 'flux' structure
*  option 2: with scattering reduction
*            type B - B1 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 1 2
  MERGE REGI 1 2 3 4 5 6 7 8 9 10 11 12 13
  SAVE ON MAC11
  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 2
  MERG COMP
  SAVE ON MAC12
  STAT ALL REFE 'MAC8'
  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPMAC := DELETE: TMPMAC ;
```

```
*----
*  Restore 'macrolib' structure from TMPEDI
*  MERGE PER REGION
*----
TMPEDI :=  UTL:  TMPEDI ::
  STEP UP MAC3 STEP UP MACROLIB ;
TMPMAC :=  TMPEDI ;
TMPEDI :=  UTL:  TMPEDI ::
  STEP DOWN STEP DOWN ;
*----
*  Evaluate 'asmpij' structure
*----
TMPPIJ := ASM: TMPMAC TMPVOL TMPFIL  ::
  EDIT 1 ;
*----
*  Evaluate 'flux' structure
*             type B - B1 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 1 2
  MERGE REGI 1 2 3 4 5 6 7 8 9 10 11 12 13
  SAVE ON MAC13
  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 2
  MERG COMP
  SAVE ON MAC14
  STAT ALL REFE 'MAC8'
  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPMAC := DELETE: TMPMAC ;
TMPVOL := DELETE: TMPVOL ;
TMPFIL := DELETE: TMPFIL ;
NEWEDI := DELETE: NEWEDI ;
TMPEDI := DELETE: TMPEDI ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.19.5 Data structure generated

Contents of file `Geo/T2Dds/VOLTRK`

```
      1  'SIGNATURE   '       3      12
L_TRACK
      1  'TRACK-TYPE  '       3      12
EXCELL
      1  'TITLE       '       3      72
Verification model : T2D
      1  'EXCELL      '       0      -1
      2  'MINDIM      '       1       5
        1         7         9        13        17
      2  'MAXDIM      '       1       5
        6         8        10        14        18
      2  'ICORD       '       1       5
        1         2         3         3         3
      2  'INDEX       '       1     104
        5         8         9         0         4         8         9         0
        6         7         9         0         5         6         9         0
        4         6         9         0         3         8         9         0
        3         6         9         0         2         8         9         0
        1         8         9         0         0         7         9         0
        2         6         9         0         1         6         9         0
        0         0         0         0         1         7         9        12
        1         7         9        13         1         7         9         0
        2         7         9        12         2         7         9        13
        2         7         9         0         3         7         9         0
        4         7         9        16         4         7         9        17
        4         7         9         0         5         7         9        16
        5         7         9        17         5         7         9         0
      2  'REMESH      '       2      18
  0.00000000E+00  1.42875004E+01  2.15750008E+01  3.55750008E+01  4.28625031E+01
  5.71500015E+01  0.00000000E+00  2.85750008E+01  0.00000000E+00  1.00000000E+00
  1.42875004E+01  1.42875004E+01  2.67172718E+01  4.33949203E+01  4.28625031E+01
  1.42875004E+01  2.67172718E+01  4.33949203E+01
      2  'KEYMRG      '       1      26
      -12       -11       -10        -9        -8        -7        -6        -5
       -4        -3        -2        -1         0         1         2         3
        4         5         6         7         8         9        10        11
       12        13
      2  'MATALB      '       1      26
       -4        -4        -2        -3        -3        -4        -3        -4
       -4        -1        -3        -3         0         1         5        11
        1         5        11        11         1         5        11         1
        5        11
      2  'VOLSUR      '       2      26
  3.57187510E+00  1.82187510E+00  7.14375019E+00  3.57187510E+00  1.82187510E+00
  3.50000000E+00  3.50000000E+00  1.82187510E+00  3.57187510E+00  7.14375019E+00
  1.82187510E+00  3.57187510E+00  0.00000000E+00  4.19673920E+01  2.61971893E+01
  3.40100739E+02  4.19673920E+01  2.61971893E+01  1.40075745E+02  4.00050018E+02
  4.19673920E+01  2.61971893E+01  1.40075745E+02  4.19673920E+01  2.61971893E+01
  3.40100739E+02
      2  'STATE-VECTOR'       1      20
        2        12        13         5        18        26         0         0
        0         0         0         0         0         0         0         0
        0         0         0         0
      1  'BC-REFL+TRAN'       1      12
        1         2         3         4         5         6         7         8
```

```
         9          10          11          12
     1  'STATE-VECTOR'       1       20
        13          13           1          11          12           1           1           0
         0           0          15           1           0           0           0           0
         0           0           0           0
     1  'EXCELTRACKOP'       2        3
 0.00000000E+00  3.00020447E+01  0.00000000E+00
     1  'MATCOD      '       1       13
         1           5          11           1           5          11          11           1
         5          11           1           5          11
     1  'VOLUME      '       2       13
 4.19673920E+01  2.61971893E+01  3.40100739E+02  4.19673920E+01  2.61971893E+01
 1.40075745E+02  4.00050018E+02  4.19673920E+01  2.61971893E+01  1.40075745E+02
 4.19673920E+01  2.61971893E+01  3.40100739E+02
     1  'KEYFLX      '       1       13
         1           2           3           4           5           6           7           8
         9          10          11          12          13
     1  'ALBEDO      '       2        6
 1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
 1.00000000E+00
```

Contents of file `Geo/T2Dds/PIJMATSTD`

```
     1  'SIGNATURE   '       3       12
  L_PIJ
     1  'STATE-VECTOR'       1       20
         0           1           0           0           0           2           2          13
        17           1           1          13          12           0           0           0
         0           0           0           0
     1  'GROUP  1/  2'       0       -1
     2  'DRAGON-TXSC '       2       18
 0.00000000E+00  3.25573593E-01  2.94397712E-01  2.96656132E-01  2.94024080E-01
 1.08258009E-01  3.25573593E-01  2.94397771E-01  2.96656132E-01  2.94024020E-01
 1.08258016E-01  2.64682710E-01  8.37840736E-01  2.64991134E-01  8.31609249E-01
 2.65020490E-01  2.71528214E-01  2.65051723E-01
     2  'DRAGON-S0XSC'       2       18
 0.00000000E+00  3.12665552E-01  2.83534408E-01  2.84851104E-01  2.80805469E-01
 1.07063353E-01  3.12665582E-01  2.83534437E-01  2.84851104E-01  2.80805439E-01
 1.07063361E-01  2.53611684E-01  8.23869348E-01  2.52386063E-01  8.17773104E-01
 2.52767861E-01  2.64678836E-01  2.53184795E-01
     2  'DRAGON-PIS  '       2       13
-5.52034749E-07 -9.27196595E-08 -2.26951855E-07  2.74941840E-07 -1.96150253E-07
 2.12308777E-07  1.12614657E-07 -3.92631083E-09 -1.48984242E-07 -1.97061823E-07
-3.13392064E-07  2.14318177E-07 -1.21928053E-07
     2  'DRAGON-PCSCT'       2      169
 1.89615238E+00  7.22183824E-01  8.02338868E-02  3.33172679E-01  1.23030514E-01
 3.97702157E-02  3.84886167E-03  6.10015086E-05  1.09361892E-04  9.80006662E-05
 1.17128684E-05  1.54832815E-05  4.75931347E-06  4.50806856E-01  1.76398993E+00
 1.30083755E-01  7.68255591E-02  1.34983212E-01  4.35292237E-02  2.59181648E-03
 4.89054910E-05  7.15078568E-05  7.39849129E-05  9.66530024E-06  6.29642363E-06
 2.77324966E-06  6.50209725E-01  1.68879104E+00  3.43806243E+00  1.70276314E-01
 2.73445964E-01  3.38336468E-01  1.20332316E-02  1.80959702E-04  2.94577068E-04
 3.12142860E-04  3.85672356E-05  3.60086015E-05  1.33325821E-05  3.33172679E-01
 1.23073056E-01  2.10115761E-02  1.89593387E+00  7.22114086E-01  1.23996474E-01
 2.45389827E-02  3.33772099E-04  6.10838470E-04  4.49310144E-04  6.09973613E-05
 7.83369542E-05  2.23202787E-05  7.67989978E-02  1.34983212E-01  2.10629236E-02
 4.50763315E-01  1.76334131E+00  2.18964145E-01  3.36400680E-02  3.81309073E-04
```

```
 6.38380006E-04  5.01497358E-04  6.82645477E-05  7.15014976E-05  2.26837201E-05
 1.32742181E-01  2.32749715E-01  1.39349103E-01  4.13866520E-01  1.17079604E+00
 2.59007120E+00  1.87603638E-01  1.50048465E-03  2.68250960E-03  3.88719863E-03
 3.27129703E-04  3.95661191E-04  1.28572516E-04  3.66888940E-02  3.95789072E-02
 1.41543187E-02  2.33915433E-01  5.13708115E-01  5.35787523E-01  3.27940679E+00
 2.33904421E-01  5.13692081E-01  5.35666347E-01  3.66861932E-02  3.95759940E-02
 1.41504733E-02  6.10015086E-05  7.83456489E-05  2.23298739E-05  3.33772099E-04
 6.10849762E-04  4.49552666E-04  2.45378278E-02  1.89595151E+00  7.22157955E-01
 1.23991802E-01  3.33173424E-01  1.23071596E-01  2.10107546E-02  6.82666796E-05
 7.15078568E-05  2.26906031E-05  3.81302030E-04  6.38380006E-04  5.01687231E-04
 3.36390175E-02  4.50790673E-01  1.76329637E+00  2.18963712E-01  7.67952949E-02
 1.34986535E-01  2.10619643E-02  3.27099609E-04  3.95595562E-04  1.28560860E-04
 1.49967510E-03  2.68149446E-03  3.88719863E-03  1.87561214E-01  4.13850933E-01
 1.17079365E+00  2.59017015E+00  1.32737100E-01  2.32765198E-01  1.39361709E-01
 1.17128684E-05  1.54836234E-05  4.75907882E-06  6.09973613E-05  1.09358480E-04
 9.80096884E-05  3.84857808E-03  3.33173424E-01  1.23024568E-01  3.97686958E-02
 1.89616656E+00  7.22130418E-01  8.02343413E-02  9.66508742E-06  6.29642363E-06
 2.77366098E-06  4.89000668E-05  7.15014976E-05  7.39971874E-05  2.59162579E-03
 7.68246427E-02  1.34986535E-01  4.35321182E-02  4.50773507E-01  1.76414931E+00
 1.30082771E-01  3.85691346E-05  3.60032609E-05  1.33325821E-05  1.80881951E-04
 2.94487691E-04  3.12171149E-04  1.20299617E-02  1.70269653E-01  2.73433506E-01
 3.38367045E-01  6.50213420E-01  1.68877828E+00  3.43805456E+00
    1  'GROUP  2/  2'       0      -1
    2  'DRAGON-TXSC '       2      18
 0.00000000E+00  4.45026428E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  4.45026457E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  3.99664789E-01  1.08252847E+00  3.97724301E-01  1.08740294E+00
 3.98030460E-01  2.85094976E-01  3.99067879E-01
    2  'DRAGON-S0XSC'       2      18
 0.00000000E+00  3.49167198E-01  3.35775822E-01  3.37583899E-01  3.37695420E-01
 8.29786733E-02  3.49167198E-01  3.35775852E-01  3.37583899E-01  3.37695390E-01
 8.29786733E-02  3.99550319E-01  8.89993608E-01  3.97603214E-01  8.90379846E-01
 3.97910595E-01  2.80846745E-01  3.98950040E-01
    2  'DRAGON-PIS  '       2      13
-2.22238540E-07  3.67331481E-08 -3.43353975E-07 -3.83373333E-07  1.61949288E-07
 2.82989106E-07 -2.21405017E-07 -2.52906744E-07 -8.26561664E-09 -1.66115640E-07
 5.70825840E-08  7.27212690E-09 -2.65752277E-07
    2  'DRAGON-PCSCT'       2     169
 1.56242263E+00  5.86384296E-01  4.46720421E-02  2.15992704E-01  7.56521970E-02
 1.87801812E-02  8.95006990E-04  2.37687254E-06  4.58712157E-06  4.13509952E-06
 3.26831270E-07  4.54206486E-07  8.00632378E-08  3.66037071E-01  1.83352053E+00
 9.08847600E-02  4.72418703E-02  1.35018229E-01  2.81985365E-02  8.01167625E-04
 2.69324278E-06  4.30839918E-06  4.08594451E-06  2.83539578E-07  5.67895768E-07
 4.23686117E-08  3.62019032E-01  1.17989659E+00  2.35119724E+00  7.13038743E-02
 1.63097322E-01  1.61604449E-01  2.22918158E-03  5.02801640E-06  8.77311504E-06
 1.11753125E-05  6.48822152E-07  5.50165737E-07  1.11901699E-07  2.15992704E-01
 7.56805614E-02  8.79868027E-03  1.56235480E+00  5.86609721E-01  7.83524737E-02
 1.05256587E-02  2.28198169E-05  4.55148947E-05  2.87997409E-05  2.37680388E-06
 4.31419312E-06  6.20182163E-07  4.72241677E-02  1.35018229E-01  1.25630181E-02
 3.66177768E-01  1.83303165E+00  1.71871319E-01  1.70565508E-02  2.84120179E-05
 5.36857005E-05  3.54875810E-05  2.86337422E-06  4.30806176E-06  6.75527076E-07
 6.26831427E-02  1.50776908E-01  6.65592924E-02  2.61519283E-01  9.18991804E-01
 1.92621267E+00  9.19558853E-02  9.61692276E-05  1.89819984E-04  5.59175038E-04
 1.38041833E-05  2.18520527E-05  4.60309502E-06  8.53156578E-03  1.22344075E-02
 2.62211752E-03  1.00334801E-01  2.60465831E-01  2.62621850E-01  2.28066111E+00
 1.00333072E-01  2.60461718E-01  2.62560695E-01  8.53099767E-03  1.22337220E-02
```

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   2.62055593E-03  2.37687254E-06  4.31452281E-06  6.20441824E-07  2.28198169E-05
   4.55155023E-05  2.88127794E-05  1.05254771E-02  1.56236446E+00  5.86656868E-01
   7.83480182E-02  2.15993077E-01  7.56807476E-02  8.79852846E-03  2.86340628E-06
   4.30839918E-06  6.75773208E-07  2.84116395E-05  5.36857005E-05  3.55004377E-05
   1.70562807E-02  3.66207212E-01  1.83295918E+00  1.71867236E-01  4.72207852E-02
   1.35023579E-01  1.25625692E-02  1.38018386E-05  2.18474470E-05  4.60272531E-06
   9.61257101E-05  1.89751256E-04  5.59175038E-04  9.19344723E-02  2.61504382E-01
   9.18970048E-01  1.92627084E+00  6.26776740E-02  1.50787637E-01  6.65639713E-02
   3.26831270E-07  4.54224875E-07  8.00626694E-08  2.37680388E-06  4.58707018E-06
   4.13580165E-06  8.94947385E-04  2.15993077E-01  7.56467804E-02  1.87785439E-02
   1.56243610E+00  5.86328864E-01  4.46718037E-02  2.83528067E-07  5.67895768E-07
   4.23780193E-08  2.69303700E-06  4.30806176E-06  4.08680580E-06  8.01122689E-04
   4.72419895E-02  1.35023579E-01  2.82005444E-02  3.66002470E-01  1.83373225E+00
   9.08851475E-02  6.48826813E-07  5.50043580E-07  1.11901699E-07  5.02591183E-06
   8.76991999E-06  1.11762101E-05  2.22785398E-03  7.13026449E-02  1.63091511E-01
   1.61615819E-01  3.62017125E-01  1.17990160E+00  2.35119438E+00
```

Contents of file `Geo/T2Dds/PIJMATSMD`

```
       1   'SIGNATURE   '       3       12
  L_PIJ
       1   'STATE-VECTOR'       1       20
           0         0         0         0         0         2         2        13
          17         1         1        13        12         0         0         0
           0         0         0         0
       1   'GROUP  1/  2'       0       -1
       2   'DRAGON-TXSC '       2       18
   0.00000000E+00  3.25573593E-01  2.94397712E-01  2.96656132E-01  2.94024080E-01
   1.08258009E-01  3.25573593E-01  2.94397771E-01  2.96656132E-01  2.94024020E-01
   1.08258016E-01  2.64682710E-01  8.37840736E-01  2.64991134E-01  8.31609249E-01
   2.65020490E-01  2.71528214E-01  2.65051723E-01
       2   'DRAGON-S0XSC'       2       18
   0.00000000E+00  3.12665552E-01  2.83534408E-01  2.84851104E-01  2.80805469E-01
   1.07063353E-01  3.12665582E-01  2.83534437E-01  2.84851104E-01  2.80805439E-01
   1.07063361E-01  2.53611684E-01  8.23869348E-01  2.52386063E-01  8.17773104E-01
   2.52767861E-01  2.64678836E-01  2.53184795E-01
       2   'DRAGON-PIS  '       2       13
  -5.52034749E-07 -9.27196595E-08 -2.26951855E-07  2.74941840E-07 -1.96150253E-07
   2.12308777E-07  1.12614657E-07 -3.92631083E-09 -1.48984242E-07 -1.97061823E-07
  -3.13392064E-07  2.14318177E-07 -1.21928053E-07
       2   'DRAGON-PCSCT'       2      169
   8.84094429E+00  6.18561220E+00  4.28957891E+00  5.20240355E+00  3.94004345E+00
   3.15994096E+00  1.78277647E+00  9.46144521E-01  1.05920303E+00  1.09682977E+00
   7.41433263E-01  7.12795079E-01  6.44013643E-01  3.86122751E+00  5.19880629E+00
   3.08602858E+00  2.55041313E+00  2.31365156E+00  1.98140574E+00  1.06987214E+00
   5.67775846E-01  6.35603189E-01  6.58290803E-01  4.44945455E-01  4.27752525E-01
   3.86487424E-01  3.47624435E+01  4.00638657E+01  4.68018265E+01  2.60851364E+01
   2.48196011E+01  2.41348610E+01  1.25512152E+01  6.65940857E+00  7.45524836E+00
   7.72234583E+00  5.21904564E+00  5.01752234E+00  4.53356934E+00  5.20240355E+00
   4.08571291E+00  3.21882629E+00  8.33278179E+00  5.50131273E+00  3.63387275E+00
   2.27558851E+00  1.20753276E+00  1.35183918E+00  1.39932227E+00  9.46134329E-01
   9.09557521E-01  8.21740925E-01  2.45948243E+00  2.31365156E+00  1.91179776E+00
   3.43406940E+00  4.65060091E+00  2.57633042E+00  1.59161079E+00  8.43854845E-01
   9.44684327E-01  9.78028715E-01  6.61176324E-01  6.35597348E-01  5.74254155E-01
   1.05470238E+01  1.05945292E+01  9.94031525E+00  1.21288786E+01  1.37755766E+01
   1.63811817E+01  8.81249046E+00  4.67070007E+00  5.22965479E+00  5.41938019E+00
   3.66099167E+00  3.51993990E+00  3.18062711E+00  1.69941406E+01  1.63377209E+01
```

```
 1.47636070E+01  2.16918240E+01  2.43050480E+01  2.51680756E+01  3.75624809E+01
 2.16905708E+01  2.43036537E+01  2.51658878E+01  1.69929886E+01  1.63366413E+01
 1.47625952E+01  9.46144521E-01  9.09565985E-01  8.21750641E-01  1.20753276E+00
 1.35183918E+00  1.39936495E+00  2.27545714E+00  8.33297443E+00  5.50151205E+00
 3.63395596E+00  5.20250320E+00  4.08576441E+00  3.21888185E+00  6.61183417E-01
 6.35603189E-01  5.74260890E-01  8.43854845E-01  9.44684327E-01  9.78058398E-01
 1.59151959E+00  3.43419385E+00  4.65060329E+00  2.57639217E+00  2.45952773E+00
 2.31370020E+00  1.91183782E+00  3.66091943E+00  3.51986527E+00  3.18056750E+00
 4.67055750E+00  5.22949600E+00  5.41938019E+00  8.81172371E+00  1.21291571E+01
 1.37759075E+01  1.63819695E+01  1.05474186E+01  1.05950813E+01  9.94092083E+00
 7.41433263E-01  7.12794006E-01  6.44014299E-01  9.46134329E-01  1.05919170E+00
 1.09685135E+00  1.78265560E+00  5.20250320E+00  3.94011593E+00  3.16005945E+00
 8.84106350E+00  6.18556023E+00  4.28962564E+00  4.44946110E-01  4.27752525E-01
 3.86488408E-01  5.67770600E-01  6.35597348E-01  6.58304811E-01  1.06980145E+00
 2.55044556E+00  2.31370020E+00  1.98150909E+00  3.86119533E+00  5.19904280E+00
 3.08605552E+00  5.21904039E+00  5.01750994E+00  4.53356934E+00  6.65932941E+00
 7.45516109E+00  7.72249079E+00  1.25503540E+01  2.60855885E+01  2.48201218E+01
 2.41363316E+01  3.47628174E+01  4.00642128E+01  4.68019981E+01
    1  'GROUP  2/  2'       0       -1
    2  'DRAGON-TXSC '       2       18
 0.00000000E+00  4.45026428E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  4.45026457E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  3.99664789E-01  1.08252847E+00  3.97724301E-01  1.08740294E+00
 3.98030460E-01  2.85094976E-01  3.99067879E-01
    2  'DRAGON-S0XSC'       2       18
 0.00000000E+00  3.49167198E-01  3.35775822E-01  3.37583899E-01  3.37695420E-01
 8.29786733E-02  3.49167198E-01  3.35775852E-01  3.37583899E-01  3.37695390E-01
 8.29786733E-02  3.99550319E-01  8.89993608E-01  3.97603214E-01  8.90379846E-01
 3.97910595E-01  2.80846745E-01  3.98950040E-01
    2  'DRAGON-PIS  '       2       13
-2.22238540E-07  3.67331481E-08 -3.43353975E-07 -3.83373333E-07  1.61949288E-07
 2.82989106E-07 -2.21405017E-07 -2.52906744E-07 -8.26561664E-09 -1.66115640E-07
 5.70825840E-08  7.27212690E-09 -2.65752277E-07
    2  'DRAGON-PCSCT'       2      169
 5.87244940E+00  4.94337082E+00  4.44906855E+00  2.87085843E+00  2.97397208E+00
 3.07365274E+00  2.19839811E+00  7.92730272E-01  1.21531105E+00  1.48709631E+00
 6.24593616E-01  8.78390372E-01  1.02226043E+00  3.08578682E+00  5.64740658E+00
 4.38576174E+00  1.91676617E+00  2.56379890E+00  2.76341748E+00  1.92981648E+00
 6.95892632E-01  1.06685400E+00  1.30546284E+00  5.48300207E-01  7.71098018E-01
 8.97396147E-01  3.60549355E+01  5.69374352E+01  7.62074432E+01  2.61244488E+01
 3.61364784E+01  4.23042526E+01  2.91571388E+01  1.05140896E+01  1.61189175E+01
 1.97242279E+01  8.28421116E+00  1.16504574E+01  1.35587091E+01  2.87085843E+00
 3.07062244E+00  3.22367716E+00  5.49001932E+00  4.27410793E+00  3.54594994E+00
 2.79051995E+00  1.00616276E+00  1.54250312E+00  1.88732243E+00  7.92721689E-01
 1.11482489E+00  1.29741037E+00  1.85643435E+00  2.56379890E+00  2.78351092E+00
 2.66801476E+00  4.93201780E+00  3.44540215E+00  2.67060089E+00  9.62872386E-01
 1.47614372E+00  1.80616200E+00  7.58621991E-01  1.06687140E+00  1.24160731E+00
 1.02590170E+01  1.47759275E+01  1.74236603E+01  1.18354168E+01  1.84224834E+01
 2.42009029E+01  1.74690018E+01  6.29938555E+00  9.65753078E+00  1.18179741E+01
 4.96348238E+00  6.98041153E+00  8.12377262E+00  2.09560127E+01  2.94696922E+01
 3.42966461E+01  2.66003551E+01  4.07820053E+01  4.98906822E+01  7.13737183E+01
 2.65985870E+01  4.07792969E+01  4.98872375E+01  2.09543934E+01  2.94682198E+01
 3.42944641E+01  7.92730272E-01  1.11480653E+00  1.29740655E+00  1.00616276E+00
 1.54250300E+00  1.88732731E+00  2.79033446E+00  5.49002886E+00  4.27415180E+00
 3.54592443E+00  2.87084222E+00  3.07063770E+00  3.22366929E+00  7.58630276E-01
 1.06685400E+00  1.24160373E+00  9.62872446E-01  1.47614372E+00  1.80616689E+00
```

```
  2.67042351E+00  2.66804218E+00  4.93187714E+00  3.44538903E+00  1.85640860E+00
  2.56383252E+00  2.78351092E+00  4.96352339E+00  6.98027849E+00  8.12372780E+00
  6.29936886E+00  9.65750504E+00  1.18179741E+01  1.74677944E+01  1.18353319E+01
  1.84224129E+01  2.42016048E+01  1.02591362E+01  1.47766304E+01  1.74243469E+01
  6.24593616E-01  8.78366411E-01  1.02224636E+00  7.92721689E-01  1.21529782E+00
  1.48708403E+00  2.19822812E+00  2.87084222E+00  2.97393084E+00  3.07368851E+00
  5.87247086E+00  4.94329691E+00  4.44905090E+00  5.48315227E-01  7.71098018E-01
  8.97408307E-01  6.95904076E-01  1.06687140E+00  1.30548775E+00  1.92972004E+00
  1.91677570E+00  2.56383252E+00  2.76354909E+00  3.08574057E+00  5.64776754E+00
  4.38583612E+00  8.28432465E+00  1.16502991E+01  1.35587091E+01  1.05141201E+01
  1.61189632E+01  1.97243366E+01  2.91552868E+01  2.61243858E+01  3.61364784E+01
  4.23059235E+01  3.60547867E+01  5.69384041E+01  7.62076797E+01
```

Contents of file `Geo/T2Dds/PIJMATLEA`

```
       1  'SIGNATURE   '       3       12
 L_PIJ
       1  'STATE-VECTOR'       1       20
           0          1          0          0         -1          2          2         13
          17          1          1         13         12          0          0          0
           0          0          0          0
       1  'GROUP  1/  2'       0       -1
       2  'DRAGON-TXSC '       2       18
  0.00000000E+00  3.25573593E-01  2.94397712E-01  2.96656132E-01  2.94024080E-01
  1.08258009E-01  3.25573593E-01  2.94397771E-01  2.96656132E-01  2.94024020E-01
  1.08258016E-01  2.64682710E-01  8.37840736E-01  2.64991134E-01  8.31609249E-01
  2.65020490E-01  2.71528214E-01  2.65051723E-01
       2  'DRAGON-S0XSC'       2       18
  0.00000000E+00  3.12665552E-01  2.83534408E-01  2.84851104E-01  2.80805469E-01
  1.07063353E-01  3.12665582E-01  2.83534437E-01  2.84851104E-01  2.80805439E-01
  1.07063361E-01  2.53611684E-01  8.23869348E-01  2.52386063E-01  8.17773104E-01
  2.52767861E-01  2.64678836E-01  2.53184795E-01
       2  'DRAGON-PIS  '       2       13
  9.52912524E-06  1.92364714E-05  1.77704118E-04 -9.19381182E-06 -1.86245834E-05
 -2.17629000E-04 -1.31832465E-04 -6.33112904E-06 -1.35112250E-05 -1.44422331E-04
  1.12267617E-05  2.19759349E-05  1.81330252E-04
       2  'DRAGON-PCSCT'       2      169
  1.89614689E+00  7.22171903E-01  8.02280232E-02  3.33173513E-01  1.23033494E-01
  3.97734344E-02  3.84952524E-03  6.10160823E-05  1.09390094E-04  9.80941040E-05
  1.17169766E-05  1.54889240E-05  4.76203058E-06  4.50799406E-01  1.76394320E+00
  1.30079105E-01  7.68250152E-02  1.34984866E-01  4.35313359E-02  2.59244931E-03
  4.89177291E-05  7.15315182E-05  7.40682954E-05  9.66878542E-06  6.30141722E-06
  2.77511572E-06  6.50162160E-01  1.68873084E+00  3.43729901E+00  1.70293197E-01
  2.73494214E-01  3.38542700E-01  1.20426575E-02  1.81060299E-04  2.94767291E-04
  3.12520599E-04  3.85913117E-05  3.60371196E-05  1.33431959E-05  3.33173513E-01
  1.23072185E-01  2.10136604E-02  1.89594531E+00  7.22132206E-01  1.23993583E-01
  2.45397948E-02  3.33819044E-04  6.10932126E-04  4.49636194E-04  6.10112584E-05
  7.83555442E-05  2.23307215E-05  7.68008679E-02  1.34984866E-01  2.10666396E-02
  4.50774640E-01  1.76341546E+00  2.18953729E-01  3.36412266E-02  3.81369784E-04
  6.38498110E-04  5.01882809E-04  6.82817918E-05  7.15244096E-05  2.26962620E-05
  1.32752925E-01  2.32761011E-01  1.39434054E-01  4.13856894E-01  1.17074037E+00
  2.59050798E+00  1.87664703E-01  1.50163460E-03  2.68466794E-03  3.89465760E-03
  3.27442831E-04  3.96122981E-04  1.28721003E-04  3.66952196E-02  3.95885743E-02
  1.41654061E-02  2.33923182E-01  5.13725817E-01  5.35961926E-01  3.27977490E+00
  2.33909562E-01  5.13701856E-01  5.35805881E-01  3.66911031E-02  3.95834073E-02
  1.41585516E-02  6.10160823E-05  7.83652577E-05  2.23422867E-05  3.33819044E-04
  6.10947027E-04  4.49897198E-04  2.45383680E-02  1.89595807E+00  7.22169518E-01
```

```
 1.23989239E-01  3.33173841E-01  1.23070352E-01  2.10125744E-02  6.82842801E-05
 7.15315182E-05  2.27052569E-05  3.81360529E-04  6.38498110E-04  5.02090843E-04
 3.36396582E-02  4.50797915E-01  1.76334500E+00  2.18955994E-01  7.67964646E-02
 1.34986967E-01  2.10652556E-02  3.27411457E-04  3.96041403E-04  1.28716434E-04
 1.50076346E-03  2.68355524E-03  3.89465760E-03  1.87610060E-01  4.13842410E-01
 1.17075253E+00  2.59040284E+00  1.32743418E-01  2.32770473E-01  1.39430791E-01
 1.17169766E-05  1.54892059E-05  4.76204968E-06  6.10112584E-05  1.09386114E-04
 9.81034973E-05  3.84909334E-03  3.33173841E-01  1.23026453E-01  3.97705883E-02
 1.89616215E+00  7.22118556E-01  8.02284479E-02  9.66860807E-06  6.30141722E-06
 2.77585764E-06  4.89116646E-05  7.15244096E-05  7.40835530E-05  2.59211101E-03
 7.68238753E-02  1.34986967E-01  4.35331054E-02  4.50766087E-01  1.76410198E+00
 1.30078137E-01  3.85911590E-05  3.60274862E-05  1.33431959E-05  1.80966570E-04
 2.94650526E-04  3.12531658E-04  1.20368302E-02  1.70284390E-01  2.73476243E-01
 3.38534802E-01  6.50165558E-01  1.68871808E+00  3.43729734E+00
    1  'GROUP  2/  2'       0       -1
    2  'DRAGON-TXSC '       2       18
 0.00000000E+00  4.45026428E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  4.45026457E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  3.99664789E-01  1.08252847E+00  3.97724301E-01  1.08740294E+00
 3.98030460E-01  2.85094976E-01  3.99067879E-01
    2  'DRAGON-S0XSC'       2       18
 0.00000000E+00  3.49167198E-01  3.35775822E-01  3.37583899E-01  3.37695420E-01
 8.29786733E-02  3.49167198E-01  3.35775852E-01  3.37583899E-01  3.37695390E-01
 8.29786733E-02  3.99550319E-01  8.89993608E-01  3.97603214E-01  8.90379846E-01
 3.97910595E-01  2.80846745E-01  3.98950040E-01
    2  'DRAGON-PIS  '       2       13
 2.19091567E-06  4.98351028E-06  1.20913195E-04 -2.29090051E-06 -4.85841383E-06
-1.52518565E-04 -8.76325357E-05 -1.72911473E-06 -3.45468607E-06 -9.91469424E-05
 2.62291724E-06  5.64721859E-06  1.22684884E-04
    2  'DRAGON-PCSCT'       2      169
 1.56241393E+00  5.86372435E-01  4.46727462E-02  2.15992942E-01  7.56538734E-02
 1.87797770E-02  8.95048026E-04  2.37711515E-06  4.58768409E-06  4.14026363E-06
 3.26885299E-07  4.54296782E-07  8.01040727E-08  3.66029650E-01  1.83345747E+00
 9.08864811E-02  4.72412594E-02  1.35019243E-01  2.81970687E-02  8.01212736E-04
 2.69347447E-06  4.30895398E-06  4.09168115E-06  2.83596080E-07  5.67986831E-07
 4.24068602E-08  3.62024754E-01  1.17991889E+00  2.35085773E+00  7.13101327E-02
 1.63115725E-01  1.61681414E-01  2.23098299E-03  5.03040110E-06  8.77793263E-06
 1.11978070E-05  6.49181629E-07  5.50724792E-07  1.12054501E-07  2.15992942E-01
 7.56795779E-02  8.79945233E-03  1.56236649E+00  5.86626351E-01  7.83479363E-02
 1.05254781E-02  2.28209246E-05  4.55177906E-05  2.88217125E-05  2.37704103E-06
 4.31454964E-06  6.20435173E-07  4.72252108E-02  1.35019243E-01  1.25644356E-02
 3.66188198E-01  1.83312118E+00  1.71862796E-01  1.70565266E-02  2.84140315E-05
 5.36904627E-05  3.55168231E-05  2.86374052E-06  4.30863201E-06  6.75853357E-07
 6.26817942E-02  1.50769055E-01  6.65909871E-02  2.61504114E-01  9.18946266E-01
 1.92646551E+00  9.19763148E-02  9.62436461E-05  1.89976854E-04  5.60848683E-04
 1.38213190E-05  2.18827390E-05  4.61207037E-06  8.53195693E-03  1.22350976E-02
 2.62423651E-03  1.00333080E-01  2.60465473E-01  2.62680203E-01  2.28084040E+00
 1.00330956E-01  2.60458618E-01  2.62607485E-01  8.53124820E-03  1.22341337E-02
 2.62201321E-03  2.37711515E-06  4.31489389E-06  6.20736103E-07  2.28209246E-05
 4.55187255E-05  2.88350748E-05  1.05252555E-02  1.56237221E+00  5.86667597E-01
 7.83449560E-02  2.15993032E-01  7.56795704E-02  8.79926793E-03  2.86375735E-06
 4.30895398E-06  6.76144282E-07  2.84134458E-05  5.36904627E-05  3.55297743E-05
 1.70560777E-02  3.66213948E-01  1.83301723E+00  1.71861514E-01  4.72214073E-02
 1.35023266E-01  1.25638507E-02  1.38190744E-05  2.18781206E-05  4.61198988E-06
 9.61990445E-05  1.89907601E-04  5.60848683E-04  9.19508487E-02  2.61494190E-01
 9.18939412E-01  1.92641199E+00  6.26766384E-02  1.50781274E-01  6.65900037E-02
```

```
  3.26885299E-07  4.54315426E-07  8.01070286E-08  2.37704103E-06  4.58765680E-06
  4.14093574E-06  8.94973695E-04  2.15993032E-01  7.56477788E-02  1.87782329E-02
  1.56242716E+00  5.86316347E-01  4.46725301E-02  2.83584455E-07  5.67986831E-07
  4.24210853E-08  2.69325960E-06  4.30863201E-06  4.09254517E-06  8.01149639E-04
  4.72412519E-02  1.35023266E-01  2.81993542E-02  3.65994632E-01  1.83366489E+00
  9.08868089E-02  6.49157641E-07  5.50540165E-07  1.12054501E-07  5.02796229E-06
  8.77415550E-06  1.11980016E-05  2.22909288E-03  7.13086426E-02  1.63108140E-01
  1.61679015E-01  3.62022996E-01  1.17992318E+00  2.35085702E+00
```

Contents of file `Geo/T2Dds/FLUXSK`

```
     1  'SIGNATURE   '       3       12
L_FLUX
     1  'FLUXDIRECT  '       0       -1
     2  'FLUX  1     '       2       13
  1.74349642E+00  1.32112801E+00  9.99664068E-01  1.74019718E+00  1.31709003E+00
  1.03439665E+00  9.04972374E-01  1.74021983E+00  1.31711566E+00  1.03440928E+00
  1.74350941E+00  1.32112193E+00  9.99671817E-01
     2  'FLUX  2     '       2       13
  8.95130873E-01  1.32411802E+00  1.65026569E+00  8.99777889E-01  1.32907975E+00
  1.61937928E+00  1.78112030E+00  8.99760485E-01  1.32905447E+00  1.61937332E+00
  8.95116389E-01  1.32413125E+00  1.65026271E+00
     2  '1/EIGENVALUE'       2        1
  1.09054446E+00
     1  'K-EFFECTIVE '       2        1
  1.09054446E+00
     1  'EPS-CONVERGE'       2        5
  9.99999975E-05  9.99999975E-06  9.99999975E-05  1.00000000E+01  1.00000000E+02
     1  'STATE-VECTOR'       1       20
         1         0         3         3         1        40        25         0
         2        13         0         0         0         0         0         0
         0         0         0         0
```

Contents of file `Geo/T2Dds/FLUXK`

```
     1  'SIGNATURE   '       3       12
L_FLUX
     1  'FLUXDIRECT  '       0       -1
     2  'FLUX  1     '       2       13
  1.74329007E+00  1.32087409E+00  9.99329865E-01  1.74041021E+00  1.31733096E+00
  1.03463793E+00  9.05467331E-01  1.74042153E+00  1.31734836E+00  1.03464460E+00
  1.74328923E+00  1.32085657E+00  9.99328434E-01
     2  'FLUX  2     '       2       13
  8.95119727E-01  1.32407379E+00  1.65016866E+00  8.99852335E-01  1.32920706E+00
  1.61954892E+00  1.78140533E+00  8.99832964E-01  1.32917917E+00  1.61954045E+00
  8.95101488E-01  1.32408094E+00  1.65015745E+00
     2  '1/EIGENVALUE'       2        1
  1.09054828E+00
     1  'K-EFFECTIVE '       2        1
  1.09054828E+00
     1  'EPS-CONVERGE'       2        5
  4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
     1  'STATE-VECTOR'       1       20
         1         0         3         3         1         4        25         0
         2        13         0         0         0         0         0         0
         0         0         0         0
```

Contents of file Geo/T2Dds/FLUXB0

```
      1  'SIGNATURE   '       3      12
  L_FLUX
      1  'FLUXDIRECT  '       0      -1
      2  'FLUX  1     '       2      13
   9.19571444E-02  6.91834465E-02  5.18804006E-02  9.17983651E-02  6.89986125E-02
   5.37914895E-02  4.68674302E-02  9.17989239E-02  6.89995289E-02  5.37918322E-02
   9.19570550E-02  6.91824630E-02  5.18802889E-02
      2  'FLUX  2     '       2      13
   4.41604555E-02  6.53592274E-02  8.14952254E-02  4.43675630E-02  6.55601621E-02
   7.99089521E-02  8.77962261E-02  4.43666205E-02  6.55587986E-02  7.99085572E-02
   4.41595465E-02  6.53595850E-02  8.14946815E-02
      2  'DIFFB1HOM   '       2       2
   1.03435767E+00  7.63059080E-01
      2  'B2  B1HOM   '       2       1
   4.01627796E-04
      2  '1/EIGENVALUE'       2       1
   9.99998033E-01
      2  'PNL         '       2       2
   9.98420417E-01  9.99205410E-01
      1  'K-EFFECTIVE '       2       1
   9.99998033E-01
      1  'EPS-CONVERGE'       2       5
   4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
      1  'STATE-VECTOR'       1      20
          4         2         3         3         1         4       131         0
          2        13         0         0         0         0         0         0
          0         0         0         0
```

Contents of file Geo/T2Dds/FLUXB1

```
      1  'SIGNATURE   '       3      12
  L_FLUX
      1  'FLUXDIRECT  '       0      -1
      2  'FLUX  1     '       2      13
   9.18546841E-02  6.90856501E-02  5.17875180E-02  9.16965529E-02  6.89015612E-02
   5.36987633E-02  4.67778631E-02  9.16971117E-02  6.89024851E-02  5.36991060E-02
   9.18545946E-02  6.90846816E-02  5.17874062E-02
      2  'FLUX  2     '       2      13
   4.41660918E-02  6.53656945E-02  8.15016553E-02  4.43737842E-02  6.55677691E-02
   7.99169540E-02  8.78063664E-02  4.43728305E-02  6.55663982E-02  7.99165368E-02
   4.41651903E-02  6.53660521E-02  8.15010965E-02
      2  'DIFFB1HOM   '       2       2
   1.27469993E+00  8.65831077E-01
      2  'B2  B1HOM   '       2       1
   3.40281345E-04
      2  '1/EIGENVALUE'       2       1
   1.00000072E+00
      2  'PNL         '       2       2
   9.98350739E-01  9.99236047E-01
      1  'K-EFFECTIVE '       2       1
   1.00000072E+00
      1  'EPS-CONVERGE'       2       5
   4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
      1  'STATE-VECTOR'       1      20
          4         2         3         3         1         4       131         0
```

```
          2        13         0         0         0         0         0         0
          0         0         0         0
```

Contents of file `Geo/T2Dds/FLUXKB0`

```
      1  'SIGNATURE   '       3      12
 L_FLUX
      1  'FLUXDIRECT  '       0      -1
      2  'FLUX  1     '       2      13
   9.19571966E-02  6.91834539E-02  5.18803932E-02  9.17983204E-02  6.89985901E-02
   5.37914746E-02  4.68674190E-02  9.17989388E-02  6.89995363E-02  5.37918434E-02
   9.19571742E-02  6.91825300E-02  5.18803224E-02
      2  'FLUX  2     '       2      13
   4.41604443E-02  6.53592125E-02  8.14952180E-02  4.43675555E-02  6.55601546E-02
   7.99089372E-02  8.77962038E-02  4.43666205E-02  6.55587986E-02  7.99085423E-02
   4.41595502E-02  6.53595924E-02  8.14946964E-02
      2  'DIFFB1HOM   '       2       2
   1.03435767E+00  7.63059080E-01
      2  'B2  B1HOM   '       2       1
   4.01628000E-04
      2  '1/EIGENVALUE'       2       1
   9.99997973E-01
      2  'PNL         '       2       2
   9.98420358E-01  9.99205410E-01
      1  'K-EFFECTIVE '       2       1
   9.99997973E-01
      1  'EPS-CONVERGE'       2       5
   4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
      1  'STATE-VECTOR'       1      20
          3         2         3         3         1         4       131         0
          2        13         0         0         0         0         0         0
          0         0         0         0
```

Contents of file `Geo/T2Dds/FLUXKB1`

```
      1  'SIGNATURE   '       3      12
 L_FLUX
      1  'FLUXDIRECT  '       0      -1
      2  'FLUX  1     '       2      13
   9.18546245E-02  6.90856129E-02  5.17875031E-02  9.16964263E-02  6.89015165E-02
   5.36987484E-02  4.67778631E-02  9.16970670E-02  6.89024702E-02  5.36991134E-02
   9.18546095E-02  6.90846890E-02  5.17874360E-02
      2  'FLUX  2     '       2      13
   4.41660844E-02  6.53656945E-02  8.15016329E-02  4.43737805E-02  6.55677617E-02
   7.99169466E-02  8.78063589E-02  4.43728417E-02  6.55664131E-02  7.99165517E-02
   4.41652015E-02  6.53660670E-02  8.15011188E-02
      2  'DIFFB1HOM   '       2       2
   1.27469993E+00  8.65831077E-01
      2  'B2  B1HOM   '       2       1
   3.40280996E-04
      2  '1/EIGENVALUE'       2       1
   1.00000083E+00
      2  'PNL         '       2       2
   9.98350799E-01  9.99236107E-01
      1  'K-EFFECTIVE '       2       1
   1.00000083E+00
      1  'EPS-CONVERGE'       2       5
```

```
    4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
       1  'STATE-VECTOR'       1       20
           3         2         3         3         1         4       131         0
           2        13         0         0         0         0         0         0
           0         0         0         0
```

Contents of file `Geo/T2Dds/FLUXKB1DB2`

```
       1  'SIGNATURE   '       3       12
  L_FLUX
       1  'FLUXDIRECT  '       0       -1
       2  'FLUX  1     '       2       13
    9.18546543E-02  6.90856501E-02  5.17875291E-02  9.16965157E-02  6.89015612E-02
    5.36987782E-02  4.67778705E-02  9.16970447E-02  6.89024553E-02  5.36991097E-02
    9.18545350E-02  6.90846518E-02  5.17874099E-02
       2  'FLUX  2     '       2       13
    4.41666767E-02  6.53665662E-02  8.15027431E-02  4.43743728E-02  6.55686408E-02
    7.99180120E-02  8.78075287E-02  4.43734229E-02  6.55672699E-02  7.99176022E-02
    4.41657752E-02  6.53669164E-02  8.15021694E-02
       2  'DIFFB1HOM   '       2        2
    1.27469993E+00  8.65831077E-01
       2  'B2  B1HOM   '       2        1
    3.40281345E-04
       2  '1/EIGENVALUE'       2        1
    1.00000238E+00
       2  'PNL         '       2        2
    9.98350799E-01  9.99236107E-01
       1  'K-EFFECTIVE '       2        1
    1.00000238E+00
       1  'EPS-CONVERGE'       2        5
    4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
       1  'STATE-VECTOR'       1       20
           2         2         3         3         1         4       131         0
           2        13         0         0         0         0         0         0
           0         0         0         0
```

Contents of file `Geo/T2Dds/EDIRES`

```
       1  'SIGNATURE   '       3       12
  L_EDIT
       1  'TITLE       '       3       72
  Verification model : T2D
       1  'STATE-VECTOR'       1       20
           1         1         0         0         0         0         0         0
           0         1         2         1         1         2        13         0
           0         0         0         0
       1  'REF:IMERGE  '       1       13
           1         1         1         1         1         1         1         1
           1         1         1         1         1
       1  'REF:IGCOND  '       1        1
           2
       1  'LAST-EDIT   '       3       12
  MAC8
       1  'MAC1        '       0       -1
       2  'FLXNORMALIZE'       2        1
    1.00000000E+00
       2  'MACROLIB    '       0       -1
```

```
      3  'TIMESTAMP   '       2       3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
      3  'ADDXSNAME   '       3      16
 NG      N2N
      3  'FISSIONNAMES'       3       8
 MACROFIS
      3  'FISSIONNB   '       1      13
         -1        -1        -1        -1        -1        -1        -1        -1
         -1        -1        -1        -1        -1
      3  'EFISS       '       2      13
   2.06069351E+02  0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00
   0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00  0.00000000E+00
   2.06069351E+02  0.00000000E+00  0.00000000E+00
      3  'GROUP  1/  2'       0      -1
      4  'NG          '       2      13
   9.39363055E-03  1.07356778E-03  2.90488206E-05  9.39363055E-03  1.07356778E-03
   2.90488206E-05  2.90488206E-05  9.39363055E-03  1.07356778E-03  2.90488206E-05
   9.39363055E-03  1.07356778E-03  2.90488206E-05
      4  'N2N         '       2      13
   9.45518768E-05  2.54264660E-06  3.32042036E-05  9.45518768E-05  2.54264660E-06
   3.32042036E-05  3.32042036E-05  9.45518768E-05  2.54264660E-06  3.32042036E-05
   9.45518768E-05  2.54264660E-06  3.32042036E-05
      4  'OVERV       '       2      13
   1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08
   1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08
   1.44596930E-08  1.44596930E-08  1.44596930E-08
      4  'TOTAL       '       2      13
   3.66972268E-01  1.19784400E-01  3.33053291E-01  3.66972268E-01  1.19784400E-01
   3.33053291E-01  3.33053291E-01  3.66972268E-01  1.19784400E-01  3.33053291E-01
   3.66972268E-01  1.19784400E-01  3.33053291E-01
      4  'ABS         '       2      13
   1.18469121E-02  1.07102608E-03 -4.13320959E-06  1.18469121E-02  1.07102608E-03
  -4.13320959E-06 -4.13320959E-06  1.18469121E-02  1.07102608E-03 -4.13320959E-06
   1.18469121E-02  1.07102608E-03 -4.13320959E-06
      4  'PRODUCTION  '       2      13
   6.47233129E-02  0.00000000E+00  0.00000000E+00  6.50949553E-02  0.00000000E+00
   0.00000000E+00  0.00000000E+00  6.50933534E-02  0.00000000E+00  0.00000000E+00
   6.47221878E-02  0.00000000E+00  0.00000000E+00
      4  'NUSIGF      '       2      13
   6.97151665E-03  0.00000000E+00  0.00000000E+00  6.97151665E-03  0.00000000E+00
   0.00000000E+00  0.00000000E+00  6.97151665E-03  0.00000000E+00  0.00000000E+00
   6.97151665E-03  0.00000000E+00  0.00000000E+00
      4  'CHI         '       2      13
   1.00000000E+00  0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  0.00000000E+00
   1.00000000E+00  0.00000000E+00  0.00000000E+00
      4  'NFTOT       '       2      13
   2.54667969E-03  0.00000000E+00  0.00000000E+00  2.54667969E-03  0.00000000E+00
   0.00000000E+00  0.00000000E+00  2.54667969E-03  0.00000000E+00  0.00000000E+00
   2.54667969E-03  0.00000000E+00  0.00000000E+00
      4  'TRANC       '       2      13
   4.13986780E-02  1.15263890E-02  6.83705956E-02  4.13986780E-02  1.15263890E-02
   6.83705956E-02  6.83705956E-02  4.13986780E-02  1.15263890E-02  6.83705956E-02
   4.13986780E-02  1.15263890E-02  6.83705956E-02
      4  'DIFFHOM     '       2      13
   1.27469993E+00  1.27469993E+00  1.27469993E+00  1.27469993E+00  1.27469993E+00
```

```
 1.27469993E+00  1.27469993E+00  1.27469993E+00  1.27469993E+00  1.27469993E+00
 1.27469993E+00  1.27469993E+00  1.27469993E+00
    4  'FLUX-INTG   '       2       13
 3.85490155E+00  1.80984986E+00  1.76129723E+01  3.84826517E+00  1.80502725E+00
 7.52189445E+00  1.87134857E+01  3.84828854E+00  1.80505145E+00  7.52194214E+00
 3.85489774E+00  1.80982447E+00  1.76129360E+01
    4  'SIGW 0      '       2       13
 3.54064226E-01  1.18589744E-01  3.21982294E-01  3.54064226E-01  1.18589744E-01
 3.21982294E-01  3.21982294E-01  3.54064226E-01  1.18589744E-01  3.21982294E-01
 3.54064226E-01  1.18589744E-01  3.21982294E-01
    4  'SCAD 0      '       2       26
 3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05
 3.21982294E-01  3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01
 6.96978459E-05  3.21982294E-01  6.96978459E-05  3.21982294E-01  3.84946383E-04
 3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05  3.21982294E-01
 3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05
 3.21982294E-01
    4  'NJJD 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
    4  'IJJD 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
    4  'IPOD 0      '       1       13
       1         3         5         7         9        11        13        15
      17        19        21        23        25
    4  'SCAA 0      '       2       26
 1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02
 3.21982294E-01  1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01
 1.10751297E-02  3.21982294E-01  1.10751297E-02  3.21982294E-01  1.06112938E-03
 3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02  3.21982294E-01
 1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02
 3.21982294E-01
    4  'NJJA 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
    4  'IJJA 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
    4  'IPOA 0      '       1       13
       1         3         5         7         9        11        13        15
      17        19        21        23        25
    4  'SIGW 1      '       2       13
 4.56812121E-02  1.31940767E-02  6.90087155E-02  4.56812121E-02  1.31940767E-02
 6.90087155E-02  6.90087155E-02  4.56812121E-02  1.31940767E-02  6.90087155E-02
 4.56812121E-02  1.31940767E-02  6.90087155E-02
    4  'SCAD 1      '       2       26
-3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05
 6.90087155E-02 -3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02
 3.57782919E-05  6.90087155E-02  3.57782919E-05  6.90087155E-02 -3.03763445E-05
 4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05  6.90087155E-02
-3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05
 6.90087155E-02
    4  'NJJD 1      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
```

```
    4  'IJJD 1      '        1       13
       2         2         2          2         2         2         2         2
       2         2         2          2         2
    4  'IPOD 1      '        1       13
       1         3         5          7         9        11        13        15
      17        19        21         23        25
    4  'SCAA 1      '        2       26
 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04
  6.90087155E-02 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02
 -8.15864187E-04  6.90087155E-02 -8.15864187E-04  6.90087155E-02 -1.17839634E-04
  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04  6.90087155E-02
 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04
  6.90087155E-02
    4  'NJJA 1      '        1       13
       2         2         2          2         2         2         2         2
       2         2         2          2         2
    4  'IJJA 1      '        1       13
       2         2         2          2         2         2         2         2
       2         2         2          2         2
    4  'IPOA 1      '        1       13
       1         3         5          7         9        11        13        15
      17        19        21         23        25
    3  'GROUP  2/  2'        0       -1
    4  'NG          '        2       13
  4.98777106E-02  2.65579834E-03  4.47517668E-05  4.98777106E-02  2.65579834E-03
  4.47517668E-05  4.47517668E-05  4.98777106E-02  2.65579834E-03  4.47517668E-05
  4.98777106E-02  2.65579834E-03  4.47517668E-05
    4  'N2N         '        2       13
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'OVERV       '        2       13
  6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06
  6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06
  6.83756662E-06  6.83756662E-06  6.83756662E-06
    4  'TOTAL       '        2       13
  4.59974349E-01  8.63326862E-02  4.56327349E-01  4.59974349E-01  8.63326862E-02
  4.56327349E-01  4.56327349E-01  4.59974349E-01  8.63326862E-02  4.56327349E-01
  4.59974349E-01  8.63326862E-02  4.56327349E-01
    4  'ABS         '        2       13
  9.54742879E-02  2.65579647E-03  4.47728744E-05  9.54742879E-02  2.65579647E-03
  4.47728744E-05  4.47728744E-05  9.54742879E-02  2.65579647E-03  4.47728744E-05
  9.54742879E-02  2.65579647E-03  4.47728744E-05
    4  'PRODUCTION  '        2       13
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NUSIGF      '        2       13
  1.20109625E-01  0.00000000E+00  0.00000000E+00  1.20109625E-01  0.00000000E+00
  0.00000000E+00  0.00000000E+00  1.20109625E-01  0.00000000E+00  0.00000000E+00
  1.20109625E-01  0.00000000E+00  0.00000000E+00
    4  'CHI         '        2       13
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NFTOT       '        2       13
```

```
4.55965549E-02  0.00000000E+00  0.00000000E+00  4.55965549E-02  0.00000000E+00
0.00000000E+00  0.00000000E+00  4.55965549E-02  0.00000000E+00  0.00000000E+00
4.55965549E-02  0.00000000E+00  0.00000000E+00
   4  'TRANC       '       2       13
1.49479350E-02  6.65545289E-04  5.66625595E-02  1.49479350E-02  6.65545289E-04
5.66625595E-02  5.66625595E-02  1.49479350E-02  6.65545289E-04  5.66625595E-02
1.49479350E-02  6.65545289E-04  5.66625595E-02
   4  'DIFFHOM     '       2       13
8.65831077E-01  8.65831077E-01  8.65831077E-01  8.65831077E-01  8.65831077E-01
8.65831077E-01  8.65831077E-01  8.65831077E-01  8.65831077E-01  8.65831077E-01
8.65831077E-01  8.65831077E-01  8.65831077E-01
   4  'FLUX-INTG   '       2       13
1.85353565E+00  1.71239746E+00  2.77187729E+01  1.86225200E+00  1.71769130E+00
1.11944265E+01  3.51269379E+01  1.86221194E+00  1.71765530E+00  1.11943684E+01
1.85349786E+00  1.71240687E+00  2.77185822E+01
   4  'SIGW 0      '       2       13
3.64115119E-01  8.36442187E-02  4.56212878E-01  3.64115119E-01  8.36442187E-02
4.56212878E-01  4.56212878E-01  3.64115119E-01  8.36442187E-02  4.56212878E-01
3.64115119E-01  8.36442187E-02  4.56212878E-01
   4  'SCAD 0      '       2       26
3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01
1.10751297E-02  3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04
4.56212878E-01  1.10751297E-02  4.56212878E-01  1.10751297E-02  3.64115119E-01
1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01  1.10751297E-02
3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01
1.10751297E-02
   4  'NJJD 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
   4  'IJJD 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
   4  'IPOD 0      '       1       13
       1         3         5         7         9        11        13        15
      17        19        21        23        25
   4  'SCAA 0      '       2       26
3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01
6.96978459E-05  3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05
4.56212878E-01  6.96978459E-05  4.56212878E-01  6.96978459E-05  3.64115119E-01
3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01  6.96978459E-05
3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01
6.96978459E-05
   4  'NJJA 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
   4  'IJJA 0      '       1       13
       2         2         2         2         2         2         2         2
       2         2         2         2         2
   4  'IPOA 0      '       1       13
       1         3         5         7         9        11        13        15
      17        19        21        23        25
   4  'SIGW 1      '       2       13
1.51528064E-02  6.68138091E-04  5.80918901E-02  1.51528064E-02  6.68138091E-04
5.80918901E-02  5.80918901E-02  1.51528064E-02  6.68138091E-04  5.80918901E-02
1.51528064E-02  6.68138091E-04  5.80918901E-02
   4  'SCAD 1      '       2       26
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 1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02
-8.15864187E-04  1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05
 5.80918901E-02 -8.15864187E-04  5.80918901E-02 -8.15864187E-04  1.51528064E-02
-1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02 -8.15864187E-04
 1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02
-8.15864187E-04
    4  'NJJD 1      '       1       13
        2         2         2         2         2         2         2         2
        2         2         2         2         2
    4  'IJJD 1      '       1       13
        2         2         2         2         2         2         2         2
        2         2         2         2         2
    4  'IPOD 1      '       1       13
        1         3         5         7         9        11        13        15
       17        19        21        23        25
    4  'SCAA 1      '       2       26
 1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02
 3.57782919E-05  1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07
 5.80918901E-02  3.57782919E-05  5.80918901E-02  3.57782919E-05  1.51528064E-02
-3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02  3.57782919E-05
 1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02
 3.57782919E-05
    4  'NJJA 1      '       1       13
        2         2         2         2         2         2         2         2
        2         2         2         2         2
    4  'IJJA 1      '       1       13
        2         2         2         2         2         2         2         2
        2         2         2         2         2
    4  'IPOA 1      '       1       13
        1         3         5         7         9        11        13        15
       17        19        21        23        25
    3  'DIFFB1HOM   '       2        2
 1.27470005E+00  8.65830958E-01
    3  'B2  B1HOM   '       2        1
 3.40281345E-04
    3  'FGWITHUPSCAT'       1       26
        1         1         1         1         1         1         1         1
        1         1         1         1         1         1         1         1
        1         1         1         1         1         1         1         1
        1         1
    3  'STATE-VECTOR'       1       20
        2        13         2         1         2         2         0         0
        2         0         0         0         0         0         0         0
        0         0         0         0
    3  'SIGNATURE   '       3       12
L_MACROLIB
    3  'ENERGY      '       2        3
 1.00000000E+07  6.25000000E-01  1.99999995E-04
    3  'DELTAU      '       2        2
 1.65880985E+01  8.04718971E+00
    3  'VOLUME      '       2       13
 4.19673920E+01  2.61971893E+01  3.40100739E+02  4.19673920E+01  2.61971893E+01
 1.40075745E+02  4.00050018E+02  4.19673920E+01  2.61971893E+01  1.40075745E+02
 4.19673920E+01  2.61971893E+01  3.40100739E+02
    3  'MATCOD      '       1       13
        1         2         3         4         5         6         7         8
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          9         10         11         12         13
      3  'KEYFLX      '        1       13
          1          2          3          4          5          6          7          8
          9         10         11         12         13
      3  'K-EFFECTIVE '        2        1
   1.00000072E+00
      3  'FLUXDISAFACT'        2        2
   1.63584900E+00  5.68155229E-01
      1  'MAC2        '        0       -1
      2  'FLXNORMALIZE'        2        1
   1.00000000E+00
      2  'MACROLIB    '        0       -1
      3  'TIMESTAMP   '        2        3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
      3  'ADDXSNAME   '        3       16
 NG      N2N
      3  'FISSIONNAMES'        3        8
 MACROFIS
      3  'FISSIONNB   '        1        3
         -1         -1         -1
      3  'EFISS       '        2        3
   2.06069351E+02  0.00000000E+00  0.00000000E+00
      3  'GROUP  1/  2'        0       -1
      4  'NG          '        2        3
   9.39363055E-03  1.07356778E-03  2.90488206E-05
      4  'N2N         '        2        3
   9.45518768E-05  2.54264660E-06  3.32042036E-05
      4  'OVERV       '        2        3
   1.44596930E-08  1.44596930E-08  1.44596930E-08
      4  'TOTAL       '        2        3
   3.66972268E-01  1.19784400E-01  3.33053291E-01
      4  'ABS         '        2        3
   1.18469121E-02  1.07102608E-03 -4.13320959E-06
      4  'PRODUCTION  '        2        3
   6.49082884E-02  0.00000000E+00  0.00000000E+00
      4  'NUSIGF      '        2        3
   6.97151665E-03  0.00000000E+00  0.00000000E+00
      4  'CHI         '        2        3
   1.00000000E+00  0.00000000E+00  0.00000000E+00
      4  'NFTOT       '        2        3
   2.54667969E-03  0.00000000E+00  0.00000000E+00
      4  'TRANC       '        2        3
   4.13986780E-02  1.15263890E-02  6.83705956E-02
      4  'DIFFHOM     '        2        3
   1.27469993E+00  1.27469993E+00  1.27469993E+00
      4  'FLUX-INTG   '        2        3
   1.54063530E+01  7.22975302E+00  6.89832306E+01
      4  'SIGW 0      '        2        3
   3.54064226E-01  1.18589744E-01  3.21982294E-01
      4  'SCAD 0      '        2        6
   3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05
   3.21982294E-01
      4  'NJJD 0      '        1        3
          2          2          2
      4  'IJJD 0      '        1        3
          2          2          2
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    4  'IPOD 0       '       1        3
        1          3          5
    4  'SCAA 0       '       2        6
 1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02
 3.21982294E-01
    4  'NJJA 0       '       1        3
        2          2          2
    4  'IJJA 0       '       1        3
        2          2          2
    4  'IPOA 0       '       1        3
        1          3          5
    4  'SIGW 1       '       2        3
 4.56812121E-02  1.31940767E-02  6.90087155E-02
    4  'SCAD 1       '       2        6
-3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05
 6.90087155E-02
    4  'NJJD 1       '       1        3
        2          2          2
    4  'IJJD 1       '       1        3
        2          2          2
    4  'IPOD 1       '       1        3
        1          3          5
    4  'SCAA 1       '       2        6
-1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04
 6.90087155E-02
    4  'NJJA 1       '       1        3
        2          2          2
    4  'IJJA 1       '       1        3
        2          2          2
    4  'IPOA 1       '       1        3
        1          3          5
    3  'GROUP  2/  2'       0       -1
    4  'NG           '       2        3
 4.98777106E-02  2.65579834E-03  4.47517668E-05
    4  'N2N          '       2        3
 0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'OVERV        '       2        3
 6.83756662E-06  6.83756662E-06  6.83756662E-06
    4  'TOTAL        '       2        3
 4.59974349E-01  8.63326862E-02  4.56327349E-01
    4  'ABS          '       2        3
 9.54742879E-02  2.65579647E-03  4.47728744E-05
    4  'PRODUCTION   '       2        3
 0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NUSIGF       '       2        3
 1.20109625E-01  0.00000000E+00  0.00000000E+00
    4  'CHI          '       2        3
 0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NFTOT        '       2        3
 4.55965549E-02  0.00000000E+00  0.00000000E+00
    4  'TRANC        '       2        3
 1.49479350E-02  6.65545289E-04  5.66625595E-02
    4  'DIFFHOM      '       2        3
 8.65831077E-01  8.65831077E-01  8.65831077E-01
    4  'FLUX-INTG    '       2        3
 7.43149757E+00  6.86015081E+00  1.12953087E+02
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     4  'SIGW 0      '       2       3
   3.64115119E-01  8.36442187E-02  4.56212878E-01
     4  'SCAD 0      '       2       6
   3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01
   1.10751297E-02
     4  'NJJD 0      '       1       3
         2         2         2
     4  'IJJD 0      '       1       3
         2         2         2
     4  'IPOD 0      '       1       3
         1         3         5
     4  'SCAA 0      '       2       6
   3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01
   6.96978459E-05
     4  'NJJA 0      '       1       3
         2         2         2
     4  'IJJA 0      '       1       3
         2         2         2
     4  'IPOA 0      '       1       3
         1         3         5
     4  'SIGW 1      '       2       3
   1.51528064E-02  6.68138091E-04  5.80918901E-02
     4  'SCAD 1      '       2       6
   1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02
  -8.15864187E-04
     4  'NJJD 1      '       1       3
         2         2         2
     4  'IJJD 1      '       1       3
         2         2         2
     4  'IPOD 1      '       1       3
         1         3         5
     4  'SCAA 1      '       2       6
   1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02
   3.57782919E-05
     4  'NJJA 1      '       1       3
         2         2         2
     4  'IJJA 1      '       1       3
         2         2         2
     4  'IPOA 1      '       1       3
         1         3         5
     3  'DIFFB1HOM   '       2       2
   1.27469993E+00  8.65831077E-01
     3  'B2  B1HOM   '       2       1
   3.40281345E-04
     3  'FGWITHUPSCAT'       1       6
         1         1         1         1         1         1
     3  'STATE-VECTOR'       1      20
         2         3         2         1         2         2         0         0
         2         0         0         0         0         0         0         0
         0         0         0         0
     3  'SIGNATURE   '       3      12
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     3  'ENERGY      '       2       3
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     3  'DELTAU      '       2       2
   1.65880985E+01  8.04718971E+00
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     3  'KEYFLX      '       1       3
         1          2          3
     3  'K-EFFECTIVE '       2       1
  1.00000072E+00
     3  'FLUXDISAFACT'       2       2
  1.63584900E+00  5.68155229E-01
     1  'MAC3        '       0      -1
     2  'FLXNORMALIZE'       2       1
  1.00000000E+00
     2  'MACROLIB    '       0      -1
     3  'TIMESTAMP   '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
     3  'ADDXSNAME   '       3      16
NG      N2N
     3  'FISSIONNAMES'       3       8
MACROFIS
     3  'FISSIONNB   '       1       3
        -1         -1         -1
     3  'EFISS       '       2       3
  2.06069351E+02  0.00000000E+00  0.00000000E+00
     3  'GROUP  1/  2'       0      -1
     4  'NG          '       2       3
  9.39363055E-03  1.07356778E-03  2.90488206E-05
     4  'N2N         '       2       3
  9.45518768E-05  2.54264660E-06  3.32042036E-05
     4  'OVERV       '       2       3
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     4  'TOTAL       '       2       3
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     4  'ABS         '       2       3
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  6.49082884E-02  0.00000000E+00  0.00000000E+00
     4  'NUSIGF      '       2       3
  6.97151665E-03  0.00000000E+00  0.00000000E+00
     4  'CHI         '       2       3
  1.00000000E+00  0.00000000E+00  0.00000000E+00
     4  'NFTOT       '       2       3
  2.54667969E-03  0.00000000E+00  0.00000000E+00
     4  'TRANC       '       2       3
  4.13986780E-02  1.15263890E-02  6.83705956E-02
     4  'DIFFHOM     '       2       3
  1.27469993E+00  1.27469993E+00  1.27469993E+00
     4  'FLUX-INTG   '       2       3
  1.54063530E+01  7.22975302E+00  6.89832306E+01
     4  'SIGW 0      '       2       3
  3.54064226E-01  1.18589744E-01  3.21982294E-01
     4  'SCAD 0      '       2       6
  3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05
  3.21982294E-01
     4  'NJJD 0      '       1       3
         2          2          2
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         2          2          2
     4  'IPOD 0       '        1        3
         1          3          5
     4  'SCAA 0       '        2        6
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  3.21982294E-01
     4  'NJJA 0       '        1        3
         2          2          2
     4  'IJJA 0       '        1        3
         2          2          2
     4  'IPOA 0       '        1        3
         1          3          5
     4  'SIGW 1       '        2        3
  4.56812121E-02  1.31940767E-02  6.90087155E-02
     4  'SCAD 1       '        2        6
 -3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05
  6.90087155E-02
     4  'NJJD 1       '        1        3
         2          2          2
     4  'IJJD 1       '        1        3
         2          2          2
     4  'IPOD 1       '        1        3
         1          3          5
     4  'SCAA 1       '        2        6
 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04
  6.90087155E-02
     4  'NJJA 1       '        1        3
         2          2          2
     4  'IJJA 1       '        1        3
         2          2          2
     4  'IPOA 1       '        1        3
         1          3          5
     3  'GROUP  2/  2'        0       -1
     4  'NG           '        2        3
  4.98777106E-02  2.65579834E-03  4.47517668E-05
     4  'N2N          '        2        3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
     4  'OVERV        '        2        3
  6.83756662E-06  6.83756662E-06  6.83756662E-06
     4  'TOTAL        '        2        3
  4.59974349E-01  8.63326862E-02  4.56327349E-01
     4  'ABS          '        2        3
  9.54742879E-02  2.65579647E-03  4.47728744E-05
     4  'PRODUCTION   '        2        3
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     4  'NUSIGF       '        2        3
  1.20109625E-01  0.00000000E+00  0.00000000E+00
     4  'CHI          '        2        3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
     4  'NFTOT        '        2        3
  4.55965549E-02  0.00000000E+00  0.00000000E+00
     4  'TRANC        '        2        3
  1.49479350E-02  6.65545289E-04  5.66625595E-02
     4  'DIFFHOM      '        2        3
  8.65831077E-01  8.65831077E-01  8.65831077E-01
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    4  'SCAD 0      '       2       6
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  1.10751297E-02
    4  'NJJD 0      '       1       3
        2         2         2
    4  'IJJD 0      '       1       3
        2         2         2
    4  'IPOD 0      '       1       3
        1         3         5
    4  'SCAA 0      '       2       6
  3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01
  6.96978459E-05
    4  'NJJA 0      '       1       3
        2         2         2
    4  'IJJA 0      '       1       3
        2         2         2
    4  'IPOA 0      '       1       3
        1         3         5
    4  'SIGW 1      '       2       3
  1.51528064E-02  6.68138091E-04  5.80918901E-02
    4  'SCAD 1      '       2       6
  1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02
 -8.15864187E-04
    4  'NJJD 1      '       1       3
        2         2         2
    4  'IJJD 1      '       1       3
        2         2         2
    4  'IPOD 1      '       1       3
        1         3         5
    4  'SCAA 1      '       2       6
  1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02
  3.57782919E-05
    4  'NJJA 1      '       1       3
        2         2         2
    4  'IJJA 1      '       1       3
        2         2         2
    4  'IPOA 1      '       1       3
        1         3         5
    3  'DIFFB1HOM   '       2       2
  1.27469993E+00  8.65831077E-01
    3  'B2  B1HOM   '       2       1
  3.40281345E-04
    3  'FGWITHUPSCAT'       1       6
        1         1         1         1         1         1
    3  'STATE-VECTOR'       1      20
        2         3         2         1         2         2         0         0
        2         0         0         0         0         0         0         0
        0         0         0         0
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 L_MACROLIB
    3  'ENERGY      '       2       3
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          1         2         3
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          1         2         3
      3  'K-EFFECTIVE '       2       1
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      3  'FLUXDISAFACT'       2       2
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      1  'MAC4        '       0      -1
      2  'FLXNORMALIZE'       2       1
   1.00000000E+00
      2  'MACROLIB    '       0      -1
      3  'TIMESTAMP   '       2       3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
      3  'ADDXSNAME   '       3      16
 NG      N2N
      3  'FISSIONNAMES'       3       8
 MACROFIS
      3  'FISSIONNB   '       1       1
         -1
      3  'EFISS       '       2       1
   2.06069351E+02
      3  'GROUP  1/  2'       0      -1
      4  'NG          '       2       1
   1.68618443E-03
      4  'N2N         '       2       1
   4.11006658E-05
      4  'OVERV       '       2       1
   1.44596930E-08
      4  'TOTAL       '       2       1
   3.21927756E-01
      4  'ABS         '       2       1
   2.07353430E-03
      4  'PRODUCTION  '       2       1
   1.09147271E-02
      4  'NUSIGF      '       2       1
   1.17230322E-03
      4  'CHI         '       2       1
   1.00000000E+00
      4  'NFTOT       '       2       1
   4.28239815E-04
      4  'TRANC       '       2       1
   5.93494810E-02
      4  'DIFFHOM     '       2       1
   1.27469993E+00
      4  'FLUX-INTG   '       2       1
   9.16193390E+01
      4  'SIGW 0      '       2       1
   3.11327219E-01
      4  'SCAD 0      '       2       2
   8.61131339E-05  3.11327219E-01
      4  'NJJD 0      '       1       1
```

```
        2
    4  'IJJD 0      '       1       1
        2
    4  'IPOD 0      '       1       1
        1
    4  'SCAA 0      '       2       2
 8.52702279E-03  3.11327219E-01
    4  'NJJA 0      '       1       1
        2
    4  'IJJA 0      '       1       1
        2
    4  'IPOA 0      '       1       1
        1
    4  'SIGW 1      '       2       1
 6.06816746E-02
    4  'SCAD 1      '       2       2
 2.99455278E-05  6.06816746E-02
    4  'NJJD 1      '       1       1
        2
    4  'IJJD 1      '       1       1
        2
    4  'IPOD 1      '       1       1
        1
    4  'SCAA 1      '       2       2
-6.36049837E-04  6.06816746E-02
    4  'NJJA 1      '       1       1
        2
    4  'IJJA 1      '       1       1
        2
    4  'IPOA 1      '       1       1
        1
    3  'GROUP  2/  2'       0      -1
    4  'NG          '       2       1
 3.09592462E-03
    4  'N2N         '       2       1
 0.00000000E+00
    4  'OVERV       '       2       1
 6.83756662E-06
    4  'TOTAL       '       2       1
 4.36592817E-01
    4  'ABS         '       2       1
 5.75892814E-03
    4  'PRODUCTION  '       2       1
 0.00000000E+00
    4  'NUSIGF      '       2       1
 7.01478450E-03
    4  'CHI         '       2       1
 0.00000000E+00
    4  'NFTOT       '       2       1
 2.66298396E-03
    4  'TRANC       '       2       1
 5.12073226E-02
    4  'DIFFHOM     '       2       1
 8.65831077E-01
    4  'FLUX-INTG   '       2       1
 1.27244736E+02
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    4  'SIGW 0      '       2       1
 4.30747777E-01
    4  'SCAD 0      '       2       2
 4.30747777E-01  8.52702279E-03
    4  'NJJD 0      '       1       1
        2
    4  'IJJD 0      '       1       1
        2
    4  'IPOD 0      '       1       1
        1
    4  'SCAA 0      '       2       2
 4.30747777E-01  8.61131339E-05
    4  'NJJA 0      '       1       1
        2
    4  'IJJA 0      '       1       1
        2
    4  'IPOA 0      '       1       1
        1
    4  'SIGW 1      '       2       1
 5.24882227E-02
    4  'SCAD 1      '       2       2
 5.24882227E-02 -6.36049837E-04
    4  'NJJD 1      '       1       1
        2
    4  'IJJD 1      '       1       1
        2
    4  'IPOD 1      '       1       1
        1
    4  'SCAA 1      '       2       2
 5.24882227E-02  2.99455278E-05
    4  'NJJA 1      '       1       1
        2
    4  'IJJA 1      '       1       1
        2
    4  'IPOA 1      '       1       1
        1
    3  'DIFFB1HOM   '       2       2
 1.27469993E+00  8.65831077E-01
    3  'B2  B1HOM   '       2       1
 3.40281345E-04
    3  'FGWITHUPSCAT'       1       2
        1          1
    3  'STATE-VECTOR'       1      20
        2          1          2          1          2          2          0          0
        2          0          0          0          0          0          0          0
        0          0          0          0
    3  'SIGNATURE   '       3      12
L_MACROLIB
    3  'ENERGY      '       2       3
 1.00000000E+07  6.25000000E-01  1.99999995E-04
    3  'DELTAU      '       2       2
 1.65880985E+01  8.04718971E+00
    3  'VOLUME      '       2       1
 1.63306128E+03
    3  'MATCOD      '       1       1
        1
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      3  'KEYFLX      '       1       1
          1
      3  'K-EFFECTIVE '       2       1
   1.00000072E+00
      3  'FLUXDISAFACT'       2       2
   1.63584900E+00  5.68155229E-01
      1  'MAC5        '       0      -1
      2  'FLXNORMALIZE'       2       1
   1.00000000E+00
      2  'MACROLIB    '       0      -1
      3  'TIMESTAMP   '       2       3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
      3  'ADDXSNAME   '       3      16
 NG      N2N
      3  'FISSIONNAMES'       3       8
 MACROFIS
      3  'FISSIONNB   '       1      13
         -1         -1         -1         -1         -1         -1         -1         -1
         -1         -1         -1         -1         -1
      3  'EFISS       '       2      13
   2.06069351E+02  0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00
   0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00  0.00000000E+00
   2.06069351E+02  0.00000000E+00  0.00000000E+00
      3  'GROUP  1/  1'       0      -1
      4  'NG          '       2      13
   2.25388557E-02  1.84279471E-03  3.86506217E-05  2.25958601E-02  1.84506958E-03
   3.84409177E-05  3.92938455E-05  2.25956161E-02  1.84505596E-03  3.84408741E-05
   2.25386824E-02  1.84280251E-03  3.86506035E-05
      4  'N2N         '       2      13
   6.38507845E-05  1.30649789E-06  1.29009977E-05  6.37176418E-05  1.30284218E-06
   1.33444237E-05  1.15408902E-05  6.37182166E-05  1.30286401E-06  1.33445155E-05
   6.38511847E-05  1.30648550E-06  1.29010350E-05
      4  'OVERV       '       2      13
   2.22992981E-06  3.33162347E-06  4.18655054E-06  2.23953748E-06  3.34143328E-06
   4.09543100E-06  4.46603781E-06  2.23949610E-06  3.34137462E-06  4.09541235E-06
   2.22990070E-06  3.33165667E-06  4.18654281E-06
      4  'TOTAL       '       2      13
   3.97170156E-01  1.03521310E-01  4.08431053E-01  3.97301108E-01  1.03473216E-01
   4.06784803E-01  4.13480610E-01  3.97300541E-01  1.03473499E-01  4.06784445E-01
   3.97169739E-01  1.03521146E-01  4.08430934E-01
      4  'ABS         '       2      13
   3.90008092E-02  1.84148783E-03  2.57711472E-05  3.91185656E-02  1.84376631E-03
   2.51180281E-05  2.77744330E-05  3.91180590E-02  1.84375269E-03  2.51178935E-05
   3.90004553E-02  1.84149551E-03  2.57710908E-05
      4  'PRODUCTION  '       2      13
   4.37075831E-02  0.00000000E+00  0.00000000E+00  4.38668951E-02  0.00000000E+00
   0.00000000E+00  0.00000000E+00  4.38662060E-02  0.00000000E+00  0.00000000E+00
   4.37070988E-02  0.00000000E+00  0.00000000E+00
      4  'NUSIGF      '       2      13
   4.37075831E-02  0.00000000E+00  0.00000000E+00  4.38668914E-02  0.00000000E+00
   0.00000000E+00  0.00000000E+00  4.38662060E-02  0.00000000E+00  0.00000000E+00
   4.37070988E-02  0.00000000E+00  0.00000000E+00
      4  'CHI         '       2      13
   1.00000000E+00  0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  0.00000000E+00
   1.00000000E+00  0.00000000E+00  0.00000000E+00
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```
   4  'NFTOT       '        2       13
1.65250208E-02  0.00000000E+00  0.00000000E+00  1.65856387E-02  0.00000000E+00
0.00000000E+00  0.00000000E+00  1.65853780E-02  0.00000000E+00  0.00000000E+00
1.65248364E-02  0.00000000E+00  0.00000000E+00
   4  'TRANC       '        2       13
3.28100957E-02  6.24621427E-03  6.12115413E-02  3.27728502E-02  6.23059925E-03
6.13678992E-02  6.07319586E-02  3.27730104E-02  6.23069284E-03  6.13679290E-02
3.28102075E-02  6.24616165E-03  6.12115562E-02
   4  'DIFFHOM     '        2       13
1.14193976E+00  1.07592177E+00  1.02469099E+00  1.14136410E+00  1.07533395E+00
1.03015125E+00  1.00794291E+00  1.14136660E+00  1.07533741E+00  1.03015232E+00
1.14194155E+00  1.07591975E+00  1.02469146E+00
   4  'FLUX-INTG   '        2       13
5.70843697E+00  3.52224731E+00  4.53317451E+01  5.71051693E+00  3.52271843E+00
1.87163200E+01  5.38404236E+01  5.71050024E+00  3.52270675E+00  1.87163105E+01
5.70839548E+00  3.52223134E+00  4.53315163E+01
   4  'SIGW 0      '        2       13
3.58169347E-01  1.01679824E-01  4.08405304E-01  3.58182549E-01  1.01629451E-01
4.06759679E-01  4.13452834E-01  3.58182490E-01  1.01629749E-01  4.06759322E-01
3.58169287E-01  1.01679653E-01  4.08405155E-01
   4  'SCAD 0      '        2       13
3.58169347E-01  1.01679824E-01  4.08405304E-01  3.58182549E-01  1.01629451E-01
4.06759679E-01  4.13452834E-01  3.58182490E-01  1.01629749E-01  4.06759322E-01
3.58169287E-01  1.01679653E-01  4.08405155E-01
   4  'NJJD 0      '        1       13
       1          1          1          1          1          1          1          1
       1          1          1          1          1
   4  'IJJD 0      '        1       13
       1          1          1          1          1          1          1          1
       1          1          1          1          1
   4  'IPOD 0      '        1       13
       1          2          3          4          5          6          7          8
       9         10         11         12         13
   4  'SCAA 0      '        2       13
3.58169347E-01  1.01679824E-01  4.08405304E-01  3.58182549E-01  1.01629451E-01
4.06759679E-01  4.13452834E-01  3.58182490E-01  1.01629749E-01  4.06759322E-01
3.58169287E-01  1.01679653E-01  4.08405155E-01
   4  'NJJA 0      '        1       13
       1          1          1          1          1          1          1          1
       1          1          1          1          1
   4  'IJJA 0      '        1       13
       1          1          1          1          1          1          1          1
       1          1          1          1          1
   4  'IPOA 0      '        1       13
       1          2          3          4          5          6          7          8
       9         10         11         12         13
   4  'SIGW 1      '        2       13
3.80690619E-02  8.27821344E-03  6.29924908E-02  3.80327627E-02  8.26106686E-03
6.31330311E-02  6.25519231E-02  3.80329192E-02  8.26116931E-03  6.31330609E-02
3.80691700E-02  8.27815570E-03  6.29925057E-02
   4  'SCAD 1      '        2       13
3.80690619E-02  8.27821344E-03  6.29924908E-02  3.80327627E-02  8.26106686E-03
6.31330311E-02  6.25519231E-02  3.80329192E-02  8.26116931E-03  6.31330609E-02
3.80691700E-02  8.27815570E-03  6.29925057E-02
   4  'NJJD 1      '        1       13
       1          1          1          1          1          1          1          1
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```
       1         1         1         1         1
    4  'IJJD 1      '      1      13
       1         1         1         1         1         1         1         1
       1         1         1         1         1
    4  'IPOD 1      '      1      13
       1         2         3         4         5         6         7         8
       9        10        11        12        13
    4  'SCAA 1      '      2      13
  3.80690619E-02  8.27821344E-03  6.29924908E-02  3.80327627E-02  8.26106686E-03
  6.31330311E-02  6.25519231E-02  3.80329192E-02  8.26116931E-03  6.31330609E-02
  3.80691700E-02  8.27815570E-03  6.29925057E-02
    4  'NJJA 1      '      1      13
       1         1         1         1         1         1         1         1
       1         1         1         1         1
    4  'IJJA 1      '      1      13
       1         1         1         1         1         1         1         1
       1         1         1         1         1
    4  'IPOA 1      '      1      13
       1         2         3         4         5         6         7         8
       9        10        11        12        13
    3  'DIFFB1HOM   '      2       1
  1.03698909E+00
    3  'B2  B1HOM   '      2       1
  3.40281345E-04
    3  'FGWITHUPSCAT'      1      26
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2         2
    3  'STATE-VECTOR'      1      20
       1        13         2         1         2         2         0         0
       2         0         0         0         0         0         0         0
       0         0         0         0
    3  'SIGNATURE   '      3      12
L_MACROLIB
    3  'ENERGY      '      2       2
  1.00000000E+07  1.99999995E-04
    3  'DELTAU      '      2       1
  2.46352882E+01
    3  'VOLUME      '      2      13
  4.19673920E+01  2.61971893E+01  3.40100739E+02  4.19673920E+01  2.61971893E+01
  1.40075745E+02  4.00050018E+02  4.19673920E+01  2.61971893E+01  1.40075745E+02
  4.19673920E+01  2.61971893E+01  3.40100739E+02
    3  'MATCOD      '      1      13
       1         2         3         4         5         6         7         8
       9        10        11        12        13
    3  'KEYFLX      '      1      13
       1         2         3         4         5         6         7         8
       9        10        11        12        13
    3  'K-EFFECTIVE '      2       1
  1.00000072E+00
    3  'FLUXDISAFACT'      2       1
  1.01510572E+00
    1  'MAC6        '      0      -1
    2  'FLXNORMALIZE'      2       1
  1.00000000E+00
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      2  'MACROLIB    '        0       -1
      3  'TIMESTAMP   '        2        3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
      3  'ADDXSNAME   '        3       16
 NG      N2N
      3  'FISSIONNAMES'        3        8
 MACROFIS
      3  'FISSIONNB   '        1        3
         -1        -1        -1
      3  'EFISS       '        2        3
   2.06069351E+02  0.00000000E+00  0.00000000E+00
      3  'GROUP  1/  1'        0       -1
      4  'NG          '        2        3
   2.25672591E-02  1.84393080E-03  3.87978180E-05
      4  'N2N         '        2        3
   6.37844423E-05  1.30467231E-06  1.25897532E-05
      4  'OVERV       '        2        3
   2.23471693E-06  3.33652247E-06  4.25050803E-06
      4  'TOTAL       '        2        3
   3.97235394E-01  1.03497289E-01  4.09586579E-01
      4  'ABS         '        2        3
   3.90594825E-02  1.84262567E-03  2.62295744E-05
      4  'PRODUCTION  '        2        3
   4.37869616E-02  0.00000000E+00  0.00000000E+00
      4  'NUSIGF      '        2        3
   4.37869579E-02  0.00000000E+00  0.00000000E+00
      4  'CHI         '        2        3
   1.00000000E+00  0.00000000E+00  0.00000000E+00
      4  'NFTOT       '        2        3
   1.65552236E-02  0.00000000E+00  0.00000000E+00
      4  'TRANC       '        2        3
   3.27915363E-02  6.23841630E-03  6.11017942E-02
      4  'DIFFHOM     '        2        3
   1.14165294E+00  1.07562816E+00  1.02085841E+00
      4  'FLUX-INTG   '        2        3
   2.28378506E+01  1.40899038E+01  1.81936310E+02
      4  'SIGW 0      '        2        3
   3.58175904E-01  1.01654664E-01  4.09560353E-01
      4  'SCAD 0      '        2        3
   3.58175904E-01  1.01654664E-01  4.09560353E-01
      4  'NJJD 0      '        1        3
          1         1         1
      4  'IJJD 0      '        1        3
          1         1         1
      4  'IPOD 0      '        1        3
          1         2         3
      4  'SCAA 0      '        2        3
   3.58175904E-01  1.01654664E-01  4.09560353E-01
      4  'NJJA 0      '        1        3
          1         1         1
      4  'IJJA 0      '        1        3
          1         1         1
      4  'IPOA 0      '        1        3
          1         2         3
      4  'SIGW 1      '        2        3
   3.80509794E-02  8.26965366E-03  6.28929436E-02
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      4  'SCAD 1      '       2       3
   3.80509794E-02  8.26965366E-03  6.28929436E-02
      4  'NJJD 1      '       1       3
          1         1         1
      4  'IJJD 1      '       1       3
          1         1         1
      4  'IPOD 1      '       1       3
          1         2         3
      4  'SCAA 1      '       2       3
   3.80509794E-02  8.26965366E-03  6.28929436E-02
      4  'NJJA 1      '       1       3
          1         1         1
      4  'IJJA 1      '       1       3
          1         1         1
      4  'IPOA 1      '       1       3
          1         2         3
      3  'DIFFB1HOM   '       2       1
   1.03698885E+00
      3  'B2  B1HOM   '       2       1
   3.40281345E-04
      3  'FGWITHUPSCAT'       1       6
          2         2         2         2         2         2
      3  'STATE-VECTOR'       1      20
          1         3         2         1         2         2         0         0
          2         0         0         0         0         0         0         0
          0         0         0         0
      3  'SIGNATURE   '       3      12
L_MACROLIB
      3  'ENERGY      '       2       2
   1.00000000E+07  1.99999995E-04
      3  'DELTAU      '       2       1
   2.46352882E+01
      3  'VOLUME      '       2       3
   1.67869568E+02  1.04788757E+02  1.36040295E+03
      3  'MATCOD      '       1       3
          1         2         3
      3  'KEYFLX      '       1       3
          1         2         3
      3  'K-EFFECTIVE '       2       1
   1.00000072E+00
      3  'FLUXDISAFACT'       2       1
   1.01510572E+00
      1  'MAC7        '       0      -1
      2  'FLXNORMALIZE'       2       1
   1.00000000E+00
      2  'MACROLIB    '       0      -1
      3  'TIMESTAMP   '       2       3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
      3  'ADDXSNAME   '       3      16
NG      N2N
      3  'FISSIONNAMES'       3       8
MACROFIS
      3  'FISSIONNB   '       1       3
         -1        -1        -1
      3  'EFISS       '       2       3
   2.06069351E+02  0.00000000E+00  0.00000000E+00
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   3  'GROUP  1/  1'       0       -1
   4  'NG          '       2        3
2.25672591E-02  1.84393080E-03  3.87978180E-05
   4  'N2N         '       2        3
6.37844423E-05  1.30467231E-06  1.25897532E-05
   4  'OVERV       '       2        3
2.23471693E-06  3.33652247E-06  4.25050803E-06
   4  'TOTAL       '       2        3
3.97235394E-01  1.03497289E-01  4.09586579E-01
   4  'ABS         '       2        3
3.90594825E-02  1.84262567E-03  2.62295744E-05
   4  'PRODUCTION  '       2        3
4.37869616E-02  0.00000000E+00  0.00000000E+00
   4  'NUSIGF      '       2        3
4.37869579E-02  0.00000000E+00  0.00000000E+00
   4  'CHI         '       2        3
1.00000000E+00  0.00000000E+00  0.00000000E+00
   4  'NFTOT       '       2        3
1.65552236E-02  0.00000000E+00  0.00000000E+00
   4  'TRANC       '       2        3
3.27915363E-02  6.23841630E-03  6.11017942E-02
   4  'DIFFHOM     '       2        3
1.14165294E+00  1.07562816E+00  1.02085841E+00
   4  'FLUX-INTG   '       2        3
2.28378506E+01  1.40899038E+01  1.81936310E+02
   4  'SIGW 0      '       2        3
3.58175904E-01  1.01654664E-01  4.09560353E-01
   4  'SCAD 0      '       2        3
3.58175904E-01  1.01654664E-01  4.09560353E-01
   4  'NJJD 0      '       1        3
       1          1          1
   4  'IJJD 0      '       1        3
       1          1          1
   4  'IPOD 0      '       1        3
       1          2          3
   4  'SCAA 0      '       2        3
3.58175904E-01  1.01654664E-01  4.09560353E-01
   4  'NJJA 0      '       1        3
       1          1          1
   4  'IJJA 0      '       1        3
       1          1          1
   4  'IPOA 0      '       1        3
       1          2          3
   4  'SIGW 1      '       2        3
3.80509794E-02  8.26965366E-03  6.28929436E-02
   4  'SCAD 1      '       2        3
3.80509794E-02  8.26965366E-03  6.28929436E-02
   4  'NJJD 1      '       1        3
       1          1          1
   4  'IJJD 1      '       1        3
       1          1          1
   4  'IPOD 1      '       1        3
       1          2          3
   4  'SCAA 1      '       2        3
3.80509794E-02  8.26965366E-03  6.28929436E-02
   4  'NJJA 1      '       1        3
```

```
         1         1         1
     4  'IJJA 1      '       1        3
         1         1         1
     4  'IPOA 1      '       1        3
         1         2         3
     3  'DIFFB1HOM   '       2        1
  1.03698885E+00
     3  'B2  B1HOM   '       2        1
  3.40281345E-04
     3  'FGWITHUPSCAT'       1        6
         2         2         2         2         2         2
     3  'STATE-VECTOR'       1       20
         1         3         2         1         2         2         0         0
         2         0         0         0         0         0         0         0
         0         0         0         0
     3  'SIGNATURE   '       3       12
L_MACROLIB
     3  'ENERGY      '       2        2
  1.00000000E+07  1.99999995E-04
     3  'DELTAU      '       2        1
  2.46352882E+01
     3  'VOLUME      '       2        3
  1.67869568E+02  1.04788757E+02  1.36040295E+03
     3  'MATCOD      '       1        3
         1         2         3
     3  'KEYFLX      '       1        3
         1         2         3
     3  'K-EFFECTIVE '       2        1
  1.00000072E+00
     3  'FLUXDISAFACT'       2        1
  1.01510572E+00
     1  'MAC8        '       0       -1
     2  'FLXNORMALIZE'       2        1
  1.00000000E+00
     2  'MACROLIB    '       0       -1
     3  'TIMESTAMP   '       2        3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
     3  'ADDXSNAME   '       3       16
NG      N2N
     3  'FISSIONNAMES'       3        8
MACROFIS
     3  'FISSIONNB   '       1        1
        -1
     3  'EFISS       '       2        1
  2.06069351E+02
     3  'GROUP  1/  1'       0       -1
     4  'NG          '       2        1
  2.50578905E-03
     4  'N2N         '       2        1
  1.72052714E-05
     4  'OVERV       '       2        1
  3.98132579E-06
     4  'TOTAL       '       2        1
  3.88592541E-01
     4  'ABS         '       2        1
  4.21617460E-03
```

```
   4  'PRODUCTION  '        2        1
4.56904620E-03
   4  'NUSIGF      '        2        1
4.56904620E-03
   4  'CHI         '        2        1
1.00000000E+00
   4  'NFTOT       '        2        1
1.72749104E-03
   4  'TRANC       '        2        1
5.46157360E-02
   4  'DIFFHOM     '        2        1
1.03698885E+00
   4  'FLUX-INTG   '        2        1
2.18864075E+02
   4  'SIGW 0      '        2        1
3.84376377E-01
   4  'SCAD 0      '        2        1
3.84376377E-01
   4  'NJJD 0      '        1        1
       1
   4  'IJJD 0      '        1        1
       1
   4  'IPOD 0      '        1        1
       1
   4  'SCAA 0      '        2        1
3.84376377E-01
   4  'NJJA 0      '        1        1
       1
   4  'IJJA 0      '        1        1
       1
   4  'IPOA 0      '        1        1
       1
   4  'SIGW 1      '        2        1
5.63915893E-02
   4  'SCAD 1      '        2        1
5.63915893E-02
   4  'NJJD 1      '        1        1
       1
   4  'IJJD 1      '        1        1
       1
   4  'IPOD 1      '        1        1
       1
   4  'SCAA 1      '        2        1
5.63915893E-02
   4  'NJJA 1      '        1        1
       1
   4  'IJJA 1      '        1        1
       1
   4  'IPOA 1      '        1        1
       1
   3  'DIFFB1HOM   '        2        1
1.03698885E+00
   3  'B2  B1HOM   '        2        1
3.40281345E-04
   3  'FGWITHUPSCAT'        1        2
       2          2
```

```
      3  'STATE-VECTOR'       1       20
          1         1         2         1         2         2         0         0
          2         0         0         0         0         0         0         0
          0         0         0         0
      3  'SIGNATURE   '       3       12
L_MACROLIB
      3  'ENERGY      '       2        2
  1.00000000E+07  1.99999995E-04
      3  'DELTAU      '       2        1
  2.46352882E+01
      3  'VOLUME      '       2        1
  1.63306128E+03
      3  'MATCOD      '       1        1
          1
      3  'KEYFLX      '       1        1
          1
      3  'K-EFFECTIVE '       2        1
  1.00000072E+00
      3  'FLUXDISAFACT'       2        1
  1.01510572E+00
```

B.20 Test case T3D

B.20.1 Geometry description, tracking and CP integration

Contents of file `Geo/T3DT.did`

```
MODULE
  GEO:  EXCELT:  ASM:
  DELETE:  END:
  ;
LINKED_LIST
  TMPGEO TMPVOL TMPMAC TMPPIJ
  ;
SEQ_BINARY
  TRKFIL
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  MAC2G
  ;
*----
*  Files created in this procedure
*----
SEQ_ASCII
  VOLTRK
  PIJMATLEA PIJMATSTD PIJMATSMD
  ;
*----
*  3-D model 4/Fine mesh with symmetry
*----
```

```
TMPGEO  := GEO:  :: CAR3D 3 1 1
  EDIT 1
  CELL c1 c2 c3
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  Z- REFL Z+ REFL
  ::: c1 := GEO: CARCELZ 2 2 1 1
    MESHX -28.575  -14.2875 -7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   5   11
       1   5   11
    ;
  ::: c2 := GEO: CARCELY 2 1 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    RADIUS 0.000000 3.62458 4.75200
    MIX
      11   11   11
    ;
  ::: c3 := GEO: CARCELZ 2 2 1 1
    MESHX   7.0    14.2875  28.575
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER -3.5 0.0 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   5   11
       1   5   11
    ;
  ;
TMPVOL TRKFIL := EXCELT: TMPGEO ::
  TITLE  'Verification model : T3D'
  EDIT  2
  MAXR  15
  TRAK TISO 4 25.0
  ;
VOLTRK := TMPVOL ;
*----
*  Restore 'macrolib' structure from MAC2G
*----
TMPMAC :=  MAC2G ;
*----
*  Evaluate 'asmpij' structure
*  option 1: no scattering reduction
*            no normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TRKFIL  ::
  EDIT 100 SKIP PNOR NONE ;
PIJMATLEA :=  TMPPIJ ;
TMPPIJ := DELETE: TMPPIJ  ;
*----
```

```
*  Evaluate 'asmpij' structure
*  option 2: no scattering reduction
*            with normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TRKFIL  ::
  EDIT 100 SKIP ;
PIJMATSTD :=  TMPPIJ ;
TMPPIJ := DELETE: TMPPIJ ;
*----
*  Evaluate 'asmpij' structure
*  option 3: with scattering reduction
*            with normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TRKFIL  ::
  EDIT 100 ;
PIJMATSMD :=  TMPPIJ ;
TMPPIJ := DELETE: TMPPIJ ;
*
TMPMAC := DELETE: TMPMAC ;
TMPVOL := DELETE: TMPVOL ;
TRKFIL := DELETE: TRKFIL ;
TMPGEO := DELETE: TMPGEO ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.20.2 Flux Solution

Contents of file `Geo/T3DF.did`

```
MODULE
  FLU:
  DELETE:  END:
  ;
LINKED_LIST
  TMPMAC TMPVOL TMPPIJ TMPFLU
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  MAC2G
  ;
*----
*  Local 'tracking' file from T3DT.did
*----
SEQ_ASCII
  VOLTRK
  ;
*----
*  Local 'asmpij' file from T3DA.did
*----
```

```
SEQ_ASCII
  PIJMATSTD PIJMATSMD
  ;
*----
*  Files created in this procedure
*----
SEQ_ASCII
  FLUXSK  FLUXK   FLUXKB0    FLUXKB1
  FLUXB0  FLUXB1  FLUXKB1DB2
  ;
*----
*  Restore 'macrolib' structure from MAC2D
*----
TMPMAC :=  MAC2G ;
*----
*  Restore 'tracking' structure from VOLTRK
*----
TMPVOL := VOLTRK ;
*----
*  Restore 'asmpij' structure from PIJMATSTD
*  option 2: no scattering reduction
*            with normalization
*----
TMPPIJ := PIJMATSTD ;
*----
*  Evaluate 'flux' structure
*  option 1: no scattering reduction
*            type k - no leakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 20 TYPE K THER 40 1.0E-4 ;
FLUXSK := TMPFLU ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
*----
*  Restore 'asmpij' structure from PIJMATSMD
*  option 3: with scattering reduction
*            with normalization
*----
TMPPIJ := PIJMATSMD ;
*----
*  Evaluate 'flux' structure
*  option 2: with scattering reduction
*            type k - no leakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 20 TYPE K  ;
FLUXK := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 3: with scattering reduction
*            type k - B0 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE K B0 PNL BUCK 3.98740E-04 ;
```

```
FLUXKB0 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 4: with scattering reduction
*            type k - B1 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE K B1 PNL BUCK 3.37864E-04 ;
FLUXKB1 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 5: with scattering reduction
*            type B - B0 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B0 PNL ;
FLUXB0 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 6: with scattering reduction
*            type B - B1 lakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL ;
FLUXB1 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
*----
*  Evaluate 'flux' structure
*  option 7: with scattering reduction
*            type k - B1 lakage
*            Leakage from FLUXB1 flux file
*----
TMPFLU := FLUXB1  ;
TMPFLU := FLU: TMPFLU TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE K B1 PNL IDEM DB2 ;
FLUXKB1DB2 := TMPFLU  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPVOL := DELETE: TMPVOL ;
TMPMAC := DELETE: TMPMAC ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

Contents of file `Geo/T3DE.did`

```
MODULE
  EDI:
  DELETE:  END:
  ;
LINKED_LIST
  TMPMAC TMPVOL TMPFLU TMPEDI
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  MAC2G
  ;
*----
*  Local 'tracking' file from T2DT.did
*----
SEQ_ASCII
  VOLTRK
  ;
*----
*  Local 'flxunk' file from T2DF.did
*----
*  Files created in this procedure
*----
SEQ_ASCII
  FLUXB1
  ;
*----
*  Files created in this procedure
*----
SEQ_ASCII
  EDIRES
  ;
*----
*  Restore 'macrolib' structure from MAC2D
*----
TMPMAC :=  MAC2G ;
*----
*  Restore 'tracking' structure from VOLTRK
*----
TMPVOL := VOLTRK ;
*----
*  Restore 'flxunk' structure from FLUXB1
*----
TMPFLU := FLUXB1 ;
*----
*  CREATE EDIT FILE
*  option 1) no condensed, no merge
*----
TMPEDI := EDI: TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  MERG NONE
  SAVE ON 'MAC1'
  ;
```

```
*----
*  option 2) no condensed, merge per mixture
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  TAKE MIX 1 5 11
  SAVE ON 'MAC2'
  ;
*----
*  option 3) no condensed, merge per regions
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  MERG REGI 1 2 3 1 2 3 3 3 3 1 2 3 1 2 3
  SAVE ON 'MAC3'
  ;
*----
*  option 4) no condensed, complete merge
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND NONE
  MERG COMP
  SAVE ON 'MAC4'
  ;
*----
*  option 5) condensed, no merge
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND 2
  MERG NONE
  SAVE ON 'MAC5'
  ;
*----
*  option 6) condensed, merge per mixture
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND 2
  TAKE MIX 1 5 11
  SAVE ON 'MAC6'
  ;
*----
*  option 7) condensed, merge per regions
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND 2
  MERG REGI 1 2 3 1 2 3 3 3 3 1 2 3 1 2 3
  SAVE ON 'MAC7'
  ;
*----
*  option 8) no condensed complete merge
```

```
*----
TMPEDI := EDI: TMPEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 1
  COND 2
  MERG COMP
  SAVE ON 'MAC8'
  ;
*
EDIRES := TMPEDI ;
TMPEDI := DELETE: TMPEDI ;
TMPFLU := DELETE: TMPFLU ;
TMPVOL := DELETE: TMPVOL ;
TMPMAC := DELETE: TMPMAC ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.20.4 Global verification of EDITION *data structure*

Contents of file `Geo/T3DG.did`

```
MODULE
  GEO: EXCELT: ASM: FLU: EDI:
  UTL: DELETE:  END:
  ;
LINKED_LIST
  TMPGEO TMPVOL TMPMAC TMPPIJ TMPFLU TMPEDI
  NEWEDI
  ;
SEQ_BINARY
  TMPFIL
  ;
*----
*  Local 'macrolib' cross section file
*----
SEQ_ASCII
  EDIRES
  ;
TMPEDI := EDIRES ;
NEWEDI := EDIRES ;
*----
*  3-D model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR3D 3 1 1
  EDIT 1
  CELL c1 c2 c3
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  Z- REFL Z+ REFL
```

```
  ::: c1 := GEO: CARCELZ 2 2 1 1
    MESHX -28.575  -14.2875 -7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   2    3
       4   5    6
    ;
  ::: c2 := GEO: CARCELY 2 1 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    RADIUS 0.000000 3.62458 4.75200
    MIX
       7    8    9
    ;
  ::: c3 := GEO: CARCELZ 2 2 1 1
    MESHX   7.0    14.2875  28.575
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER -3.5 0.0 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       10  11  12
       13  14  15
    ;
  ;
TMPVOL TMPFIL := EXCELT: TMPGEO ::
  TITLE  'Verification model : T3D'
  EDIT  2
  MAXR  15
  TRAK TISO 4 25.0
  ;
TMPGEO := DELETE: TMPGEO ;
*----
*  Restore 'macrolib' structure from TMPEDI
*  no merge
*----
TMPEDI :=  UTL:  TMPEDI ::
  STEP UP MAC1 STEP UP MACROLIB ;
TMPMAC :=  TMPEDI ;
TMPEDI :=  UTL:  TMPEDI ::
  STEP DOWN STEP DOWN ;
*----
*  Evaluate 'asmpij' structure
*  option 1: no scattering reduction
*            no normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TMPFIL  ::
  EDIT 1 ;
*----
*  Evaluate 'flux' structure
*  option 2: with scattering reduction
*            type k - no leakage
```

```
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 1 2
  MERGE REGI 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
  SAVE ON MAC9
  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 2
  MERG COMP
  SAVE ON MAC10
  STAT ALL REFE 'MAC8'
  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPMAC := DELETE: TMPMAC ;
TMPVOL := DELETE: TMPVOL ;
TMPFIL := DELETE: TMPFIL ;
*----
*  3-D model 4/Fine mesh with symmetry
*----
TMPGEO  := GEO:  :: CAR3D 3 1 1
  EDIT 1
  CELL c1 c2 c3
  X- REFL X+ REFL
  Y- REFL Y+ REFL
  Z- REFL Z+ REFL
  ::: c1 := GEO: CARCELZ 2 2 1 1
    MESHX -28.575  -14.2875 -7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER 3.5 0.0 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   2   3
       1   2   3
    ;
  ::: c2 := GEO: CARCELY 2 1 1 1
    MESHX  -7.0       7.0
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    RADIUS 0.000000 3.62458 4.75200
    MIX
       3   3   3
    ;
  ::: c3 := GEO: CARCELZ 2 2 1 1
    MESHX   7.0    14.2875  28.575
    MESHY -14.2875  14.2875
    MESHZ -24.765   24.765
    OFFCENTER -3.5 0.0 0.0
    RADIUS 0.000000 5.168875 6.587482
    MIX
       1   2   3
```

```
       1   2   3
     ;
   ;
TMPVOL TMPFIL := EXCELT: TMPGEO ::
  TITLE  'Verification model : T3D'
  EDIT  2
  MAXR  15
  TRAK TISO 4 25.0
  ;
TMPGEO := DELETE: TMPGEO ;
*----
*  Restore 'macrolib' structure from TMPEDI
*  MERGE PER MIXTURE
*----
TMPEDI :=  UTL:  TMPEDI ::
  STEP UP MAC2 STEP UP MACROLIB ;
TMPMAC :=  TMPEDI ;
TMPEDI :=  UTL:  TMPEDI ::
  STEP DOWN STEP DOWN ;
*----
*  Evaluate 'asmpij' structure
*  option 1: no scattering reduction
*            no normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TMPFIL  ::
  EDIT 1 ;
*----
*  Evaluate 'flux' structure
*  option 2: with scattering reduction
*            type k - no leakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 1 2
  MERGE REGI 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
  SAVE ON MAC11
  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 2
  MERG COMP
  SAVE ON MAC12
  STAT ALL REFE 'MAC8'
  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPMAC := DELETE: TMPMAC ;
*----
*  Restore 'macrolib' structure from TMPEDI
*  MERGE PER REGION
*----
TMPEDI :=  UTL:  TMPEDI ::
  STEP UP MAC3 STEP UP MACROLIB ;
TMPMAC :=  TMPEDI ;
```

```
TMPEDI := UTL: TMPEDI ::
  STEP DOWN STEP DOWN ;
*----
*  Evaluate 'asmpij' structure
*  option 1: no scattering reduction
*            no normalization
*----
TMPPIJ := ASM: TMPMAC TMPVOL TMPFIL  ::
  EDIT 1 ;
*----
*  Evaluate 'flux' structure
*  option 2: with scattering reduction
*            type k - no leakage
*----
TMPFLU := FLU: TMPPIJ TMPMAC TMPVOL  ::
  EDIT 1 TYPE B B1 PNL  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 1 2
  MERGE REGI 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
  SAVE ON MAC13
  ;
NEWEDI := EDI: NEWEDI TMPFLU TMPMAC TMPVOL ::
  EDIT 2
  COND 2
  MERG COMP
  SAVE ON MAC14
  STAT ALL REFE 'MAC8'
  ;
TMPFLU := DELETE: TMPFLU ;
TMPPIJ := DELETE: TMPPIJ ;
TMPMAC := DELETE: TMPMAC ;
TMPVOL := DELETE: TMPVOL ;
TMPFIL := DELETE: TMPFIL ;
NEWEDI := DELETE: NEWEDI ;
TMPEDI := DELETE: TMPEDI ;
*----
*  END, QUIT
*----
END: ;
QUIT "LIST" .
```

B.20.5 Data structure generated

Contents of file `Geo/T3Dds/VOLTRK`

```
     1  'SIGNATURE   '       3      12
L_TRACK
     1  'TRACK-TYPE  '       3      12
EXCELL
     1  'TITLE       '       3      72
```

```
Verification model : T3D
     1  'EXCELL      '       0      -1
     2  'MINDIM      '       1       6
         1         7         9        13        17        21
     2  'MAXDIM      '       1       6
         6         8        10        14        18        22
     2  'ICORD       '       1       6
         1         2         3         2         3         3
     2  'INDEX       '       1     232
         5         7        10         0         5         7        10        21
         5         7        10        20         4         7        10         0
         4         7        10        21         4         7        10        20
         5         8         9         0         4         8         9         0
         6         7         9         0         5         6         9         0
         4         6         9         0         5         7         8         0
         5         7         8        21         5         7         8        20
         4         7         8         0         4         7         8        21
         4         7         8        20         3         8         9         0
         3         8         9        13         3         8         9        12
         3         7        10         0         3         7         8         0
         3         6         9         0         3         6         9        13
         3         6         9        12         2         7        10         0
         2         7        10        17         2         7        10        16
         1         7        10         0         1         7        10        17
         1         7        10        16         2         8         9         0
         1         8         9         0         0         7         9         0
         2         6         9         0         1         6         9         0
         2         7         8         0         2         7         8        17
         2         7         8        16         1         7         8         0
         1         7         8        17         1         7         8        16
         0         0         0         0         1         7         9        16
         1         7         9        17         1         7         9         0
         2         7         9        16         2         7         9        17
         2         7         9         0         3         7         9        12
         3         7         9        13         3         7         9         0
         4         7         9        20         4         7         9        21
         4         7         9         0         5         7         9        20
         5         7         9        21         5         7         9         0
     2  'REMESH      '       2      22
  0.00000000E+00  1.42875004E+01  2.15750008E+01  3.55750008E+01  4.28625031E+01
  5.71500015E+01  0.00000000E+00  2.85750008E+01  0.00000000E+00  4.95299988E+01
  2.47649994E+01  2.85750008E+01  1.31375799E+01  2.25815029E+01  1.42875004E+01
  1.42875004E+01  2.67172718E+01  4.33949203E+01  4.28625031E+01  1.42875004E+01
  2.67172718E+01  4.33949203E+01
     2  'KEYMRG      '       1      58
       -42       -41       -40       -39       -38       -37       -36       -35
       -34       -33       -32       -31       -30       -29       -28       -27
       -26       -25       -24       -23       -22       -21       -20       -19
       -18       -17       -16       -15       -14       -13       -12       -11
       -10        -9        -8        -7        -6        -5        -4        -3
        -2        -1         0         1         2         3         4         5
         6         7         8         9        10        11        12        13
        14        15
     2  'MATALB      '       1      58
        -6        -6        -6        -6        -6        -6        -4        -4
        -2        -3        -3        -5        -5        -5        -5        -5
```

```
        -5          -4          -4          -4          -6          -5          -3          -3
        -3          -6          -6          -6          -6          -6          -6          -4
        -4          -1          -3          -3          -5          -5          -5          -5
        -5          -5           0           1           5          11           1           5
        11          11          11          11           1           5          11           1
         5          11
     2  'VOLSUR      '        2       58
  8.50251846E+01  6.54929733E+00  1.04918480E+01  3.50189362E+01  6.54929733E+00
  1.04918480E+01  1.76914963E+02  9.02374725E+01  3.53829926E+02  1.76914963E+02
  9.02374725E+01  8.50251846E+01  6.54929733E+00  1.04918480E+01  3.50189362E+01
  6.54929733E+00  1.04918480E+01  1.55619522E+02  7.41724014E+00  1.03182316E+01
  1.00012505E+02  1.00012505E+02  1.55619522E+02  7.41724014E+00  1.03182316E+01
  3.50189362E+01  6.54929733E+00  1.04918480E+01  8.50251846E+01  6.54929733E+00
  1.04918480E+01  9.02374725E+01  1.76914963E+02  3.53829926E+02  9.02374725E+01
  1.76914963E+02  3.50189362E+01  6.54929733E+00  1.04918480E+01  8.50251846E+01
  6.54929733E+00  1.04918480E+01  0.00000000E+00  2.07864478E+03  1.29754688E+03
  1.68451895E+04  2.07864478E+03  1.29754688E+03  6.93795215E+03  1.17937390E+03
  8.47790527E+02  1.77873125E+04  2.07864478E+03  1.29754688E+03  6.93795215E+03
  2.07864478E+03  1.29754688E+03  1.68451895E+04
     2  'STATE-VECTOR'        1       20
         3          42          15           6          22          58           0           0
         0           0           0           0           0           0           0           0
         0           0           0           0
     1  'BC-REFL+TRAN'        1       42
         1           2           3           4           5           6           7           8
         9          10          11          12          13          14          15          16
        17          18          19          20          21          22          23          24
        25          26          27          28          29          30          31          32
        33          34          35          36          37          38          39          40
        41          42
     1  'STATE-VECTOR'        1       20
        15          15           1          11          42           1           1           0
         0           0          12           1           0           0           0           0
         0           0           0           0
     1  'EXCELTRACKOP'        2        3
  0.00000000E+00  2.50961075E+01  0.00000000E+00
     1  'MATCOD      '        1       15
         1           5          11           1           5          11          11          11
        11           1           5          11           1           5          11
     1  'VOLUME      '        2       15
  2.07864478E+03  1.29754688E+03  1.68451895E+04  2.07864478E+03  1.29754688E+03
  6.93795215E+03  1.17937390E+03  8.47790527E+02  1.77873125E+04  2.07864478E+03
  1.29754688E+03  6.93795215E+03  2.07864478E+03  1.29754688E+03  1.68451895E+04
     1  'KEYFLX      '        1       15
         1           2           3           4           5           6           7           8
         9          10          11          12          13          14          15
     1  'ALBEDO      '        2        6
  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00
  1.00000000E+00
```

Contents of file `Geo/T3Dds/PIJMATSTD`

```
     1  'SIGNATURE   '        3       12
L_PIJ
     1  'STATE-VECTOR'        1       20
         0           1           0           0           0           2           2          15
        17           1           1          15          42           0           0           0
```

```
          0           0           0           0
       1  'GROUP  1/  2'        0       -1
       2  'DRAGON-TXSC '        2       18
  0.00000000E+00  3.25573593E-01  2.94397712E-01  2.96656132E-01  2.94024080E-01
  1.08258009E-01  3.25573593E-01  2.94397771E-01  2.96656132E-01  2.94024020E-01
  1.08258016E-01  2.64682710E-01  8.37840736E-01  2.64991134E-01  8.31609249E-01
  2.65020490E-01  2.71528214E-01  2.65051723E-01
       2  'DRAGON-S0XSC'        2       18
  0.00000000E+00  3.12665552E-01  2.83534408E-01  2.84851104E-01  2.80805469E-01
  1.07063353E-01  3.12665582E-01  2.83534437E-01  2.84851104E-01  2.80805439E-01
  1.07063361E-01  2.53611684E-01  8.23869348E-01  2.52386063E-01  8.17773104E-01
  2.52767861E-01  2.64678836E-01  2.53184795E-01
       2  'DRAGON-PIS  '        2       15
 -1.58120557E-07  2.82560194E-07 -1.92282485E-07  8.59776321E-08  7.02921028E-08
 -5.41166457E-07  3.22646002E-07 -6.00280998E-07  2.06721651E-07  1.88214472E-07
 -5.90949867E-08 -4.21724479E-07  3.48442143E-07  5.00196677E-07 -2.78927217E-07
       2  'DRAGON-PCSCT'        2      225
  1.88304341E+00  7.21792400E-01  7.71629661E-02  3.49700987E-01  1.37034908E-01
  4.51709107E-02  2.20494485E-03  2.79063685E-03  3.91272083E-03  7.09304641E-06
  2.41114303E-05  1.28091066E-04  1.83637462E-06  2.34840900E-06  4.55114468E-06
  4.50562537E-01  1.72584522E+00  1.30505607E-01  8.54793340E-02  1.04638644E-01
  4.47483957E-02  1.51427928E-03  1.92105048E-03  2.66818539E-03  1.02605354E-05
  9.64819410E-05  5.24623429E-05  1.46582454E-06  1.27841504E-05  3.58689272E-06
  6.25323176E-01  1.69426763E+00  3.43688941E+00  1.88375801E-01  2.81642258E-01
  3.43323708E-01  6.24534860E-03  8.20029527E-03  1.23324413E-02  2.51750520E-04
  4.95450047E-04  2.78575812E-04  3.68774927E-05  4.65591693E-05  1.06448633E-05
  3.49700987E-01  1.36936232E-01  2.32449975E-02  1.88261116E+00  7.22265422E-01
  1.20544717E-01  1.11001274E-02  1.48532838E-02  2.41871532E-02  5.17229018E-05
  2.63651309E-04  7.29069638E-04  7.09301958E-06  1.64370085E-05  3.10647702E-05
  8.55409354E-02  1.04638644E-01  2.16942672E-02  4.50857788E-01  1.72300816E+00
  2.15559661E-01  1.32044936E-02  1.93259418E-02  3.71593498E-02  1.64577665E-04
  8.19852401E-04  7.69293285E-04  1.50514006E-05  9.64819192E-05  3.81644750E-05
  1.50768235E-01  2.39268601E-01  1.41403183E-01  4.02345538E-01  1.15259242E+00
  2.55178404E+00  6.75655752E-02  1.01304889E-01  2.11609349E-01  2.43355427E-03
  4.11363039E-03  4.64412197E-03  4.27541381E-04  2.80530250E-04  1.14749892E-04
  1.25103351E-03  1.37636764E-03  4.37252515E-04  6.29795017E-03  1.20019056E-02
  1.14853894E-02  2.20280719E+00  8.00603330E-01  5.35334162E-02  6.29798137E-03
  1.20020555E-02  1.14857610E-02  1.25106983E-03  1.37641071E-03  4.37312236E-04
  1.13818166E-03  1.25517498E-03  4.12707275E-04  6.05802052E-03  1.26271741E-02
  1.23790596E-02  5.75512052E-01  1.26080883E+00  6.84863776E-02  6.05804706E-03
  1.26272906E-02  1.23793436E-02  1.13821856E-03  1.25520118E-03  4.12770838E-04
  3.34818102E-02  3.65765952E-02  1.30221751E-02  2.06973538E-01  5.09395838E-01
  5.42517722E-01  8.07390749E-01  1.43689811E+00  3.10649443E+00  2.06974894E-01
  5.09400785E-01  5.42513192E-01  3.34833078E-02  3.65786441E-02  1.30249700E-02
  7.09304641E-06  1.64371777E-05  3.10652467E-05  5.17229018E-05  2.63650203E-04
  7.29104970E-04  1.11001823E-02  1.48533490E-02  2.41873134E-02  1.88261175E+00
  7.22268879E-01  1.20543174E-01  3.49703908E-01  1.36936083E-01  2.32447553E-02
  1.50510132E-05  9.64819410E-05  3.81633981E-05  1.64578349E-04  8.19852401E-04
  7.69337756E-04  1.32046575E-02  1.93261188E-02  3.71597111E-02  4.50859934E-01
  1.72303271E+00  2.15555370E-01  8.55413303E-02  1.04639672E-01  2.16944665E-02
  4.27533232E-04  2.80514883E-04  1.14735762E-04  2.43343646E-03  4.11339290E-03
  4.64412197E-03  6.75677657E-02  1.01307213E-01  2.11607590E-01  4.02340382E-01
  1.15256941E+00  2.55156946E+00  1.50772080E-01  2.39275426E-01  1.41493678E-01
  1.83637462E-06  2.34822232E-06  4.55056988E-06  7.09301958E-06  2.41120506E-05
  1.28093525E-04  2.20500864E-03  2.79072719E-03  3.91289592E-03  3.49703908E-01
  1.37035549E-01  4.51720655E-02  1.88303339E+00  7.21790433E-01  7.71631896E-02
```

```
1.46594095E-06  1.27841504E-05  3.58634770E-06  1.02604290E-05  9.64819192E-05
5.24652132E-05  1.51432666E-03  1.92109065E-03  2.66833487E-03  8.54792446E-02
1.04639672E-01  4.47496735E-02  4.50561285E-01  1.72582209E+00  1.30505756E-01
3.68821529E-05  4.65662451E-05  1.06448633E-05  2.51746678E-04  4.95464017E-04
2.78610125E-04  6.24620169E-03  8.20155814E-03  1.23350890E-02  1.88373834E-01
2.81644851E-01  3.43543440E-01  6.25324965E-01  1.69426954E+00  3.43679619E+00
   1  'GROUP  2/  2'       0       -1
   2  'DRAGON-TXSC '       2       18
0.00000000E+00  4.45026428E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
8.56671408E-02  4.45026457E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
8.56671408E-02  3.99664789E-01  1.08252847E+00  3.97724301E-01  1.08740294E+00
3.98030460E-01  2.85094976E-01  3.99067879E-01
   2  'DRAGON-S0XSC'       2       18
0.00000000E+00  3.49167198E-01  3.35775822E-01  3.37583899E-01  3.37695420E-01
8.29786733E-02  3.49167198E-01  3.35775852E-01  3.37583899E-01  3.37695390E-01
8.29786733E-02  3.99550319E-01  8.89993608E-01  3.97603214E-01  8.90379846E-01
3.97910595E-01  2.80846745E-01  3.98950040E-01
   2  'DRAGON-PIS  '       2       15
1.82958857E-07 -2.12989931E-07  1.38650393E-07 -2.84881736E-07 -2.25391261E-07
2.30265329E-07  1.17676677E-07  2.98096836E-07  6.56414727E-07 -7.55955512E-07
1.19265078E-08  4.22177351E-08  4.46807462E-07 -7.07064842E-08  1.27525041E-07
   2  'DRAGON-PCSCT'       2      225
1.55406165E+00  5.86196303E-01  4.33794893E-02  2.25646973E-01  8.58206600E-02
2.10247003E-02  3.27506597E-04  5.19392954E-04  9.74640890E-04  5.28115606E-07
1.88909360E-06  5.12638189E-06  4.86063279E-08  8.07866343E-08  5.97579302E-08
3.65919739E-01  1.78127146E+00  9.14201513E-02  5.35523146E-02  9.91807505E-02
2.83437632E-02  2.89775810E-04  4.59932227E-04  8.59653053E-04  8.03104683E-07
7.14493808E-06  3.26126610E-06  5.04286746E-08  9.25796257E-07  1.29171468E-07
3.51544291E-01  1.18684709E+00  2.34968042E+00  7.93402195E-02  1.64882779E-01
1.65572762E-01  7.06050720E-04  1.16141106E-03  2.44698557E-03  6.41549332E-06
1.91833715E-05  1.57459017E-05  4.84166890E-07  1.67677513E-06  2.38167971E-07
2.25646973E-01  8.57897624E-02  9.79034044E-03  1.55402482E+00  5.87094247E-01
7.70299137E-02  2.99006794E-03  4.88384860E-03  1.05239777E-02  6.60965952E-06
2.87666662E-05  5.81443564E-05  5.28101111E-07  1.28653187E-06  7.91663183E-07
5.35716005E-02  9.91807505E-02  1.27005484E-02  3.66480261E-01  1.77839649E+00
1.71403155E-01  3.88383796E-03  6.81266142E-03  1.90014429E-02  1.79565941E-05
8.48284180E-05  8.37501866E-05  1.17917534E-06  7.14482940E-06  1.47768822E-06
7.01747462E-02  1.51553422E-01  6.81937039E-02  2.57104933E-01  9.16488588E-01
1.90603900E+00  1.84251554E-02  3.36715207E-02  1.05423093E-01  1.94089807E-04
4.47874860E-04  8.53593927E-04  1.71116371E-05  1.74397392E-05  6.48608511E-06
1.85819503E-04  2.63384718E-04  4.94323831E-05  1.69649394E-03  3.53012094E-03
3.13206972E-03  1.72775090E+00  5.27512789E-01  2.30542161E-02  1.69649499E-03
3.53015470E-03  3.13217239E-03  1.85822340E-04  2.63389084E-04  4.94402302E-05
2.11838225E-04  3.00510292E-04  5.84518966E-05  1.99191342E-03  4.45125345E-03
4.11452772E-03  3.79201442E-01  1.05010450E+00  4.00204621E-02  1.99191854E-03
4.45128605E-03  4.11468465E-03  2.11842285E-04  3.00509739E-04  5.84612899E-05
8.34016595E-03  1.17844818E-02  2.58384133E-03  9.00554433E-02  2.60479689E-01
2.70280540E-01  3.47703576E-01  8.39660823E-01  2.18915820E+00  9.00557265E-02
2.60481626E-01  2.70279527E-01  8.34032428E-03  1.17847938E-02  2.58450839E-03
5.28115606E-07  1.28655813E-06  7.91652212E-07  6.60965952E-06  2.87661151E-05
5.81502682E-05  2.99006980E-03  4.88386117E-03  1.05240103E-02  1.55402613E+00
5.87096095E-01  7.70288259E-02  2.25649163E-01  8.57895240E-02  9.79038794E-03
1.17922389E-06  7.14493808E-06  1.47765172E-06  1.79569397E-05  8.48284180E-05
8.37622720E-05  3.88387521E-03  6.81271125E-03  1.90015845E-02  3.66481423E-01
1.77842414E+00  1.71400428E-01  5.35716973E-02  9.91818979E-02  1.27008185E-02
1.71104712E-05  1.74379129E-05  6.48519335E-06  1.94070075E-04  4.47810220E-04
```

```
  8.53593927E-04  1.84257608E-02  3.36728059E-02  1.05422691E-01  2.57101327E-01
  9.16474044E-01  1.90593863E+00  7.01747686E-02  1.51552886E-01  6.82362914E-02
  4.86063279E-08  8.07857532E-08  5.97447070E-08  5.28101111E-07  1.88901595E-06
  5.12673159E-06  3.27511603E-04  5.19402907E-04  9.74659342E-04  2.25649163E-01
  8.58208165E-02  2.10247096E-02  1.55405605E+00  5.86196303E-01  4.33798395E-02
  5.04292217E-08  9.25796257E-07  1.29158209E-07  8.03088312E-07  7.14482940E-06
  3.26160762E-06  2.89780612E-04  4.59931383E-04  8.59675754E-04  5.35521619E-02
  9.91818979E-02  2.83436626E-02  3.65919739E-01  1.78124726E+00  9.14205462E-02
  4.84273983E-07  1.67694748E-06  2.38167971E-07  6.41558199E-06  1.91838444E-05
  1.57480663E-05  7.06162828E-04  1.16159767E-03  2.44761724E-03  7.93405995E-02
  1.64886296E-01  1.65676162E-01  3.51547122E-01  1.18685222E+00  2.34963679E+00
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Contents of file `Geo/T3Dds/PIJMATSMD`

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     1  'SIGNATURE   '       3       12
L_PIJ
     1  'STATE-VECTOR'       1       20
         0          0          0          0          0          2          2         15
        17          1          1         15         42          0          0          0
         0          0          0          0
     1  'GROUP  1/  2'       0       -1
     2  'DRAGON-TXSC '       2       18
  0.00000000E+00  3.25573593E-01  2.94397712E-01  2.96656132E-01  2.94024080E-01
  1.08258009E-01  3.25573593E-01  2.94397771E-01  2.96656132E-01  2.94024020E-01
  1.08258016E-01  2.64682710E-01  8.37840736E-01  2.64991134E-01  8.31609249E-01
  2.65020490E-01  2.71528214E-01  2.65051723E-01
     2  'DRAGON-S0XSC'       2       18
  0.00000000E+00  3.12665552E-01  2.83534408E-01  2.84851104E-01  2.80805469E-01
  1.07063353E-01  3.12665582E-01  2.83534437E-01  2.84851104E-01  2.80805439E-01
  1.07063361E-01  2.53611684E-01  8.23869348E-01  2.52386063E-01  8.17773104E-01
  2.52767861E-01  2.64678836E-01  2.53184795E-01
     2  'DRAGON-PIS  '       2       15
 -1.58120557E-07  2.82560194E-07 -1.92282485E-07  8.59776321E-08  7.02921028E-08
 -5.41166457E-07  3.22646002E-07 -6.00280998E-07  2.06721651E-07  1.88214472E-07
 -5.90949867E-08 -4.21724479E-07  3.48442143E-07  5.00196677E-07 -2.78927217E-07
     2  'DRAGON-PCSCT'       2      225
  8.76164150E+00  6.12885237E+00  4.22366476E+00  5.30661631E+00  3.99046803E+00
  3.17207575E+00  1.68307018E+00  1.72604620E+00  1.81010723E+00  9.54034507E-01
  1.08314085E+00  1.12948108E+00  7.65747964E-01  7.33420789E-01  6.63924873E-01
  3.82579708E+00  5.11800432E+00  3.06227708E+00  2.59765172E+00  2.27490282E+00
  1.97380888E+00  1.00468421E+00  1.03077316E+00  1.08221281E+00  5.70497870E-01
  6.47711694E-01  6.75019562E-01  4.57810104E-01  4.38449174E-01  3.96844894E-01
  3.42282791E+01  3.97555122E+01  4.65389595E+01  2.64387054E+01  2.48116379E+01
  2.40117836E+01  1.17789555E+01  1.20916510E+01  1.27149162E+01  6.70572710E+00
  7.61133432E+00  7.93011475E+00  5.37995195E+00  5.15167141E+00  4.66235638E+00
  5.30661631E+00  4.16138744E+00  3.26245522E+00  8.29408836E+00  5.46349096E+00
  3.58116174E+00  2.10017490E+00  2.15308237E+00  2.25571489E+00  1.18824959E+00
  1.34943247E+00  1.40800655E+00  9.54075396E-01  9.13988054E-01  8.27570498E-01
  2.49095917E+00  2.27490282E+00  1.91118431E+00  3.41046047E+00  4.55994654E+00
  2.52976871E+00  1.47757375E+00  1.51835895E+00  1.60030341E+00  8.42364311E-01
  9.56945419E-01  9.97406363E-01  6.76164508E-01  6.47764325E-01  5.86365879E-01
  1.05875273E+01  1.05539083E+01  9.88962460E+00  1.19529467E+01  1.35266123E+01
  1.60451088E+01  8.17909908E+00  8.41736031E+00  8.91752720E+00  4.69980288E+00
  5.33332777E+00  5.55732870E+00  3.77027059E+00  3.60975552E+00  3.26673245E+00
  9.54934180E-01  9.13183510E-01  8.24674129E-01  1.19158959E+00  1.34300494E+00
  1.39035499E+00  7.60078096E+00  4.65250349E+00  1.99612117E+00  1.19160414E+00
  1.34300327E+00  1.39029872E+00  9.54986215E-01  9.13255215E-01  8.24786663E-01
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9.92062807E-01  1.02852595E+00  7.04018831E-01  6.73538923E-01  6.08635962E-01
1.54893913E+01  1.48354235E+01  1.34260397E+01  1.93025303E+01  2.19376259E+01
2.28624878E+01  3.01054916E+01  3.13056355E+01  3.35115242E+01  1.93027267E+01
2.19375439E+01  2.28614635E+01  1.54902172E+01  1.48365784E+01  1.34278765E+01
9.54034507E-01  9.13926482E-01  8.27466190E-01  1.18824959E+00  1.34945118E+00
1.40808415E+00  2.10020041E+00  2.15310764E+00  2.25573778E+00  8.29410458E+00
5.46350908E+00  3.58112884E+00  5.30663919E+00  4.16141367E+00  3.26250482E+00
6.76126122E-01  6.47711694E-01  5.86283863E-01  8.42352629E-01  9.56945419E-01
9.97447491E-01  1.47757185E+00  1.51835620E+00  1.60029745E+00  3.41047144E+00
4.55996704E+00  2.52968478E+00  2.49100041E+00  2.27496386E+00  1.91128755E+00
3.76990104E+00  3.60931349E+00  3.26614070E+00  4.69954395E+00  5.33310795E+00
5.55732870E+00  8.17876816E+00  8.41701221E+00  8.91712761E+00  1.19528360E+01
1.35261641E+01  1.60437737E+01  1.05880938E+01  1.05548143E+01  9.89123726E+00
7.65747964E-01  7.33402848E-01  6.63869619E-01  9.54075396E-01  1.08320236E+00
1.12959170E+00  1.68316174E+00  1.72613990E+00  1.81020379E+00  5.30663919E+00
3.99053431E+00  3.17224550E+00  8.76151466E+00  6.12872028E+00  4.22348404E+00
4.57821310E-01  4.38449174E-01  3.96821588E-01  5.70536315E-01  6.47764325E-01
6.75102234E-01  1.00476325E+00  1.03085411E+00  1.08229709E+00  2.59766793E+00
2.27496386E+00  1.97397828E+00  3.82571459E+00  5.11786127E+00  3.06209564E+00
5.38039970E+00  5.15197372E+00  4.66235638E+00  6.70657253E+00  7.61239910E+00
7.93155146E+00  1.17805624E+01  1.20933037E+01  1.27166548E+01  2.64391079E+01
2.48129768E+01  2.40156975E+01  3.42268143E+01  3.97531548E+01  4.65346985E+01
   1  'GROUP  2/  2'       0      -1
   2  'DRAGON-TXSC '       2      18
0.00000000E+00  4.45026428E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
8.56671408E-02  4.45026457E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
8.56671408E-02  3.99664789E-01  1.08252847E+00  3.97724301E-01  1.08740294E+00
3.98030460E-01  2.85094976E-01  3.99067879E-01
   2  'DRAGON-S0XSC'       2      18
0.00000000E+00  3.49167198E-01  3.35775822E-01  3.37583899E-01  3.37695420E-01
8.29786733E-02  3.49167198E-01  3.35775852E-01  3.37583899E-01  3.37695390E-01
8.29786733E-02  3.99550319E-01  8.89993608E-01  3.97603214E-01  8.90379846E-01
3.97910595E-01  2.80846745E-01  3.98950040E-01
   2  'DRAGON-PIS  '       2      15
1.82958857E-07 -2.12989931E-07  1.38650393E-07 -2.84881736E-07 -2.25391261E-07
2.30265329E-07  1.17676677E-07  2.98096836E-07  6.56414727E-07 -7.55955512E-07
1.19265078E-08  4.22177351E-08  4.46807462E-07 -7.07064842E-08  1.27525041E-07
   2  'DRAGON-PCSCT'       2     225
5.79993963E+00  4.87532711E+00  4.37052488E+00  2.91377425E+00  2.98982167E+00
3.07140803E+00  2.22001791E+00  2.22138524E+00  2.22495651E+00  8.01314652E-01
1.24208093E+00  1.52604938E+00  6.45393014E-01  9.04746115E-01  1.05709696E+00
3.04331231E+00  5.53703499E+00  4.34353352E+00  1.93948209E+00  2.50456238E+00
2.74783301E+00  1.94113111E+00  1.94263959E+00  1.94693530E+00  7.01198757E-01
1.08689725E+00  1.33537698E+00  5.64755678E-01  7.91704535E-01  9.25018609E-01
3.54184227E+01  5.63892136E+01  7.55623932E+01  2.63500099E+01  3.60025368E+01
4.21880989E+01  2.94270229E+01  2.94531670E+01  2.95304966E+01  1.06357346E+01
1.64858761E+01  2.02549057E+01  8.56615734E+00  1.20084734E+01  1.40305710E+01
2.91377425E+00  3.10701251E+00  3.25151038E+00  5.44944477E+00  4.23478460E+00
3.50056481E+00  2.76292849E+00  2.76332092E+00  2.76284719E+00  9.94960845E-01
1.54226565E+00  1.89485347E+00  8.01368117E-01  1.12340462E+00  1.31257832E+00
1.86632836E+00  2.50456238E+00  2.77319407E+00  2.64346814E+00  4.82451820E+00
3.40245533E+00  2.66508174E+00  2.66725612E+00  2.67365408E+00  9.62737322E-01
1.49234140E+00  1.83343673E+00  7.75402963E-01  1.08700645E+00  1.27004278E+00
1.02515268E+01  1.46925974E+01  1.73758221E+01  1.16839361E+01  1.81928482E+01
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2.38622417E+01  1.74692898E+01  1.74909153E+01  1.75609016E+01  6.32473087E+00
9.80355835E+00  1.20451956E+01  5.09405899E+00  7.14110374E+00  8.34361744E+00
1.25958574E+00  1.76434433E+00  2.06025958E+00  1.56762028E+00  2.42236185E+00
2.96958303E+00  1.13283157E+01  7.59164381E+00  4.17533970E+00  1.56764030E+00
2.42236042E+00  2.96951747E+00  1.25968552E+00  1.76452005E+00  2.06053829E+00
9.06008303E-01  1.26928091E+00  1.48232925E+00  1.12704074E+00  1.74273050E+00
2.13732123E+00  5.45723772E+00  5.64693975E+00  3.01715565E+00  1.12705505E+00
1.74272943E+00  2.13727403E+00  9.06080127E-01  1.26940739E+00  1.48252976E+00
1.90393276E+01  2.66893978E+01  3.11820889E+01  2.36421471E+01  3.66515617E+01
4.50221100E+01  6.29724579E+01  6.33023033E+01  6.33675575E+01  2.36424294E+01
3.66515083E+01  4.50210495E+01  1.90408249E+01  2.66920433E+01  3.11862907E+01
8.01314652E-01  1.12330675E+00  1.31241703E+00  9.94960845E-01  1.54228640E+00
1.89492059E+00  2.76296377E+00  2.76335621E+00  2.76288009E+00  5.44946766E+00
4.23480511E+00  3.50056434E+00  2.91381955E+00  3.10707259E+00  3.25159764E+00
7.75340855E-01  1.08689725E+00  1.26986969E+00  9.62724388E-01  1.49234140E+00
1.83347714E+00  2.66508031E+00  2.66725469E+00  2.67365003E+00  2.64348102E+00
4.82454395E+00  3.40239453E+00  1.86639452E+00  2.50467730E+00  2.77337503E+00
5.09353876E+00  7.14022875E+00  8.34229660E+00  6.32450676E+00  9.80334282E+00
1.20451956E+01  1.74689045E+01  1.74905281E+01  1.75604877E+01  1.16839333E+01
1.81925220E+01  2.38612537E+01  1.02523146E+01  1.46940479E+01  1.73782196E+01
6.45393014E-01  9.04727638E-01  1.05703759E+00  8.01368117E-01  1.24218047E+00
1.52620530E+00  2.22019386E+00  2.22156143E+00  2.22513151E+00  2.91381955E+00
2.98992753E+00  3.07164407E+00  5.79984140E+00  4.87515640E+00  4.37022686E+00
5.64767241E-01  7.91704535E-01  9.24985588E-01  7.01259851E-01  1.08700645E+00
1.33554065E+00  1.94132459E+00  1.94283330E+00  1.94712818E+00  1.93951964E+00
2.50467730E+00  2.74810433E+00  3.04320598E+00  5.53678799E+00  4.34315205E+00
8.56663799E+00  1.20089025E+01  1.40305710E+01  1.06370411E+01  1.64881210E+01
2.02581139E+01  2.94310036E+01  2.94571533E+01  2.95344772E+01  2.63507156E+01
3.60048866E+01  4.21939201E+01  3.54160080E+01  5.63842545E+01  7.55535736E+01
```

Contents of file `Geo/T3Dds/PIJMATLEA`

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      1  'SIGNATURE   '       3       12
  L_PIJ
      1  'STATE-VECTOR'       1       20
          0          1          0          0         -1          2          2         15
         17          1          1         15         42          0          0          0
          0          0          0          0
      1  'GROUP  1/  2'       0       -1
      2  'DRAGON-TXSC '       2       18
 0.00000000E+00  3.25573593E-01  2.94397712E-01  2.96656132E-01  2.94024080E-01
 1.08258009E-01  3.25573593E-01  2.94397771E-01  2.96656132E-01  2.94024020E-01
 1.08258016E-01  2.64682710E-01  8.37840736E-01  2.64991134E-01  8.31609249E-01
 2.65020490E-01  2.71528214E-01  2.65051723E-01
      2  'DRAGON-S0XSC'       2       18
 0.00000000E+00  3.12665552E-01  2.83534408E-01  2.84851104E-01  2.80805469E-01
 1.07063353E-01  3.12665582E-01  2.83534437E-01  2.84851104E-01  2.80805439E-01
 1.07063361E-01  2.53611684E-01  8.23869348E-01  2.52386063E-01  8.17773104E-01
 2.52767861E-01  2.64678836E-01  2.53184795E-01
      2  'DRAGON-PIS  '       2       15
-2.36589275E-03 -3.30539444E-03 -9.06518381E-03 -2.04200577E-03 -2.84516881E-03
-6.58531953E-03 -3.49449250E-03 -3.24327406E-03 -5.27446251E-03 -2.03984161E-03
-2.84464750E-03 -6.53499132E-03 -2.36677844E-03 -3.30743520E-03 -9.09096468E-03
      2  'DRAGON-PCSCT'       2      225
 1.88468444E+00  7.23788798E-01  7.75937811E-02  3.50626588E-01  1.37698025E-01
 4.55475301E-02  2.20596883E-03  2.79464363E-03  3.95210972E-03  7.84073018E-06
 2.61372606E-05  1.31423090E-04  2.03344757E-06  2.59791705E-06  4.74072158E-06
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 9.80908299E-05  5.51419034E-05  1.62158369E-06  1.29844175E-05  3.69175314E-06
 6.28814459E-01  1.70042539E+00  3.46730804E+00  1.90203279E-01  2.84003556E-01
 3.49015832E-01  6.36096578E-03  8.35555419E-03  1.26951886E-02  2.58193555E-04
 5.08629368E-04  2.99214036E-04  3.84173509E-05  4.79283444E-05  1.11757709E-05
 3.50626588E-01  1.37611926E-01  2.34705023E-02  1.88408720E+00  7.24099338E-01
 1.20864339E-01  1.11007132E-02  1.48662785E-02  2.43198816E-02  5.69440854E-05
 2.76704115E-04  7.49189814E-04  7.84045551E-06  1.74397082E-05  3.18605162E-05
 8.59548673E-02  1.05013773E-01  2.18761507E-02  4.52002585E-01  1.72469628E+00
 2.15899721E-01  1.32281920E-02  1.93514507E-02  3.73357162E-02  1.72725820E-04
 8.40303372E-04  7.98862195E-04  1.63150908E-05  9.80904661E-05  3.91786962E-05
 1.52025282E-01  2.40917757E-01  1.43747583E-01  4.03412342E-01  1.15441060E+00
 2.56321597E+00  6.82772100E-02  1.02272160E-01  2.13949099E-01  2.50069867E-03
 4.27183369E-03  4.97595873E-03  4.38698800E-04  2.94906524E-04  1.23241713E-04
 1.25161465E-03  1.37817999E-03  4.45347192E-04  6.29828218E-03  1.20234462E-02
 1.16063589E-02  2.20693445E+00  8.03774834E-01  5.38729317E-02  6.29828498E-03
 1.20234722E-02  1.16062434E-02  1.25162001E-03  1.37818826E-03  4.45377955E-04
 1.13981578E-03  1.25842204E-03  4.20521246E-04  6.06332067E-03  1.26438402E-02
 1.24972574E-02  5.77791870E-01  1.26148558E+00  6.87769726E-02  6.06332161E-03
 1.26438187E-02  1.24969501E-02  1.13981706E-03  1.25840702E-03  4.20547876E-04
 3.38188671E-02  3.70004959E-02  1.34052094E-02  2.08109304E-01  5.11813521E-01
 5.48516273E-01  8.12511325E-01  1.44299507E+00  3.11980820E+00  2.08109275E-01
 5.11814415E-01  5.48482835E-01  3.38187888E-02  3.70008387E-02  1.34061854E-02
 7.84073018E-06  1.74400411E-05  3.18602943E-05  5.69440854E-05  2.76703387E-04
 7.49221712E-04  1.11007178E-02  1.48662813E-02  2.43198778E-02  1.88407719E+00
 7.24096298E-01  1.20864138E-01  3.50629479E-01  1.37612104E-01  2.34707538E-02
 1.63155928E-05  9.80908299E-05  3.91785725E-05  1.72726257E-04  8.40303372E-04
 7.98925175E-04  1.32282209E-02  1.93514153E-02  3.73357795E-02  4.52000678E-01
 1.72470438E+00  2.15898097E-01  8.59547555E-02  1.05014756E-01  2.18765922E-02
 4.38654592E-04  2.94842437E-04  1.23235935E-04  2.50059227E-03  4.27149702E-03
 4.97595873E-03  6.82765320E-02  1.02269650E-01  2.13936046E-01  4.03411657E-01
 1.15440202E+00  2.56283092E+00  1.52023062E-01  2.40920261E-01  1.43842503E-01
 2.03344757E-06  2.59774538E-06  4.74058334E-06  7.84045551E-06  2.61364567E-05
 1.31436333E-04  2.20597838E-03  2.79464666E-03  3.95210041E-03  3.50629479E-01
 1.37697846E-01  4.55468632E-02  1.88468242E+00  7.23792136E-01  7.75942355E-02
 1.62169079E-06  1.29844175E-05  3.69181225E-06  1.08863424E-05  9.80904661E-05
 5.51538869E-05  1.51628233E-03  1.92599709E-03  2.69913301E-03  8.59012306E-02
 1.05014756E-01  4.50572893E-02  4.51810807E-01  1.72777796E+00  1.30980283E-01
 3.84184677E-05  4.79275805E-05  1.11757709E-05  2.58195359E-04  5.08630998E-04
 2.99228093E-04  6.36140537E-03  8.35608412E-03  1.26961125E-02  1.90205321E-01
 2.84009248E-01  3.49246323E-01  6.28818154E-01  1.70043015E+00  3.46730828E+00
    1  'GROUP  2/  2'       0      -1
    2  'DRAGON-TXSC '       2      18
 0.00000000E+00  4.45026428E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  4.45026457E-01  4.07855779E-01  4.10690248E-01  4.04776931E-01
 8.56671408E-02  3.99664789E-01  1.08252847E+00  3.97724301E-01  1.08740294E+00
 3.98030460E-01  2.85094976E-01  3.99067879E-01
    2  'DRAGON-S0XSC'       2      18
 0.00000000E+00  3.49167198E-01  3.35775822E-01  3.37583899E-01  3.37695420E-01
 8.29786733E-02  3.49167198E-01  3.35775852E-01  3.37583899E-01  3.37695390E-01
 8.29786733E-02  3.99550319E-01  8.89993608E-01  3.97603214E-01  8.90379846E-01
 3.97910595E-01  2.80846745E-01  3.98950040E-01
    2  'DRAGON-PIS  '       2      15
-1.46143930E-03 -2.22101691E-03 -6.07847795E-03 -1.30728679E-03 -2.06395239E-03
-4.44503082E-03 -2.33261124E-03 -2.09905044E-03 -3.48897418E-03 -1.30569970E-03
```

```
 -2.06477218E-03 -4.40739421E-03 -1.46261463E-03 -2.22263369E-03 -6.09653350E-03
     2  'DRAGON-PCSCT'       2      225
   1.55548131E+00  5.87797344E-01  4.34869342E-02  2.26148233E-01  8.61939341E-02
   2.11205427E-02  3.27287358E-04  5.19302499E-04  9.81949968E-04  5.81365953E-07
   2.06191203E-06  5.35570143E-06  5.35793632E-08  8.88773073E-08  6.31140793E-08
   3.66919160E-01  1.78392053E+00  9.15814564E-02  5.37926592E-02  9.94722694E-02
   2.84421798E-02  2.89662363E-04  4.60016890E-04  8.66454502E-04  8.53774395E-07
   7.30976899E-06  3.48194908E-06  5.54791590E-08  9.35236812E-07  1.32122608E-07
   3.52415025E-01  1.18894124E+00  2.36379743E+00  7.97203481E-02  1.65500477E-01
   1.67526379E-01  7.15014583E-04  1.17697590E-03  2.51244614E-03  6.64960453E-06
   1.98529178E-05  1.71755310E-05  5.11466283E-07  1.71529803E-06  2.49858374E-07
   2.26148233E-01  8.61747935E-02  9.83724650E-03  1.55520475E+00  5.88532984E-01
   7.71740526E-02  2.98716687E-03  4.88157012E-03  1.05572492E-02  7.26386088E-06
   3.08309609E-05  6.10019342E-05  5.81338952E-07  1.36768858E-06  8.20519688E-07
   5.38046099E-02  9.94722694E-02  1.27481269E-02  3.67378354E-01  1.78050435E+00
   1.71624646E-01  3.88229312E-03  6.81031728E-03  1.90598574E-02  1.92452480E-05
   8.89018775E-05  8.89504518E-05  1.28702902E-06  7.30967031E-06  1.52916732E-06
   7.04946369E-02  1.52079657E-01  6.89983293E-02  2.57586032E-01  9.17672873E-01
   1.91267157E+00  1.85584370E-02  3.39068174E-02  1.06230184E-01  2.03629519E-04
   4.75691340E-04  9.27439425E-04  1.78780410E-05  1.86216330E-05  7.07430218E-06
   1.85695113E-04  2.63281632E-04  5.00599672E-05  1.69484783E-03  3.52871674E-03
   3.15472600E-03  1.73048437E+00  5.29208541E-01  2.31608246E-02  1.69484864E-03
   3.52872186E-03  3.15474812E-03  1.85696103E-04  2.63283611E-04  5.00632486E-05
   2.11801322E-04  3.00565618E-04  5.92352517E-05  1.99098419E-03  4.44972143E-03
   4.14327998E-03  3.80420476E-01  1.05068004E+00  4.01389971E-02  1.99098699E-03
   4.44972096E-03  4.14332235E-03  2.11802821E-04  3.00561660E-04  5.92381148E-05
   8.40271078E-03  1.18777193E-02  2.65296316E-03  9.03401598E-02  2.61280477E-01
   2.72349745E-01  3.49311441E-01  8.42147827E-01  2.19580531E+00  9.03401822E-02
   2.61281282E-01  2.72339046E-01  8.40269215E-03  1.18778497E-02  2.65315361E-03
   5.81365953E-07  1.36772996E-06  8.20540834E-07  7.26386088E-06  3.08305134E-05
   6.10084135E-05  2.98716826E-03  4.88157710E-03  1.05572520E-02  1.55519867E+00
   5.88530183E-01  7.71741271E-02  2.26150259E-01  8.61746967E-02  9.83733032E-03
   1.28710178E-06  7.30976899E-06  1.52922541E-06  1.92455263E-05  8.89018775E-05
   8.89645526E-05  3.88229871E-03  6.81031588E-03  1.90599188E-02  3.67376626E-01
   1.78051567E+00  1.71624362E-01  5.38044758E-02  9.94734019E-02  1.27483830E-02
   1.78758764E-05  1.86178986E-05  7.07400841E-06  2.03607880E-04  4.75615961E-04
   9.27439425E-04  1.85585674E-02  3.39071639E-02  1.06226012E-01  2.57586271E-01
   9.17671323E-01  1.91247940E+00  7.04944953E-02  1.52080283E-01  6.90430626E-02
   5.35793632E-08  8.88765328E-08  6.31133759E-08  5.81338952E-07  2.06179561E-06
   5.35634945E-06  3.27289104E-04  5.19306166E-04  9.81947756E-04  2.26150259E-01
   8.61937255E-02  2.11205017E-02  1.55547988E+00  5.87800741E-01  4.34871987E-02
   5.54796458E-08  9.35236812E-07  1.32125535E-07  8.53748531E-07  7.30967031E-06
   3.48264757E-06  2.89664575E-04  4.60010866E-04  8.66464048E-04  5.37925996E-02
   9.94734019E-02  2.84422971E-02  3.66921276E-01  1.78390622E+00  9.15816426E-02
   5.11472024E-07  1.71526005E-06  2.49858374E-07  6.64943309E-06  1.98521629E-05
   1.71762440E-05  7.15061498E-04  1.17703283E-03  2.51262658E-03  7.97210187E-02
   1.65503785E-01  1.67634979E-01  3.52417141E-01  1.18894362E+00  2.36379719E+00
```

Contents of file `Geo/T3Dds/FLUXSK`

```
     1  'SIGNATURE   '       3       12
L_FLUX
     1  'FLUXDIRECT  '       0       -1
     2  'FLUX  1     '       2       15
   1.74980414E+00  1.32593179E+00  9.99956906E-01  1.74604690E+00  1.32081819E+00
   1.03450370E+00  8.44469011E-01  8.65597010E-01  9.06740963E-01  1.74604642E+00
   1.32081842E+00  1.03449786E+00  1.74979770E+00  1.32592893E+00  9.99959946E-01
```

```
    2  'FLUX  2     '       2       15
 8.94471765E-01  1.32450902E+00  1.65353119E+00  8.98698211E-01  1.32968903E+00
 1.62341976E+00  1.86277378E+00  1.83404374E+00  1.78087246E+00  8.98698092E-01
 1.32968867E+00  1.62342560E+00  8.94473851E-01  1.32450974E+00  1.65352893E+00
    2  '1/EIGENVALUE'       2        1
 1.09003806E+00
    1  'K-EFFECTIVE '       2        1
 1.09003806E+00
    1  'EPS-CONVERGE'       2        5
 9.99999975E-05  9.99999975E-06  9.99999975E-05  1.00000000E+01  1.00000000E+02
    1  'STATE-VECTOR'       1       20
        1         0         3         3         1        40        29         0
        2        15         0         0         0         0         0         0
        0         0         0         0
```

Contents of file `Geo/T3Dds/FLUXK`

```
    1  'SIGNATURE   '       3       12
L_FLUX
    1  'FLUXDIRECT  '       0       -1
    2  'FLUX  1     '       2       15
 1.74963760E+00  1.32573247E+00  9.99705017E-01  1.74617064E+00  1.32097280E+00
 1.03466356E+00  8.44861925E-01  8.65972281E-01  9.07080710E-01  1.74616957E+00
 1.32097304E+00  1.03465760E+00  1.74963045E+00  1.32572913E+00  9.99707818E-01
    2  'FLUX  2     '       2       15
 8.94453943E-01  1.32447588E+00  1.65347350E+00  8.98722172E-01  1.32974315E+00
 1.62349641E+00  1.86297643E+00  1.83422780E+00  1.78102648E+00  8.98721397E-01
 1.32974255E+00  1.62350202E+00  8.94454002E-01  1.32447314E+00  1.65346658E+00
    2  '1/EIGENVALUE'       2        1
 1.09003949E+00
    1  'K-EFFECTIVE '       2        1
 1.09003949E+00
    1  'EPS-CONVERGE'       2        5
 4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
    1  'STATE-VECTOR'       1       20
        1         0         3         3         1         4        29         0
        2        15         0         0         0         0         0         0
        0         0         0         0
```

Contents of file `Geo/T3Dds/FLUXB0`

```
    1  'SIGNATURE   '       3       12
L_FLUX
    1  'FLUXDIRECT  '       0       -1
    2  'FLUX  1     '       2       15
 1.86387438E-03  1.40245608E-03  1.04819471E-03  1.86004397E-03  1.39742706E-03
 1.08643342E-03  8.81077955E-04  9.03887558E-04  9.48326488E-04  1.86004257E-03
 1.39742717E-03  1.08642702E-03  1.86386623E-03  1.40245259E-03  1.04819774E-03
    2  'FLUX  2     '       2       15
 8.91392701E-04  1.32070237E-03  1.64954632E-03  8.95142322E-04  1.32487109E-03
 1.61809148E-03  1.85338955E-03  1.82528747E-03  1.77316531E-03  8.95141507E-04
 1.32487062E-03  1.61809719E-03  8.91392876E-04  1.32069958E-03  1.64953910E-03
    2  'DIFFB1HOM   '       2        2
 1.03447533E+00  7.62996018E-01
    2  'B2  B1HOM   '       2        1
 3.98739707E-04
    2  '1/EIGENVALUE'       2        1
```

```
1.00000095E+00
   2  'PNL         '       2       2
9.98431504E-01  9.99211252E-01
   1  'K-EFFECTIVE '       2       1
1.00000095E+00
   1  'EPS-CONVERGE'       2       5
4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
   1  'STATE-VECTOR'       1      20
       4          2          3          3          1          4        151          0
       2         15          0          0          0          0          0          0
       0          0          0          0
```

Contents of file `Geo/T3Dds/FLUXB1`

```
     1  'SIGNATURE   '       3      12
  L_FLUX
     1  'FLUXDIRECT  '       0      -1
     2  'FLUX  1     '       2      15
   1.86181895E-03  1.40049576E-03  1.04633311E-03  1.85800053E-03  1.39548222E-03
   1.08457636E-03  8.79316707E-04  9.02114145E-04  9.46530839E-04  1.85799936E-03
   1.39548234E-03  1.08456973E-03  1.86181068E-03  1.40049215E-03  1.04633614E-03
     2  'FLUX  2     '       2      15
   8.91506497E-04  1.32083206E-03  1.64967531E-03  8.95266654E-04  1.32502371E-03
   1.61825272E-03  1.85362180E-03  1.82550889E-03  1.77336845E-03  8.95265781E-04
   1.32502313E-03  1.61825866E-03  8.91506439E-04  1.32082915E-03  1.64966821E-03
     2  'DIFFB1HOM   '       2       2
   1.27474570E+00  8.65786016E-01
     2  'B2  B1HOM   '       2       1
   3.37864476E-04
     2  '1/EIGENVALUE'       2       1
   1.00000155E+00
     2  'PNL         '       2       2
   9.98362422E-01  9.99241590E-01
     1  'K-EFFECTIVE '       2       1
   1.00000155E+00
     1  'EPS-CONVERGE'       2       5
   4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
     1  'STATE-VECTOR'       1      20
         4          2          3          3          1          4        151          0
         2         15          0          0          0          0          0          0
         0          0          0          0
```

Contents of file `Geo/T3Dds/FLUXKB0`

```
     1  'SIGNATURE   '       3      12
  L_FLUX
     1  'FLUXDIRECT  '       0      -1
     2  'FLUX  1     '       2      15
   1.86387496E-03  1.40245655E-03  1.04819471E-03  1.86004292E-03  1.39742671E-03
   1.08643342E-03  8.81077896E-04  9.03887325E-04  9.48326313E-04  1.86004164E-03
   1.39742682E-03  1.08642702E-03  1.86386658E-03  1.40245294E-03  1.04819774E-03
     2  'FLUX  2     '       2      15
   8.91392818E-04  1.32070237E-03  1.64954644E-03  8.95142322E-04  1.32487109E-03
   1.61809137E-03  1.85338955E-03  1.82528759E-03  1.77316531E-03  8.95141449E-04
   1.32487051E-03  1.61809730E-03  8.91392818E-04  1.32069958E-03  1.64953910E-03
     2  'DIFFB1HOM   '       2       2
   1.03447533E+00  7.62996018E-01
```

```
    2  'B2  B1HOM   '       2       1
  3.98739998E-04
    2  '1/EIGENVALUE'       2       1
  1.00000083E+00
    2  'PNL         '       2       2
  9.98431504E-01  9.99211252E-01
    1  'K-EFFECTIVE '       2       1
  1.00000083E+00
    1  'EPS-CONVERGE'       2       5
  4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
    1  'STATE-VECTOR'       1      20
        3          2          3          3          1          4        151          0
        2         15          0          0          0          0          0          0
        0          0          0          0
```

Contents of file `Geo/T3Dds/FLUXKB1`

```
    1  'SIGNATURE   '       3      12
L_FLUX
    1  'FLUXDIRECT  '       0      -1
    2  'FLUX  1     '       2      15
  1.86181883E-03  1.40049553E-03  1.04633300E-03  1.85799948E-03  1.39548187E-03
  1.08457590E-03  8.79316533E-04  9.02114029E-04  9.46530665E-04  1.85799843E-03
  1.39548164E-03  1.08456938E-03  1.86181022E-03  1.40049192E-03  1.04633591E-03
    2  'FLUX  2     '       2      15
  8.91506497E-04  1.32083194E-03  1.64967531E-03  8.95266654E-04  1.32502383E-03
  1.61825295E-03  1.85362191E-03  1.82550901E-03  1.77336868E-03  8.95265839E-04
  1.32502324E-03  1.61825889E-03  8.91506439E-04  1.32082915E-03  1.64966809E-03
    2  'DIFFB1HOM   '       2       2
  1.27474570E+00  8.65786016E-01
    2  'B2  B1HOM   '       2       1
  3.37864010E-04
    2  '1/EIGENVALUE'       2       1
  1.00000167E+00
    2  'PNL         '       2       2
  9.98362422E-01  9.99241590E-01
    1  'K-EFFECTIVE '       2       1
  1.00000167E+00
    1  'EPS-CONVERGE'       2       5
  4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
    1  'STATE-VECTOR'       1      20
        3          2          3          3          1          4        151          0
        2         15          0          0          0          0          0          0
        0          0          0          0
```

Contents of file `Geo/T3Dds/FLUXKB1DB2`

```
    1  'SIGNATURE   '       3      12
L_FLUX
    1  'FLUXDIRECT  '       0      -1
    2  'FLUX  1     '       2      15
  1.86181476E-03  1.40049274E-03  1.04633090E-03  1.85799634E-03  1.39547919E-03
  1.08457380E-03  8.79314844E-04  9.02112282E-04  9.46528802E-04  1.85799506E-03
  1.39547919E-03  1.08456716E-03  1.86180638E-03  1.40048901E-03  1.04633393E-03
    2  'FLUX  2     '       2      15
  8.91492120E-04  1.32081064E-03  1.64964888E-03  8.95252277E-04  1.32500241E-03
  1.61822699E-03  1.85359200E-03  1.82547944E-03  1.77334005E-03  8.95251520E-04
```

```
  1.32500194E-03  1.61823281E-03  8.91492062E-04  1.32080796E-03  1.64964166E-03
     2  'DIFFB1HOM   '       2       2
  1.27474570E+00  8.65786016E-01
     2  'B2  B1HOM   '       2       1
  3.37864476E-04
     2  '1/EIGENVALUE'       2       1
  9.99999881E-01
     2  'PNL         '       2       2
  9.98362422E-01  9.99241590E-01
     1  'K-EFFECTIVE '       2       1
  9.99999881E-01
     1  'EPS-CONVERGE'       2       5
  4.99999987E-05  9.99999975E-06  4.99999987E-05  1.00000000E+01  1.00000000E+02
     1  'STATE-VECTOR'       1      20
         2         2         3         3         1         4       151         0
         2        15         0         0         0         0         0         0
         0         0         0         0
```

Contents of file `Geo/T3Dds/EDIRES`

```
     1  'SIGNATURE   '       3      12
L_EDIT
     1  'TITLE       '       3      72
Verification model : T3D
     1  'STATE-VECTOR'       1      20
         1         1         0         0         0         0         0         0
         0         1         2         1         1         2        15         0
         0         0         0         0
     1  'REF:IMERGE  '       1      15
         1         1         1         1         1         1         1         1
         1         1         1         1         1         1         1
     1  'REF:IGCOND  '       1       1
         2
     1  'LAST-EDIT   '       3      12
MAC8
     1  'MAC1        '       0      -1
     2  'FLXNORMALIZE'       2       1
  1.00000000E+00
     2  'MACROLIB    '       0      -1
     3  'TIMESTAMP   '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
     3  'ADDXSNAME   '       3      16
NG      N2N
     3  'FISSIONNAMES'       3       8
MACROFIS
     3  'FISSIONNB   '       1      15
        -1        -1        -1        -1        -1        -1        -1        -1
        -1        -1        -1        -1        -1        -1        -1
     3  'EFISS       '       2      15
  2.06069351E+02  0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00
  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  2.06069351E+02
  0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00  0.00000000E+00
     3  'GROUP   1/   2'       0      -1
     4  'NG          '       2      15
  9.39363055E-03  1.07356778E-03  2.90488206E-05  9.39363055E-03  1.07356778E-03
  2.90488206E-05  2.90488206E-05  2.90488206E-05  2.90488206E-05  9.39363055E-03
  1.07356778E-03  2.90488206E-05  9.39363055E-03  1.07356778E-03  2.90488206E-05
```

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   4  'N2N          '        2      15
 9.45518768E-05  2.54264660E-06  3.32042036E-05  9.45518768E-05  2.54264660E-06
 3.32042036E-05  3.32042036E-05  3.32042036E-05  3.32042036E-05  9.45518768E-05
 2.54264660E-06  3.32042036E-05  9.45518768E-05  2.54264660E-06  3.32042036E-05
   4  'OVERV        '        2      15
 1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08
 1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08
 1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08  1.44596930E-08
   4  'TOTAL        '        2      15
 3.66972268E-01  1.19784400E-01  3.33053291E-01  3.66972268E-01  1.19784400E-01
 3.33053291E-01  3.33053291E-01  3.33053291E-01  3.33053291E-01  3.66972268E-01
 1.19784400E-01  3.33053291E-01  3.66972268E-01  1.19784400E-01  3.33053291E-01
   4  'ABS          '        2      15
 1.18469121E-02  1.07102608E-03 -4.13320959E-06  1.18469121E-02  1.07102608E-03
-4.13320959E-06 -4.13320959E-06 -4.13320959E-06 -4.13320959E-06  1.18469121E-02
 1.07102608E-03 -4.13320959E-06  1.18469121E-02  1.07102608E-03 -4.13320959E-06
   4  'PRODUCTION   '        2      15
 6.44843653E-02  0.00000000E+00  0.00000000E+00  6.48456365E-02  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  6.48456141E-02
 0.00000000E+00  0.00000000E+00  6.44846186E-02  0.00000000E+00  0.00000000E+00
   4  'NUSIGF       '        2      15
 6.97151665E-03  0.00000000E+00  0.00000000E+00  6.97151665E-03  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  6.97151665E-03
 0.00000000E+00  0.00000000E+00  6.97151665E-03  0.00000000E+00  0.00000000E+00
   4  'CHI          '        2      15
 1.00000000E+00  0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.00000000E+00
 0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  0.00000000E+00
   4  'NFTOT        '        2      15
 2.54667969E-03  0.00000000E+00  0.00000000E+00  2.54667969E-03  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  2.54667969E-03
 0.00000000E+00  0.00000000E+00  2.54667969E-03  0.00000000E+00  0.00000000E+00
   4  'TRANC        '        2      15
 4.13986780E-02  1.15263890E-02  6.83705956E-02  4.13986780E-02  1.15263890E-02
 6.83705956E-02  6.83705956E-02  6.83705956E-02  6.83705956E-02  4.13986780E-02
 1.15263890E-02  6.83705956E-02  4.13986780E-02  1.15263890E-02  6.83705956E-02
   4  'DIFFHOM      '        2      15
 1.27474570E+00  1.27474570E+00  1.27474570E+00  1.27474570E+00  1.27474570E+00
 1.27474570E+00  1.27474570E+00  1.27474570E+00  1.27474570E+00  1.27474570E+00
 1.27474570E+00  1.27474570E+00  1.27474570E+00  1.27474570E+00  1.27474570E+00
   4  'FLUX-INTG    '        2      15
 3.87006021E+00  1.81720889E+00  1.76256790E+01  3.86212301E+00  1.81070364E+00
 7.52473879E+00  1.03704321E+00  7.64803827E-01  1.68362408E+01  3.86212063E+00
 1.81070375E+00  7.52469301E+00  3.87004304E+00  1.81720424E+00  1.76257305E+01
   4  'SIGW 0       '        2      15
 3.54064226E-01  1.18589744E-01  3.21982294E-01  3.54064226E-01  1.18589744E-01
 3.21982294E-01  3.21982294E-01  3.21982294E-01  3.21982294E-01  3.54064226E-01
 1.18589744E-01  3.21982294E-01  3.54064226E-01  1.18589744E-01  3.21982294E-01
   4  'SCAD 0       '        2      30
 3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05
 3.21982294E-01  3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01
 6.96978459E-05  3.21982294E-01  6.96978459E-05  3.21982294E-01  6.96978459E-05
 3.21982294E-01  6.96978459E-05  3.21982294E-01  3.84946383E-04  3.54064226E-01
 3.26710215E-05  1.18589744E-01  6.96978459E-05  3.21982294E-01  3.84946383E-04
 3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05  3.21982294E-01
   4  'NJJD 0       '        1      15
```

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         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IJJD 0      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IPOD 0      '       1      15
         1         3         5         7         9        11        13        15
        17        19        21        23        25        27        29
     4  'SCAA 0      '       2      30
  1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02
  3.21982294E-01  1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01
  1.10751297E-02  3.21982294E-01  1.10751297E-02  3.21982294E-01  1.10751297E-02
  3.21982294E-01  1.10751297E-02  3.21982294E-01  1.06112938E-03  3.54064226E-01
  1.23629870E-04  1.18589744E-01  1.10751297E-02  3.21982294E-01  1.06112938E-03
  3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02  3.21982294E-01
     4  'NJJA 0      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IJJA 0      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IPOA 0      '       1      15
         1         3         5         7         9        11        13        15
        17        19        21        23        25        27        29
     4  'SIGW 1      '       2      15
  4.56812121E-02  1.31940767E-02  6.90087155E-02  4.56812121E-02  1.31940767E-02
  6.90087155E-02  6.90087155E-02  6.90087155E-02  6.90087155E-02  4.56812121E-02
  1.31940767E-02  6.90087155E-02  4.56812121E-02  1.31940767E-02  6.90087155E-02
     4  'SCAD 1      '       2      30
 -3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05
  6.90087155E-02 -3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02
  3.57782919E-05  6.90087155E-02  3.57782919E-05  6.90087155E-02  3.57782919E-05
  6.90087155E-02  3.57782919E-05  6.90087155E-02 -3.03763445E-05  4.56812121E-02
 -7.45777811E-07  1.31940767E-02  3.57782919E-05  6.90087155E-02 -3.03763445E-05
  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05  6.90087155E-02
     4  'NJJD 1      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IJJD 1      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IPOD 1      '       1      15
         1         3         5         7         9        11        13        15
        17        19        21        23        25        27        29
     4  'SCAA 1      '       2      30
 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04
  6.90087155E-02 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02
 -8.15864187E-04  6.90087155E-02 -8.15864187E-04  6.90087155E-02 -8.15864187E-04
  6.90087155E-02 -8.15864187E-04  6.90087155E-02 -1.17839634E-04  4.56812121E-02
 -2.46254203E-05  1.31940767E-02 -8.15864187E-04  6.90087155E-02 -1.17839634E-04
  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04  6.90087155E-02
     4  'NJJA 1      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IJJA 1      '       1      15
         2         2         2         2         2         2         2         2
```

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        2          2          2          2          2          2          2
    4  'IPOA 1      '        1       15
        1          3          5          7          9         11         13         15
       17         19         21         23         25         27         29
    3  'GROUP  2/  2'        0       -1
    4  'NG          '        2       15
 4.98777106E-02  2.65579834E-03  4.47517668E-05  4.98777106E-02  2.65579834E-03
 4.47517668E-05  4.47517668E-05  4.47517668E-05  4.47517668E-05  4.98777106E-02
 2.65579834E-03  4.47517668E-05  4.98777106E-02  2.65579834E-03  4.47517668E-05
    4  'N2N         '        2       15
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'OVERV       '        2       15
 6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06
 6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06
 6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06  6.83756662E-06
    4  'TOTAL       '        2       15
 4.59974349E-01  8.63326862E-02  4.56327349E-01  4.59974349E-01  8.63326862E-02
 4.56327349E-01  4.56327349E-01  4.56327349E-01  4.56327349E-01  4.59974349E-01
 8.63326862E-02  4.56327349E-01  4.59974349E-01  8.63326862E-02  4.56327349E-01
    4  'ABS         '        2       15
 9.54742879E-02  2.65579647E-03  4.47728744E-05  9.54742879E-02  2.65579647E-03
 4.47728744E-05  4.47728744E-05  4.47728744E-05  4.47728744E-05  9.54742879E-02
 2.65579647E-03  4.47728744E-05  9.54742879E-02  2.65579647E-03  4.47728744E-05
    4  'PRODUCTION  '        2       15
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NUSIGF      '        2       15
 1.20109625E-01  0.00000000E+00  0.00000000E+00  1.20109625E-01  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.20109625E-01
 0.00000000E+00  0.00000000E+00  1.20109625E-01  0.00000000E+00  0.00000000E+00
    4  'CHI         '        2       15
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NFTOT       '        2       15
 4.55965549E-02  0.00000000E+00  0.00000000E+00  4.55965549E-02  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.55965549E-02
 0.00000000E+00  0.00000000E+00  4.55965549E-02  0.00000000E+00  0.00000000E+00
    4  'TRANC       '        2       15
 1.49479350E-02  6.65545289E-04  5.66625595E-02  1.49479350E-02  6.65545289E-04
 5.66625595E-02  5.66625595E-02  5.66625595E-02  5.66625595E-02  1.49479350E-02
 6.65545289E-04  5.66625595E-02  1.49479350E-02  6.65545289E-04  5.66625595E-02
    4  'DIFFHOM     '        2       15
 8.65786016E-01  8.65786016E-01  8.65786016E-01  8.65786016E-01  8.65786016E-01
 8.65786016E-01  8.65786016E-01  8.65786016E-01  8.65786016E-01  8.65786016E-01
 8.65786016E-01  8.65786016E-01  8.65786016E-01  8.65786016E-01  8.65786016E-01
    4  'FLUX-INTG   '        2       15
 1.85312533E+00  1.71384156E+00  2.77890930E+01  1.86094141E+00  1.71928036E+00
 1.12273598E+01  2.18611312E+00  1.54764915E+00  3.15434589E+01  1.86093950E+00
 1.71927965E+00  1.12274008E+01  1.85312521E+00  1.71383774E+00  2.77889729E+01
    4  'SIGW 0      '        2       15
 3.64115119E-01  8.36442187E-02  4.56212878E-01  3.64115119E-01  8.36442187E-02
 4.56212878E-01  4.56212878E-01  4.56212878E-01  4.56212878E-01  3.64115119E-01
```

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 8.36442187E-02  4.56212878E-01  3.64115119E-01  8.36442187E-02  4.56212878E-01
    4  'SCAD 0      '       2      30
 3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01
 1.10751297E-02  3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04
 4.56212878E-01  1.10751297E-02  4.56212878E-01  1.10751297E-02  4.56212878E-01
 1.10751297E-02  4.56212878E-01  1.10751297E-02  3.64115119E-01  1.06112938E-03
 8.36442187E-02  1.23629870E-04  4.56212878E-01  1.10751297E-02  3.64115119E-01
 1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01  1.10751297E-02
    4  'NJJD 0      '       1      15
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2
    4  'IJJD 0      '       1      15
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2
    4  'IPOD 0      '       1      15
        1         3         5         7         9        11        13        15
       17        19        21        23        25        27        29
    4  'SCAA 0      '       2      30
 3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01
 6.96978459E-05  3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05
 4.56212878E-01  6.96978459E-05  4.56212878E-01  6.96978459E-05  4.56212878E-01
 6.96978459E-05  4.56212878E-01  6.96978459E-05  3.64115119E-01  3.84946383E-04
 8.36442187E-02  3.26710215E-05  4.56212878E-01  6.96978459E-05  3.64115119E-01
 3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01  6.96978459E-05
    4  'NJJA 0      '       1      15
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2
    4  'IJJA 0      '       1      15
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2
    4  'IPOA 0      '       1      15
        1         3         5         7         9        11        13        15
       17        19        21        23        25        27        29
    4  'SIGW 1      '       2      15
 1.51528064E-02  6.68138091E-04  5.80918901E-02  1.51528064E-02  6.68138091E-04
 5.80918901E-02  5.80918901E-02  5.80918901E-02  5.80918901E-02  1.51528064E-02
 6.68138091E-04  5.80918901E-02  1.51528064E-02  6.68138091E-04  5.80918901E-02
    4  'SCAD 1      '       2      30
 1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02
-8.15864187E-04  1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05
 5.80918901E-02 -8.15864187E-04  5.80918901E-02 -8.15864187E-04  5.80918901E-02
-8.15864187E-04  5.80918901E-02 -8.15864187E-04  1.51528064E-02 -1.17839634E-04
 6.68138091E-04 -2.46254203E-05  5.80918901E-02 -8.15864187E-04  1.51528064E-02
-1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02 -8.15864187E-04
    4  'NJJD 1      '       1      15
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2
    4  'IJJD 1      '       1      15
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2
    4  'IPOD 1      '       1      15
        1         3         5         7         9        11        13        15
       17        19        21        23        25        27        29
    4  'SCAA 1      '       2      30
 1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02
 3.57782919E-05  1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07
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```
  5.80918901E-02  3.57782919E-05  5.80918901E-02  3.57782919E-05  5.80918901E-02
  3.57782919E-05  5.80918901E-02  3.57782919E-05  1.51528064E-02 -3.03763445E-05
  6.68138091E-04 -7.45777811E-07  5.80918901E-02  3.57782919E-05  1.51528064E-02
 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02  3.57782919E-05
     4  'NJJA 1      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IJJA 1      '       1      15
         2         2         2         2         2         2         2         2
         2         2         2         2         2         2         2
     4  'IPOA 1      '       1      15
         1         3         5         7         9        11        13        15
        17        19        21        23        25        27        29
     3  'DIFFB1HOM   '       2       2
  1.27474570E+00  8.65786016E-01
     3  'B2  B1HOM   '       2       1
  3.37864476E-04
     3  'FGWITHUPSCAT'       1      30
         1         1         1         1         1         1         1         1
         1         1         1         1         1         1         1         1
         1         1         1         1         1         1         1         1
         1         1         1         1         1         1
     3  'STATE-VECTOR'       1      20
         2        15         2         1         2         2         0         0
         2         0         0         0         0         0         0         0
         0         0         0         0
     3  'SIGNATURE   '       3      12
L_MACROLIB
     3  'ENERGY      '       2       3
  1.00000000E+07  6.25000000E-01  1.99999995E-04
     3  'DELTAU      '       2       2
  1.65880985E+01  8.04718971E+00
     3  'VOLUME      '       2      15
  2.07864478E+03  1.29754688E+03  1.68451895E+04  2.07864478E+03  1.29754688E+03
  6.93795215E+03  1.17937390E+03  8.47790527E+02  1.77873125E+04  2.07864478E+03
  1.29754688E+03  6.93795215E+03  2.07864478E+03  1.29754688E+03  1.68451895E+04
     3  'MATCOD      '       1      15
         1         2         3         4         5         6         7         8
         9        10        11        12        13        14        15
     3  'KEYFLX      '       1      15
         1         2         3         4         5         6         7         8
         9        10        11        12        13        14        15
     3  'K-EFFECTIVE '       2       1
  1.00000155E+00
     3  'FLUXDISAFACT'       2       2
  1.64129472E+00  5.66297233E-01
     1  'MAC2        '       0      -1
     2  'FLXNORMALIZE'       2       1
  1.00000000E+00
     2  'MACROLIB    '       0      -1
     3  'TIMESTAMP   '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
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NG      N2N
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MACROFIS
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   4  'NG          '       2        3
 9.39363055E-03  1.07356778E-03  2.90488206E-05
   4  'N2N         '       2        3
 9.45518768E-05  2.54264660E-06  3.32042036E-05
   4  'OVERV       '       2        3
 1.44596930E-08  1.44596930E-08  1.44596930E-08
   4  'TOTAL       '       2        3
 3.66972268E-01  1.19784400E-01  3.33053291E-01
   4  'ABS         '       2        3
 1.18469121E-02  1.07102608E-03 -4.13320959E-06
   4  'PRODUCTION  '       2        3
 6.46648705E-02  0.00000000E+00  0.00000000E+00
   4  'NUSIGF      '       2        3
 6.97151665E-03  0.00000000E+00  0.00000000E+00
   4  'CHI         '       2        3
 1.00000000E+00  0.00000000E+00  0.00000000E+00
   4  'NFTOT       '       2        3
 2.54667969E-03  0.00000000E+00  0.00000000E+00
   4  'TRANC       '       2        3
 4.13986780E-02  1.15263890E-02  6.83705956E-02
   4  'DIFFHOM     '       2        3
 1.27474570E+00  1.27474570E+00  1.27474570E+00
   4  'FLUX-INTG   '       2        3
 1.54643469E+01  7.25582027E+00  6.89389267E+01
   4  'SIGW 0      '       2        3
 3.54064226E-01  1.18589744E-01  3.21982294E-01
   4  'SCAD 0      '       2        6
 3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05
 3.21982294E-01
   4  'NJJD 0      '       1        3
       2          2          2
   4  'IJJD 0      '       1        3
       2          2          2
   4  'IPOD 0      '       1        3
       1          3          5
   4  'SCAA 0      '       2        6
 1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02
 3.21982294E-01
   4  'NJJA 0      '       1        3
       2          2          2
   4  'IJJA 0      '       1        3
       2          2          2
   4  'IPOA 0      '       1        3
       1          3          5
   4  'SIGW 1      '       2        3
 4.56812121E-02  1.31940767E-02  6.90087155E-02
   4  'SCAD 1      '       2        6
-3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05
 6.90087155E-02
   4  'NJJD 1      '       1        3
       2          2          2
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    4  'IJJD 1      '       1       3
        2         2         2
    4  'IPOD 1      '       1       3
        1         3         5
    4  'SCAA 1      '       2       6
 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04
  6.90087155E-02
    4  'NJJA 1      '       1       3
        2         2         2
    4  'IJJA 1      '       1       3
        2         2         2
    4  'IPOA 1      '       1       3
        1         3         5
    3  'GROUP  2/  2'       0      -1
    4  'NG          '       2       3
  4.98777106E-02  2.65579834E-03  4.47517668E-05
    4  'N2N         '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'OVERV       '       2       3
  6.83756662E-06  6.83756662E-06  6.83756662E-06
    4  'TOTAL       '       2       3
  4.59974349E-01  8.63326862E-02  4.56327349E-01
    4  'ABS         '       2       3
  9.54742879E-02  2.65579647E-03  4.47728744E-05
    4  'PRODUCTION  '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NUSIGF      '       2       3
  1.20109625E-01  0.00000000E+00  0.00000000E+00
    4  'CHI         '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NFTOT       '       2       3
  4.55965549E-02  0.00000000E+00  0.00000000E+00
    4  'TRANC       '       2       3
  1.49479350E-02  6.65545289E-04  5.66625595E-02
    4  'DIFFHOM     '       2       3
  8.65786016E-01  8.65786016E-01  8.65786016E-01
    4  'FLUX-INTG   '       2       3
  7.42813110E+00  6.86623907E+00  1.13310043E+02
    4  'SIGW 0      '       2       3
  3.64115119E-01  8.36442187E-02  4.56212878E-01
    4  'SCAD 0      '       2       6
  3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01
  1.10751297E-02
    4  'NJJD 0      '       1       3
        2         2         2
    4  'IJJD 0      '       1       3
        2         2         2
    4  'IPOD 0      '       1       3
        1         3         5
    4  'SCAA 0      '       2       6
  3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01
  6.96978459E-05
    4  'NJJA 0      '       1       3
        2         2         2
    4  'IJJA 0      '       1       3
        2         2         2
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      4  'IPOA 0       '       1       3
          1         3         5
      4  'SIGW 1       '       2       3
  1.51528064E-02  6.68138091E-04  5.80918901E-02
      4  'SCAD 1       '       2       6
  1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02
 -8.15864187E-04
      4  'NJJD 1       '       1       3
          2         2         2
      4  'IJJD 1       '       1       3
          2         2         2
      4  'IPOD 1       '       1       3
          1         3         5
      4  'SCAA 1       '       2       6
  1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02
  3.57782919E-05
      4  'NJJA 1       '       1       3
          2         2         2
      4  'IJJA 1       '       1       3
          2         2         2
      4  'IPOA 1       '       1       3
          1         3         5
      3  'DIFFB1HOM    '       2       2
  1.27474570E+00  8.65786016E-01
      3  'B2  B1HOM    '       2       1
  3.37864476E-04
      3  'FGWITHUPSCAT'       1       6
          1         1         1         1         1         1
      3  'STATE-VECTOR'       1      20
          2         3         2         1         2         2         0         0
          2         0         0         0         0         0         0         0
          0         0         0         0
      3  'SIGNATURE    '       3      12
L_MACROLIB
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      3  'DELTAU       '       2       2
  1.65880985E+01  8.04718971E+00
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  8.31457910E+03  5.19018750E+03  6.73807578E+04
      3  'MATCOD       '       1       3
          1         2         3
      3  'KEYFLX       '       1       3
          1         2         3
      3  'K-EFFECTIVE '       2       1
  1.00000155E+00
      3  'FLUXDISAFACT'       2       2
  1.64129472E+00  5.66297233E-01
      1  'MAC3         '       0      -1
      2  'FLXNORMALIZE'       2       1
  1.00000000E+00
      2  'MACROLIB     '       0      -1
      3  'TIMESTAMP    '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
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NG      N2N
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      3  'FISSIONNB   '       1       3
         -1         -1         -1
      3  'EFISS       '       2       3
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      3  'GROUP  1/  2'       0      -1
      4  'NG          '       2       3
    9.39363055E-03  1.07356778E-03  2.90488206E-05
      4  'N2N         '       2       3
    9.45518768E-05  2.54264660E-06  3.32042036E-05
      4  'OVERV       '       2       3
    1.44596930E-08  1.44596930E-08  1.44596930E-08
      4  'TOTAL       '       2       3
    3.66972268E-01  1.19784400E-01  3.33053291E-01
      4  'ABS         '       2       3
    1.18469121E-02  1.07102608E-03 -4.13320959E-06
      4  'PRODUCTION  '       2       3
    6.46648705E-02  0.00000000E+00  0.00000000E+00
      4  'NUSIGF      '       2       3
    6.97151665E-03  0.00000000E+00  0.00000000E+00
      4  'CHI         '       2       3
    1.00000000E+00  0.00000000E+00  0.00000000E+00
      4  'NFTOT       '       2       3
    2.54667969E-03  0.00000000E+00  0.00000000E+00
      4  'TRANC       '       2       3
    4.13986780E-02  1.15263890E-02  6.83705956E-02
      4  'DIFFHOM     '       2       3
    1.27474570E+00  1.27474570E+00  1.27474570E+00
      4  'FLUX-INTG   '       2       3
    1.54643469E+01  7.25582027E+00  6.89389267E+01
      4  'SIGW 0      '       2       3
    3.54064226E-01  1.18589744E-01  3.21982294E-01
      4  'SCAD 0      '       2       6
    3.84946383E-04  3.54064226E-01  3.26710215E-05  1.18589744E-01  6.96978459E-05
    3.21982294E-01
      4  'NJJD 0      '       1       3
          2          2          2
      4  'IJJD 0      '       1       3
          2          2          2
      4  'IPOD 0      '       1       3
          1          3          5
      4  'SCAA 0      '       2       6
    1.06112938E-03  3.54064226E-01  1.23629870E-04  1.18589744E-01  1.10751297E-02
    3.21982294E-01
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          2          2          2
      4  'IJJA 0      '       1       3
          2          2          2
      4  'IPOA 0      '       1       3
          1          3          5
      4  'SIGW 1      '       2       3
    4.56812121E-02  1.31940767E-02  6.90087155E-02
      4  'SCAD 1      '       2       6
   -3.03763445E-05  4.56812121E-02 -7.45777811E-07  1.31940767E-02  3.57782919E-05
    6.90087155E-02
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        2          2          2
    4  'IJJD 1       '        1        3
        2          2          2
    4  'IPOD 1       '        1        3
        1          3          5
    4  'SCAA 1       '        2        6
 -1.17839634E-04  4.56812121E-02 -2.46254203E-05  1.31940767E-02 -8.15864187E-04
  6.90087155E-02
    4  'NJJA 1       '        1        3
        2          2          2
    4  'IJJA 1       '        1        3
        2          2          2
    4  'IPOA 1       '        1        3
        1          3          5
    3  'GROUP  2/  2'        0       -1
    4  'NG           '        2        3
  4.98777106E-02  2.65579834E-03  4.47517668E-05
    4  'N2N          '        2        3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'OVERV        '        2        3
  6.83756662E-06  6.83756662E-06  6.83756662E-06
    4  'TOTAL        '        2        3
  4.59974349E-01  8.63326862E-02  4.56327349E-01
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  9.54742879E-02  2.65579647E-03  4.47728744E-05
    4  'PRODUCTION   '        2        3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NUSIGF       '        2        3
  1.20109625E-01  0.00000000E+00  0.00000000E+00
    4  'CHI          '        2        3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    4  'NFTOT        '        2        3
  4.55965549E-02  0.00000000E+00  0.00000000E+00
    4  'TRANC        '        2        3
  1.49479350E-02  6.65545289E-04  5.66625595E-02
    4  'DIFFHOM      '        2        3
  8.65786016E-01  8.65786016E-01  8.65786016E-01
    4  'FLUX-INTG    '        2        3
  7.42813110E+00  6.86623907E+00  1.13310043E+02
    4  'SIGW 0       '        2        3
  3.64115119E-01  8.36442187E-02  4.56212878E-01
    4  'SCAD 0       '        2        6
  3.64115119E-01  1.06112938E-03  8.36442187E-02  1.23629870E-04  4.56212878E-01
  1.10751297E-02
    4  'NJJD 0       '        1        3
        2          2          2
    4  'IJJD 0       '        1        3
        2          2          2
    4  'IPOD 0       '        1        3
        1          3          5
    4  'SCAA 0       '        2        6
  3.64115119E-01  3.84946383E-04  8.36442187E-02  3.26710215E-05  4.56212878E-01
  6.96978459E-05
    4  'NJJA 0       '        1        3
        2          2          2
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         2         2         2
     4  'IPOA 0      '       1       3
         1         3         5
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     4  'SCAD 1      '       2       6
  1.51528064E-02 -1.17839634E-04  6.68138091E-04 -2.46254203E-05  5.80918901E-02
 -8.15864187E-04
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     4  'IJJD 1      '       1       3
         2         2         2
     4  'IPOD 1      '       1       3
         1         3         5
     4  'SCAA 1      '       2       6
  1.51528064E-02 -3.03763445E-05  6.68138091E-04 -7.45777811E-07  5.80918901E-02
  3.57782919E-05
     4  'NJJA 1      '       1       3
         2         2         2
     4  'IJJA 1      '       1       3
         2         2         2
     4  'IPOA 1      '       1       3
         1         3         5
     3  'DIFFB1HOM   '       2       2
  1.27474570E+00  8.65786016E-01
     3  'B2  B1HOM   '       2       1
  3.37864476E-04
     3  'FGWITHUPSCAT'       1       6
         1         1         1         1         1         1
     3  'STATE-VECTOR'       1      20
         2         3         2         1         2         2         0         0
         2         0         0         0         0         0         0         0
         0         0         0         0
     3  'SIGNATURE   '       3      12
L_MACROLIB
     3  'ENERGY      '       2       3
  1.00000000E+07  6.25000000E-01  1.99999995E-04
     3  'DELTAU      '       2       2
  1.65880985E+01  8.04718971E+00
     3  'VOLUME      '       2       3
  8.31457910E+03  5.19018750E+03  6.73807578E+04
     3  'MATCOD      '       1       3
         1         2         3
     3  'KEYFLX      '       1       3
         1         2         3
     3  'K-EFFECTIVE '       2       1
  1.00000155E+00
     3  'FLUXDISAFACT'       2       2
  1.64129472E+00  5.66297233E-01
     1  'MAC4        '       0      -1
     2  'FLXNORMALIZE'       2       1
  1.00000000E+00
     2  'MACROLIB    '       0      -1
     3  'TIMESTAMP   '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
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NG       N2N
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MACROFIS
     3  'FISSIONNB   '       1       1
        -1
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     3  'GROUP  1/  2'       0      -1
     4  'NG          '       2       1
  1.69168774E-03
     4  'N2N         '       2       1
  4.11273359E-05
     4  'OVERV       '       2       1
  1.44596930E-08
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  3.21893394E-01
     4  'ABS         '       2       1
  2.08043726E-03
     4  'PRODUCTION  '       2       1
  1.09099923E-02
     4  'NUSIGF      '       2       1
  1.17620570E-03
     4  'CHI         '       2       1
  1.00000000E+00
     4  'NFTOT       '       2       1
  4.29665350E-04
     4  'TRANC       '       2       1
  5.93201630E-02
     4  'DIFFHOM     '       2       1
  1.27474570E+00
     4  'FLUX-INTG   '       2       1
  9.16590958E+01
     4  'SIGW 0      '       2       1
  3.11294287E-01
     4  'SCAD 0      '       2       2
  8.60567816E-05  3.11294287E-01
     4  'NJJD 0      '       1       1
         2
     4  'IJJD 0      '       1       1
         2
     4  'IPOD 0      '       1       1
         1
     4  'SCAA 0      '       2       2
  8.51867814E-03  3.11294287E-01
     4  'NJJA 0      '       1       1
         2
     4  'IJJA 0      '       1       1
         2
     4  'IPOA 0      '       1       1
         1
     4  'SIGW 1      '       2       1
  6.06546551E-02
     4  'SCAD 1      '       2       2
  2.99619696E-05  6.06546551E-02
     4  'NJJD 1      '       1       1
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          2
    4  'IJJD 1      '       1       1
          2
    4  'IPOD 1      '       1       1
          1
    4  'SCAA 1      '       2       2
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    4  'NJJA 1      '       1       1
          2
    4  'IJJA 1      '       1       1
          2
    4  'IPOA 1      '       1       1
          1
    3  'GROUP  2/  2'       0      -1
    4  'NG          '       2       1
 3.08613433E-03
    4  'N2N         '       2       1
 0.00000000E+00
    4  'OVERV       '       2       1
 6.83756662E-06
    4  'TOTAL       '       2       1
 4.36630696E-01
    4  'ABS         '       2       1
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    4  'PRODUCTION  '       2       1
 0.00000000E+00
    4  'NUSIGF      '       2       1
 6.99184323E-03
    4  'CHI         '       2       1
 0.00000000E+00
    4  'NFTOT       '       2       1
 2.65427493E-03
    4  'TRANC       '       2       1
 5.12211286E-02
    4  'DIFFHOM     '       2       1
 8.65786016E-01
    4  'FLUX-INTG   '       2       1
 1.27604416E+02
    4  'SIGW 0      '       2       1
 4.30804193E-01
    4  'SCAD 0      '       2       2
 4.30804193E-01  8.51867814E-03
    4  'NJJD 0      '       1       1
          2
    4  'IJJD 0      '       1       1
          2
    4  'IPOD 0      '       1       1
          1
    4  'SCAA 0      '       2       2
 4.30804193E-01  8.60567816E-05
    4  'NJJA 0      '       1       1
          2
    4  'IJJA 0      '       1       1
          2
    4  'IPOA 0      '       1       1
          1
```

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    4  'SIGW 1      '       2       1
  5.25024086E-02
    4  'SCAD 1      '       2       2
  5.25024086E-02 -6.35461125E-04
    4  'NJJD 1      '       1       1
        2
    4  'IJJD 1      '       1       1
        2
    4  'IPOD 1      '       1       1
        1
    4  'SCAA 1      '       2       2
  5.25024086E-02  2.99619696E-05
    4  'NJJA 1      '       1       1
        2
    4  'IJJA 1      '       1       1
        2
    4  'IPOA 1      '       1       1
        1
    3  'DIFFB1HOM   '       2       2
  1.27474570E+00  8.65786016E-01
    3  'B2  B1HOM   '       2       1
  3.37864476E-04
    3  'FGWITHUPSCAT'       1       2
        1         1
    3  'STATE-VECTOR'       1      20
        2         1         2         1         2         2         0         0
        2         0         0         0         0         0         0         0
        0         0         0         0
    3  'SIGNATURE   '       3      12
L_MACROLIB
    3  'ENERGY      '       2       3
  1.00000000E+07  6.25000000E-01  1.99999995E-04
    3  'DELTAU      '       2       2
  1.65880985E+01  8.04718971E+00
    3  'VOLUME      '       2       1
  8.08855234E+04
    3  'MATCOD      '       1       1
        1
    3  'KEYFLX      '       1       1
        1
    3  'K-EFFECTIVE '       2       1
  1.00000155E+00
    3  'FLUXDISAFACT'       2       2
  1.64129472E+00  5.66297233E-01
    1  'MAC5        '       0      -1
    2  'FLXNORMALIZE'       2       1
  1.00000000E+00
    2  'MACROLIB    '       0      -1
    3  'TIMESTAMP   '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
    3  'ADDXSNAME   '       3      16
NG      N2N
    3  'FISSIONNAMES'       3       8
MACROFIS
    3  'FISSIONNB   '       1      15
       -1        -1        -1        -1        -1        -1        -1        -1
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      -1         -1         -1         -1         -1         -1         -1
   3  'EFISS       '        2       15
2.06069351E+02  0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  2.06069351E+02
0.00000000E+00  0.00000000E+00  2.06069351E+02  0.00000000E+00  0.00000000E+00
   3  'GROUP  1/  1'        0       -1
   4  'NG          '        2       15
2.25020777E-02  1.84152415E-03  3.86573847E-05  2.25576460E-02  1.84419390E-03
3.84505765E-05  3.96993819E-05  3.95582902E-05  3.92871079E-05  2.25576423E-02
1.84419379E-03  3.84506129E-05  2.25021169E-02  1.84152427E-03  3.86573556E-05
   4  'N2N         '        2       15
6.39366772E-05  1.30853982E-06  1.28867023E-05  6.38068959E-05  1.30424939E-06
1.33240001E-05  1.06833768E-05  1.09817165E-05  1.15551356E-05  6.38069032E-05
1.30424974E-06  1.33239228E-05  6.39365826E-05  1.30853959E-06  1.28867596E-05
   4  'OVERV       '        2       15
2.22373160E-06  3.32614400E-06  4.18948775E-06  2.23309667E-06  3.33765729E-06
4.09962786E-06  4.64224740E-06  4.58094200E-06  4.46311060E-06  2.23309598E-06
3.33765638E-06  4.09964377E-06  2.22373797E-06  3.32614468E-06  4.18947639E-06
   4  'TOTAL       '        2       15
3.97085667E-01  1.03548177E-01  4.08484131E-01  3.97213310E-01  1.03491731E-01
4.06860620E-01  4.16664213E-01  4.15556610E-01  4.13427711E-01  3.97213310E-01
1.03491731E-01  4.06860918E-01  3.97085756E-01  1.03548169E-01  4.08483922E-01
   4  'ABS         '        2       15
3.89248393E-02  1.84021518E-03  2.57922020E-05  3.90396230E-02  1.84288924E-03
2.51481106E-05  2.90374537E-05  2.85980332E-05  2.77534509E-05  3.90396155E-02
1.84288912E-03  2.51482252E-05  3.89249213E-02  1.84021529E-03  2.57921183E-05
   4  'PRODUCTION  '        2       15
4.36048023E-02  0.00000000E+00  0.00000000E+00  4.37600911E-02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.37600836E-02
0.00000000E+00  0.00000000E+00  4.36049104E-02  0.00000000E+00  0.00000000E+00
   4  'NUSIGF      '        2       15
4.36048023E-02  0.00000000E+00  0.00000000E+00  4.37600948E-02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  4.37600836E-02
0.00000000E+00  0.00000000E+00  4.36049141E-02  0.00000000E+00  0.00000000E+00
   4  'CHI         '        2       15
1.00000000E+00  0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.00000000E+00
0.00000000E+00  0.00000000E+00  1.00000000E+00  0.00000000E+00  0.00000000E+00
   4  'NFTOT       '        2       15
1.64859127E-02  0.00000000E+00  0.00000000E+00  1.65450014E-02  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  1.65449977E-02
0.00000000E+00  0.00000000E+00  1.64859537E-02  0.00000000E+00  0.00000000E+00
   4  'TRANC       '        2       15
3.28341238E-02  6.25493657E-03  6.12065010E-02  3.27978171E-02  6.23661000E-03
6.13606982E-02  6.04295954E-02  6.05347902E-02  6.07369840E-02  3.27978209E-02
6.23661140E-03  6.13606684E-02  3.28340977E-02  6.25493564E-03  6.12065233E-02
   4  'DIFFHOM     '        2       15
1.14232755E+00  1.07625175E+00  1.02450514E+00  1.14176631E+00  1.07556176E+00
1.02989113E+00  9.97367859E-01  1.00104237E+00  1.00810492E+00  1.14176631E+00
1.07556176E+00  1.02989018E+00  1.14232719E+00  1.07625175E+00  1.02450585E+00
   4  'FLUX-INTG   '        2       15
5.72318554E+00  3.53105044E+00  4.54147720E+01  5.72306442E+00  3.52998400E+00
1.87520981E+01  3.22315621E+00  2.31245303E+00  4.83796997E+01  5.72306013E+00
3.52998328E+00  1.87520943E+01  5.72316837E+00  3.53104186E+00  4.54147034E+01
   4  'SIGW 0      '        2       15
3.58160824E-01  1.01707958E-01  4.08458352E-01  3.58173698E-01  1.01648837E-01
```

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4.06835467E-01  4.16635185E-01  4.15527999E-01  4.13399965E-01  3.58173698E-01
1.01648845E-01  4.06835765E-01  3.58160824E-01  1.01707958E-01  4.08458143E-01
   4  'SCAD 0      '       2       15
3.58160824E-01  1.01707958E-01  4.08458352E-01  3.58173698E-01  1.01648837E-01
4.06835467E-01  4.16635185E-01  4.15527999E-01  4.13399965E-01  3.58173698E-01
1.01648845E-01  4.06835765E-01  3.58160824E-01  1.01707958E-01  4.08458143E-01
   4  'NJJD 0      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IJJD 0      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IPOD 0      '       1       15
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15
   4  'SCAA 0      '       2       15
3.58160824E-01  1.01707958E-01  4.08458352E-01  3.58173698E-01  1.01648837E-01
4.06835467E-01  4.16635185E-01  4.15527999E-01  4.13399965E-01  3.58173698E-01
1.01648845E-01  4.06835765E-01  3.58160824E-01  1.01707958E-01  4.08458143E-01
   4  'NJJA 0      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IJJA 0      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IPOA 0      '       1       15
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15
   4  'SIGW 1      '       2       15
3.80929522E-02  8.28804448E-03  6.29881546E-02  3.80575992E-02  8.26793164E-03
6.31268099E-02  6.22667633E-02  6.23667315E-02  6.25568330E-02  3.80575992E-02
8.26793350E-03  6.31267875E-02  3.80929299E-02  8.28804355E-03  6.29881769E-02
   4  'SCAD 1      '       2       15
3.80929522E-02  8.28804448E-03  6.29881546E-02  3.80575992E-02  8.26793164E-03
6.31268099E-02  6.22667633E-02  6.23667315E-02  6.25568330E-02  3.80575992E-02
8.26793350E-03  6.31267875E-02  3.80929299E-02  8.28804355E-03  6.29881769E-02
   4  'NJJD 1      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IJJD 1      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IPOD 1      '       1       15
       1         2         3         4         5         6         7         8
       9        10        11        12        13        14        15
   4  'SCAA 1      '       2       15
3.80929522E-02  8.28804448E-03  6.29881546E-02  3.80575992E-02  8.26793164E-03
6.31268099E-02  6.22667633E-02  6.23667315E-02  6.25568330E-02  3.80575992E-02
8.26793350E-03  6.31267875E-02  3.80929299E-02  8.28804355E-03  6.29881769E-02
   4  'NJJA 1      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IJJA 1      '       1       15
       1         1         1         1         1         1         1         1
       1         1         1         1         1         1         1
   4  'IPOA 1      '       1       15
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          1          2          3          4          5          6          7          8
          9         10         11         12         13         14         15
      3  'DIFFB1HOM   '        2        1
   1.03674424E+00
      3  'B2  B1HOM   '        2        1
   3.37864476E-04
      3  'FGWITHUPSCAT'        1       30
          2          2          2          2          2          2          2          2
          2          2          2          2          2          2          2          2
          2          2          2          2          2          2          2          2
          2          2          2          2          2          2
      3  'STATE-VECTOR'        1       20
          1         15          2          1          2          2          0          0
          2          0          0          0          0          0          0          0
          0          0          0          0
      3  'SIGNATURE   '        3       12
 L_MACROLIB
      3  'ENERGY      '        2        2
   1.00000000E+07  1.99999995E-04
      3  'DELTAU      '        2        1
   2.46352882E+01
      3  'VOLUME      '        2       15
   2.07864478E+03  1.29754688E+03  1.68451895E+04  2.07864478E+03  1.29754688E+03
   6.93795215E+03  1.17937390E+03  8.47790527E+02  1.77873125E+04  2.07864478E+03
   1.29754688E+03  6.93795215E+03  2.07864478E+03  1.29754688E+03  1.68451895E+04
      3  'MATCOD      '        1       15
          1          2          3          4          5          6          7          8
          9         10         11         12         13         14         15
      3  'KEYFLX      '        1       15
          1          2          3          4          5          6          7          8
          9         10         11         12         13         14         15
      3  'K-EFFECTIVE '        2        1
   1.00000155E+00
      3  'FLUXDISAFACT'        2        1
   1.01568019E+00
      1  'MAC6        '        0       -1
      2  'FLXNORMALIZE'        2        1
   1.00000000E+00
      2  'MACROLIB    '        0       -1
      3  'TIMESTAMP   '        2        3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
      3  'ADDXSNAME   '        3       16
 NG      N2N
      3  'FISSIONNAMES'        3        8
 MACROFIS
      3  'FISSIONNB   '        1        3
         -1         -1         -1
      3  'EFISS       '        2        3
   2.06069351E+02  0.00000000E+00  0.00000000E+00
      3  'GROUP  1/  1'        0       -1
      4  'NG          '        2        3
   2.25298703E-02  1.84285885E-03  3.88118497E-05
      4  'N2N         '        2        3
   6.38717684E-05  1.30639501E-06  1.25600827E-05
      4  'OVERV       '        2        3
   2.22841550E-06  3.33189973E-06  4.25660483E-06
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   4  'TOTAL       '       2       3
3.97149503E-01  1.03519954E-01  4.09696758E-01
   4  'ABS         '       2       3
3.89822498E-02  1.84155197E-03  2.62732756E-05
   4  'PRODUCTION  '       2       3
4.36824709E-02  0.00000000E+00  0.00000000E+00
   4  'NUSIGF      '       2       3
4.36824709E-02  0.00000000E+00  0.00000000E+00
   4  'CHI         '       2       3
1.00000000E+00  0.00000000E+00  0.00000000E+00
   4  'NFTOT       '       2       3
1.65154655E-02  0.00000000E+00  0.00000000E+00
   4  'TRANC       '       2       3
3.28159630E-02  6.24577468E-03  6.10913336E-02
   4  'DIFFHOM     '       2       3
1.14204681E+00  1.07590675E+00  1.02048230E+00
   4  'FLUX-INTG   '       2       3
2.28924770E+01  1.41220598E+01  1.82248978E+02
   4  'SIGW 0      '       2       3
3.58167261E-01  1.01678401E-01  4.09670472E-01
   4  'SCAD 0      '       2       3
3.58167261E-01  1.01678401E-01  4.09670472E-01
   4  'NJJD 0      '       1       3
       1          1          1
   4  'IJJD 0      '       1       3
       1          1          1
   4  'IPOD 0      '       1       3
       1          2          3
   4  'SCAA 0      '       2       3
3.58167261E-01  1.01678401E-01  4.09670472E-01
   4  'NJJA 0      '       1       3
       1          1          1
   4  'IJJA 0      '       1       3
       1          1          1
   4  'IPOA 0      '       1       3
       1          2          3
   4  'SIGW 1      '       2       3
3.80752757E-02  8.27799272E-03  6.28836378E-02
   4  'SCAD 1      '       2       3
3.80752757E-02  8.27799272E-03  6.28836378E-02
   4  'NJJD 1      '       1       3
       1          1          1
   4  'IJJD 1      '       1       3
       1          1          1
   4  'IPOD 1      '       1       3
       1          2          3
   4  'SCAA 1      '       2       3
3.80752757E-02  8.27799272E-03  6.28836378E-02
   4  'NJJA 1      '       1       3
       1          1          1
   4  'IJJA 1      '       1       3
       1          1          1
   4  'IPOA 1      '       1       3
       1          2          3
   3  'DIFFB1HOM   '       2       1
1.03674412E+00
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     3  'B2  B1HOM   '       2       1
  3.37864476E-04
     3  'FGWITHUPSCAT'       1       6
         2         2         2         2         2         2
     3  'STATE-VECTOR'       1      20
         1         3         2         1         2         2         0         0
         2         0         0         0         0         0         0         0
         0         0         0         0
     3  'SIGNATURE   '       3      12
L_MACROLIB
     3  'ENERGY      '       2       2
  1.00000000E+07  1.99999995E-04
     3  'DELTAU      '       2       1
  2.46352882E+01
     3  'VOLUME      '       2       3
  8.31457910E+03  5.19018750E+03  6.73807578E+04
     3  'MATCOD      '       1       3
         1         2         3
     3  'KEYFLX      '       1       3
         1         2         3
     3  'K-EFFECTIVE '       2       1
  1.00000155E+00
     3  'FLUXDISAFACT'       2       1
  1.01568019E+00
     1  'MAC7        '       0      -1
     2  'FLXNORMALIZE'       2       1
  1.00000000E+00
     2  'MACROLIB    '       0      -1
     3  'TIMESTAMP   '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
     3  'ADDXSNAME   '       3      16
NG      N2N
     3  'FISSIONNAMES'       3       8
MACROFIS
     3  'FISSIONNB   '       1       3
        -1        -1        -1
     3  'EFISS       '       2       3
  2.06069351E+02  0.00000000E+00  0.00000000E+00
     3  'GROUP  1/  1'       0      -1
     4  'NG          '       2       3
  2.25298703E-02  1.84285885E-03  3.88118497E-05
     4  'N2N         '       2       3
  6.38717684E-05  1.30639501E-06  1.25600827E-05
     4  'OVERV       '       2       3
  2.22841550E-06  3.33189973E-06  4.25660483E-06
     4  'TOTAL       '       2       3
  3.97149503E-01  1.03519954E-01  4.09696758E-01
     4  'ABS         '       2       3
  3.89822498E-02  1.84155197E-03  2.62732756E-05
     4  'PRODUCTION  '       2       3
  4.36824709E-02  0.00000000E+00  0.00000000E+00
     4  'NUSIGF      '       2       3
  4.36824709E-02  0.00000000E+00  0.00000000E+00
     4  'CHI         '       2       3
  1.00000000E+00  0.00000000E+00  0.00000000E+00
     4  'NFTOT       '       2       3
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  1.65154655E-02  0.00000000E+00  0.00000000E+00
     4  'TRANC        '        2        3
  3.28159630E-02  6.24577468E-03  6.10913336E-02
     4  'DIFFHOM      '        2        3
  1.14204681E+00  1.07590675E+00  1.02048230E+00
     4  'FLUX-INTG    '        2        3
  2.28924770E+01  1.41220598E+01  1.82248978E+02
     4  'SIGW 0       '        2        3
  3.58167261E-01  1.01678401E-01  4.09670472E-01
     4  'SCAD 0       '        2        3
  3.58167261E-01  1.01678401E-01  4.09670472E-01
     4  'NJJD 0       '        1        3
         1          1          1
     4  'IJJD 0       '        1        3
         1          1          1
     4  'IPOD 0       '        1        3
         1          2          3
     4  'SCAA 0       '        2        3
  3.58167261E-01  1.01678401E-01  4.09670472E-01
     4  'NJJA 0       '        1        3
         1          1          1
     4  'IJJA 0       '        1        3
         1          1          1
     4  'IPOA 0       '        1        3
         1          2          3
     4  'SIGW 1       '        2        3
  3.80752757E-02  8.27799272E-03  6.28836378E-02
     4  'SCAD 1       '        2        3
  3.80752757E-02  8.27799272E-03  6.28836378E-02
     4  'NJJD 1       '        1        3
         1          1          1
     4  'IJJD 1       '        1        3
         1          1          1
     4  'IPOD 1       '        1        3
         1          2          3
     4  'SCAA 1       '        2        3
  3.80752757E-02  8.27799272E-03  6.28836378E-02
     4  'NJJA 1       '        1        3
         1          1          1
     4  'IJJA 1       '        1        3
         1          1          1
     4  'IPOA 1       '        1        3
         1          2          3
     3  'DIFFB1HOM    '        2        1
  1.03674412E+00
     3  'B2  B1HOM    '        2        1
  3.37864476E-04
     3  'FGWITHUPSCAT'         1        6
         2          2          2          2          2          2
     3  'STATE-VECTOR'         1       20
         1          3          2          1          2          2          0          0
         2          0          0          0          0          0          0          0
         0          0          0          0
     3  'SIGNATURE    '        3       12
L_MACROLIB
     3  'ENERGY       '        2        2
```

```
  1.00000000E+07  1.99999995E-04
     3  'DELTAU      '       2       1
  2.46352882E+01
     3  'VOLUME      '       2       3
  8.31457910E+03  5.19018750E+03  6.73807578E+04
     3  'MATCOD      '       1       3
         1         2         3
     3  'KEYFLX      '       1       3
         1         2         3
     3  'K-EFFECTIVE '       2       1
  1.00000155E+00
     3  'FLUXDISAFACT'       2       1
  1.01568019E+00
     1  'MAC8        '       0      -1
     2  'FLXNORMALIZE'       2       1
  1.00000000E+00
     2  'MACROLIB    '       0      -1
     3  'TIMESTAMP   '       2       3
  0.00000000E+00  0.00000000E+00  0.00000000E+00
     3  'ADDXSNAME   '       3      16
NG      N2N
     3  'FISSIONNAMES'       3       8
MACROFIS
     3  'FISSIONNB   '       1       1
        -1
     3  'EFISS       '       2       1
  2.06069351E+02
     3  'GROUP  1/  1'       0      -1
     4  'NG          '       2       1
  2.50321138E-03
     4  'N2N         '       2       1
  1.71925294E-05
     4  'OVERV       '       2       1
  3.98529164E-06
     4  'TOTAL       '       2       1
  3.88666868E-01
     4  'ABS         '       2       1
  4.21043625E-03
     4  'PRODUCTION  '       2       1
  4.56072250E-03
     4  'NUSIGF      '       2       1
  4.56072250E-03
     4  'CHI         '       2       1
  1.00000000E+00
     4  'NFTOT       '       2       1
  1.72431767E-03
     4  'TRANC       '       2       1
  5.46067841E-02
     4  'DIFFHOM     '       2       1
  1.03674412E+00
     4  'FLUX-INTG   '       2       1
  2.19263504E+02
     4  'SIGW 0      '       2       1
  3.84456426E-01
     4  'SCAD 0      '       2       1
  3.84456426E-01
```

```
      4  'NJJD 0      '       1       1
          1
      4  'IJJD 0      '       1       1
          1
      4  'IPOD 0      '       1       1
          1
      4  'SCAA 0      '       2       1
   3.84456426E-01
      4  'NJJA 0      '       1       1
          1
      4  'IJJA 0      '       1       1
          1
      4  'IPOA 0      '       1       1
          1
      4  'SIGW 1      '       2       1
   5.63805811E-02
      4  'SCAD 1      '       2       1
   5.63805811E-02
      4  'NJJD 1      '       1       1
          1
      4  'IJJD 1      '       1       1
          1
      4  'IPOD 1      '       1       1
          1
      4  'SCAA 1      '       2       1
   5.63805811E-02
      4  'NJJA 1      '       1       1
          1
      4  'IJJA 1      '       1       1
          1
      4  'IPOA 1      '       1       1
          1
      3  'DIFFB1HOM   '       2       1
   1.03674412E+00
      3  'B2  B1HOM   '       2       1
   3.37864476E-04
      3  'FGWITHUPSCAT'       1       2
          2         2
      3  'STATE-VECTOR'       1      20
          1         1         2         1         2         2         0         0
          2         0         0         0         0         0         0         0
          0         0         0         0
      3  'SIGNATURE   '       3      12
 L_MACROLIB
      3  'ENERGY      '       2       2
   1.00000000E+07  1.99999995E-04
      3  'DELTAU      '       2       1
   2.46352882E+01
      3  'VOLUME      '       2       1
   8.08855234E+04
      3  'MATCOD      '       1       1
          1
      3  'KEYFLX      '       1       1
          1
      3  'K-EFFECTIVE '       2       1
   1.00000155E+00
```

```
       3  'FLUXDISAFACT'       2       1
   1.01568019E+00
```

B.21 Macrolib used for 2 groups calculations

Contents of file `Geo/mds/MAC2G`

```
       1  'TIMESTAMP   '       2       3
   0.00000000E+00  0.00000000E+00  0.00000000E+00
       1  'ADDXSNAME   '       3      16
  NG      N2N
       1  'FISSIONNAMES'       3       8
  MACROFIS
       1  'FISSIONNB   '       1      17
          -1         -1         -1         -1         -1         -1         -1         -1
          -1         -1         -1         -1         -1         -1         -1         -1
          -1
       1  'EFISS       '       2      17
   2.06069351E+02  2.06155655E+02  2.06402878E+02  2.06918304E+02  0.00000000E+00
   2.06069351E+02  2.06155655E+02  2.06402878E+02  2.06918304E+02  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00
       1  'GROUP  1/  2'       0      -1
       2  'NG          '       2      17
   9.39363055E-03  7.42090819E-03  8.18023738E-03  9.18334536E-03  1.07356778E-03
   9.39363241E-03  7.42090866E-03  8.18023272E-03  9.18332674E-03  1.07356720E-03
   2.90488206E-05  1.07533894E-02  2.25575914E-05  1.06278602E-02  2.34049639E-05
   2.13378668E-03  2.48200267E-05
       2  'N2N         '       2      17
   9.45518768E-05  9.06193891E-05  9.05651250E-05  8.37368716E-05  2.54264660E-06
   9.45518841E-05  9.06193382E-05  9.05650668E-05  8.37369371E-05  2.54264751E-06
   3.32042036E-05  1.28042501E-07  2.53940034E-05  1.36740653E-07  2.64002720E-05
   1.11436730E-05  2.81118046E-05
       2  'OVERV       '       2      17
   4.25829008E-08  4.45541950E-08  4.88867258E-08  5.95243783E-08  7.93758090E-08
   4.25829043E-08  4.45541950E-08  4.88866903E-08  5.95242646E-08  7.93757451E-08
   1.24673250E-07  1.40486662E-07  1.41375494E-07  1.38409902E-07  1.37604673E-07
   1.36135057E-07  1.33304781E-07
       2  'TOTAL       '       2      17
   3.66972268E-01  3.36002141E-01  3.38099569E-01  3.35170865E-01  1.19784400E-01
   3.66972268E-01  3.36002171E-01  3.38099569E-01  3.35170805E-01  1.19784415E-01
   3.33053291E-01  8.56383860E-01  3.35892975E-01  8.50560188E-01  3.35404932E-01
   3.03512335E-01  3.34769249E-01
       2  'ABS         '       2      17
   1.18468888E-02  9.26784892E-03  1.00525869E-02  1.08884582E-02  1.07102480E-03
   1.18468907E-02  9.26784892E-03  1.00525804E-02  1.08884396E-02  1.07102422E-03
  -4.15325349E-06  1.07532591E-02 -2.83437089E-06  1.06277214E-02 -2.99324006E-06
   2.12264014E-03 -3.28968076E-06
       2  'PRODUCTION  '       2      17
   5.94994873E-02  4.82291616E-02  5.68561032E-02  6.92973062E-02  0.00000000E+00
   5.94995879E-02  4.82292287E-02  5.68561070E-02  6.92971945E-02  0.00000000E+00
   0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
   0.00000000E+00  0.00000000E+00
       2  'NUSIGF      '       2      17
   6.97151665E-03  5.30293165E-03  5.37728379E-03  4.90613654E-03  0.00000000E+00
   6.97151665E-03  5.30292979E-03  5.37728099E-03  4.90613608E-03  0.00000000E+00
```

```
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00
   2  'CHI         '       2      17
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
1.00000000E+00  1.00000000E+00  1.00000000E+00  1.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00
   2  'NFTOT       '       2      17
2.54667969E-03  1.93666597E-03  1.96188735E-03  1.78768847E-03  0.00000000E+00
2.54667969E-03  1.93666539E-03  1.96188618E-03  1.78768823E-03  0.00000000E+00
0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
0.00000000E+00  0.00000000E+00
   2  'TRANC       '       2      17
4.13986780E-02  4.16044146E-02  4.14434485E-02  4.11467813E-02  1.15263890E-02
4.13986817E-02  4.16044071E-02  4.14434448E-02  4.11467887E-02  1.15263956E-02
6.83705956E-02  1.85431466E-02  7.09018335E-02  1.89509094E-02  7.03844279E-02
3.19841318E-02  6.97175413E-02
   2  'DIFFHOM     '       2      17
1.20390368E+00  1.19993532E+00  1.19601262E+00  1.17912114E+00  1.13243985E+00
1.20390368E+00  1.19993532E+00  1.19601250E+00  1.17912126E+00  1.13243985E+00
1.05584800E+00  1.03933585E+00  1.03996801E+00  1.04197168E+00  1.04260278E+00
1.04377413E+00  1.04606259E+00
   2  'FLUX-INTG   '       2      17
1.78393796E-01  1.38636959E+00  2.64689302E+00  3.92554688E+00  3.94185710E+00
1.78394109E-01  1.38637197E+00  2.64689803E+00  3.92555714E+00  3.94186449E+00
6.88388596E+01  2.81760674E-02  1.13142550E+00  8.61039758E-02  4.61066335E-01
2.51201659E-01  1.64434493E+00
   2  'SIGW 0      '       2      17
3.54064226E-01  3.25138837E-01  3.26294541E-01  3.21952254E-01  1.18589744E-01
3.54064256E-01  3.25138837E-01  3.26294541E-01  3.21952224E-01  1.18589759E-01
3.21982294E-01  8.42412472E-01  3.23287904E-01  8.36724043E-01  3.23152304E-01
2.96662956E-01  3.22902322E-01
   2  'SCAD 0      '       2      34
3.84946383E-04  3.54064226E-01  3.25490109E-04  3.25138837E-01  2.98079249E-04
3.26294541E-01  2.47671182E-04  3.21952254E-01  3.26710215E-05  1.18589744E-01
3.84945743E-04  3.54064256E-01  3.25489702E-04  3.25138837E-01  2.98078958E-04
3.26294541E-01  2.47671094E-04  3.21952224E-01  3.26709778E-05  1.18589759E-01
6.96978459E-05  3.21982294E-01  3.72809911E-04  8.42412472E-01  7.68680038E-05
3.23287904E-01  3.41795589E-04  8.36724043E-01  7.55530709E-05  3.23152304E-01
7.61851697E-05  2.96662956E-01  7.32379776E-05  3.22902322E-01
   2  'NJJD 0      '       1      17
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2
   2  'IJJD 0      '       1      17
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2
   2  'IPOD 0      '       1      17
       1         3         5         7         9        11        13        15
      17        19        21        23        25        27        29        31
      33
   2  'SCAA 0      '       2      34
1.06112938E-03  3.54064226E-01  1.59547420E-03  3.25138837E-01  1.75244489E-03
3.26294541E-01  2.33015907E-03  3.21952254E-01  1.23629870E-04  1.18589744E-01
1.06112962E-03  3.54064256E-01  1.59547443E-03  3.25138837E-01  1.75244361E-03
```

```
 3.26294541E-01  2.33015488E-03  3.21952224E-01  1.23629768E-04  1.18589759E-01
 1.10751297E-02  3.21982294E-01  3.21812928E-03  8.42412472E-01  1.26078892E-02
 3.23287904E-01  3.20846098E-03  8.36724043E-01  1.22556090E-02  3.23152304E-01
 4.72672051E-03  2.96662956E-01  1.18702101E-02  3.22902322E-01
    2  'NJJA 0      '       1       17
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2         2
        2
    2  'IJJA 0      '       1       17
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2         2
        2
    2  'IPOA 0      '       1       17
        1         3         5         7         9        11        13        15
       17        19        21        23        25        27        29        31
       33
    2  'SIGW 1      '       2       17
 4.56812121E-02  4.41160686E-02  4.40077595E-02  4.34184223E-02  1.31940767E-02
 4.56812121E-02  4.41160612E-02  4.40077558E-02  4.34184298E-02  1.31940842E-02
 6.90087155E-02  2.15053800E-02  7.20499754E-02  2.19825935E-02  7.14636743E-02
 3.37783769E-02  7.07361102E-02
    2  'SCAD 1      '       2       34
-3.03763445E-05  4.56812121E-02 -3.38265477E-06  4.41160686E-02 -2.95742825E-06
 4.40077595E-02  3.77692299E-06  4.34184223E-02 -7.45777811E-07  1.31940767E-02
-3.03762990E-05  4.56812121E-02 -3.38265272E-06  4.41160612E-02 -2.95743007E-06
 4.40077558E-02  3.77692118E-06  4.34184298E-02 -7.45776902E-07  1.31940842E-02
 3.57782919E-05  6.90087155E-02  7.57624048E-06  2.15053800E-02  3.93339615E-05
 7.20499754E-02  6.98565691E-06  2.19825935E-02  3.86814791E-05  7.14636743E-02
 1.27013163E-05  3.37783769E-02  3.75578384E-05  7.07361102E-02
    2  'NJJD 1      '       1       17
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2         2
        2
    2  'IJJD 1      '       1       17
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2         2
        2
    2  'IPOD 1      '       1       17
        1         3         5         7         9        11        13        15
       17        19        21        23        25        27        29        31
       33
    2  'SCAA 1      '       2       34
-1.17839634E-04  4.56812121E-02 -1.30644141E-04  4.41160686E-02 -1.43222744E-04
 4.40077595E-02 -1.77150898E-04  4.34184223E-02 -2.46254203E-05  1.31940767E-02
-1.17839656E-04  4.56812121E-02 -1.30644126E-04  4.41160612E-02 -1.43222656E-04
 4.40077558E-02 -1.77150578E-04  4.34184298E-02 -2.46253985E-05  1.31940842E-02
-8.15864187E-04  6.90087155E-02 -7.52160035E-04  2.15053800E-02 -9.46536602E-04
 7.20499754E-02 -7.47995102E-04  2.19825935E-02 -9.17176367E-04  7.14636743E-02
-4.01519181E-04  3.37783769E-02 -8.83174827E-04  7.07361102E-02
    2  'NJJA 1      '       1       17
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2         2
        2
    2  'IJJA 1      '       1       17
        2         2         2         2         2         2         2         2
        2         2         2         2         2         2         2         2
```

```
        2
     2  'IPOA 1       '        1       17
        1         3         5         7         9        11        13        15
       17        19        21        23        25        27        29        31
       33
     1  'GROUP  2/  2'        0       -1
     2  'NG          '        2       17
 4.98777106E-02  3.76623124E-02  3.86861376E-02  3.63860019E-02  2.65579834E-03
 4.98777181E-02  3.76623161E-02  3.86861414E-02  3.63859981E-02  2.65579880E-03
 4.47517668E-05  1.92162007E-01  4.42091405E-05  1.96681231E-01  4.42906639E-05
 4.17207647E-03  4.45891492E-05
     2  'N2N         '        2       17
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00
     2  'OVERV       '        2       17
 2.88167007E-06  2.92783784E-06  3.02614831E-06  3.21724701E-06  3.42895714E-06
 2.88167098E-06  2.92783830E-06  3.02614853E-06  3.21724610E-06  3.42895805E-06
 3.60519493E-06  3.42826684E-06  3.55421503E-06  3.52630150E-06  3.56119131E-06
 3.57598265E-06  3.59046112E-06
     2  'TOTAL       '        2       17
 4.59974349E-01  4.31600422E-01  4.34344858E-01  4.30805326E-01  8.63326862E-02
 4.59974378E-01  4.31600422E-01  4.34344858E-01  4.30805326E-01  8.63326862E-02
 4.56327349E-01  1.09385407E+00  4.54657972E-01  1.09871936E+00  4.54920352E-01
 3.06714267E-01  4.55815285E-01
     2  'ABS         '        2       17
 9.54742730E-02  7.17544556E-02  7.28082806E-02  6.68338537E-02  2.65579694E-03
 9.54742879E-02  7.17544630E-02  7.28082806E-02  6.68338463E-02  2.65579741E-03
 4.47552193E-05  1.92162022E-01  4.42126038E-05  1.96681246E-01  4.42941237E-05
 4.17207088E-03  4.45926016E-05
     2  'PRODUCTION  '        2       17
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00
     2  'NUSIGF      '        2       17
 1.20109625E-01  8.99471790E-02  9.04339552E-02  8.14552382E-02  0.00000000E+00
 1.20109648E-01  8.99471864E-02  9.04339626E-02  8.14552233E-02  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00
     2  'CHI         '        2       17
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00
     2  'NFTOT       '        2       17
 4.55965549E-02  3.40921134E-02  3.41221429E-02  3.04478221E-02  0.00000000E+00
 4.55965623E-02  3.40921171E-02  3.41221467E-02  3.04478183E-02  0.00000000E+00
 0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00  0.00000000E+00
 0.00000000E+00  0.00000000E+00
     2  'TRANC       '        2       17
 1.49479350E-02  2.37446297E-02  2.36545969E-02  2.60283984E-02  6.65545289E-04
 1.49479341E-02  2.37446297E-02  2.36545969E-02  2.60284003E-02  6.65545289E-04
 5.66625595E-02  1.13255903E-02  5.69336601E-02  1.13164289E-02  5.68898804E-02
 2.16192789E-02  5.67473918E-02
```

```
   2  'DIFFHOM     '       2       17
8.21229935E-01  8.18367124E-01  8.12096536E-01  8.00670207E-01  7.88682163E-01
8.21229875E-01  8.18367064E-01  8.12096536E-01  8.00670207E-01  7.88682163E-01
7.78611481E-01  7.86748588E-01  7.81190276E-01  7.82240689E-01  7.80761361E-01
7.80093074E-01  7.79446185E-01
   2  'FLUX-INTG   '       2       17
7.80175924E-02  6.61628425E-01  1.50672293E+00  3.10318327E+00  4.64874601E+00
7.80178607E-02  6.61630630E-01  1.50672603E+00  3.10318661E+00  4.64875603E+00
1.46662369E+02  5.45561425E-02  2.47221303E+00  1.81850106E-01  9.97574747E-01
5.45957208E-01  3.56336331E+00
   2  'SIGW 0      '       2       17
3.64115119E-01  3.59520465E-01  3.61238509E-01  3.63723814E-01  8.36442187E-02
3.64115119E-01  3.59520495E-01  3.61238509E-01  3.63723785E-01  8.36442187E-02
4.56212878E-01  9.01319206E-01  4.54536885E-01  9.01696265E-01  4.54800487E-01
3.02466035E-01  4.55697447E-01
   2  'SCAD 0      '       2       34
3.64115119E-01  1.06112938E-03  3.59520465E-01  1.59547420E-03  3.61238509E-01
1.75244489E-03  3.63723814E-01  2.33015907E-03  8.36442187E-02  1.23629870E-04
3.64115119E-01  1.06112962E-03  3.59520495E-01  1.59547443E-03  3.61238509E-01
1.75244361E-03  3.63723785E-01  2.33015488E-03  8.36442187E-02  1.23629768E-04
4.56212878E-01  1.10751297E-02  9.01319206E-01  3.21812928E-03  4.54536885E-01
1.26078892E-02  9.01696265E-01  3.20846098E-03  4.54800487E-01  1.22556090E-02
3.02466035E-01  4.72672051E-03  4.55697447E-01  1.18702101E-02
   2  'NJJD 0      '       1       17
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2
   2  'IJJD 0      '       1       17
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2
   2  'IPOD 0      '       1       17
       1         3         5         7         9        11        13        15
      17        19        21        23        25        27        29        31
      33
   2  'SCAA 0      '       2       34
3.64115119E-01  3.84946383E-04  3.59520465E-01  3.25490109E-04  3.61238509E-01
2.98079249E-04  3.63723814E-01  2.47671182E-04  8.36442187E-02  3.26710215E-05
3.64115119E-01  3.84945743E-04  3.59520495E-01  3.25489702E-04  3.61238509E-01
2.98078958E-04  3.63723785E-01  2.47671094E-04  8.36442187E-02  3.26709778E-05
4.56212878E-01  6.96978459E-05  9.01319206E-01  3.72809911E-04  4.54536885E-01
7.68680038E-05  9.01696265E-01  3.41795589E-04  4.54800487E-01  7.55530709E-05
3.02466035E-01  7.61851697E-05  4.55697447E-01  7.32379776E-05
   2  'NJJA 0      '       1       17
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2
   2  'IJJA 0      '       1       17
       2         2         2         2         2         2         2         2
       2         2         2         2         2         2         2         2
       2
   2  'IPOA 0      '       1       17
       1         3         5         7         9        11        13        15
      17        19        21        23        25        27        29        31
      33
   2  'SIGW 1      '       2       17
```

```
 1.51528064E-02  2.40635239E-02  2.39962060E-02  2.64482293E-02  6.68138091E-04
 1.51528055E-02  2.40635239E-02  2.39962060E-02  2.64482312E-02  6.68138091E-04
 5.80918901E-02  1.13375625E-02  5.83328791E-02  1.13311671E-02  5.82920983E-02
 2.21330188E-02  5.81715927E-02
    2  'SCAD 1      '       2       34
 1.51528064E-02 -1.17839634E-04  2.40635239E-02 -1.30644141E-04  2.39962060E-02
-1.43222744E-04  2.64482293E-02 -1.77150898E-04  6.68138091E-04 -2.46254203E-05
 1.51528055E-02 -1.17839656E-04  2.40635239E-02 -1.30644126E-04  2.39962060E-02
-1.43222656E-04  2.64482312E-02 -1.77150578E-04  6.68138091E-04 -2.46253985E-05
 5.80918901E-02 -8.15864187E-04  1.13375625E-02 -7.52160035E-04  5.83328791E-02
-9.46536602E-04  1.13311671E-02 -7.47995102E-04  5.82920983E-02 -9.17176367E-04
 2.21330188E-02 -4.01519181E-04  5.81715927E-02 -8.83174827E-04
    2  'NJJD 1      '       1       17
        2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2
        2
    2  'IJJD 1      '       1       17
        2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2
        2
    2  'IPOD 1      '       1       17
        1          3          5          7          9         11         13         15
       17         19         21         23         25         27         29         31
       33
    2  'SCAA 1      '       2       34
 1.51528064E-02 -3.03763445E-05  2.40635239E-02 -3.38265477E-06  2.39962060E-02
-2.95742825E-06  2.64482293E-02  3.77692299E-06  6.68138091E-04 -7.45777811E-07
 1.51528055E-02 -3.03762990E-05  2.40635239E-02 -3.38265272E-06  2.39962060E-02
-2.95743007E-06  2.64482312E-02  3.77692118E-06  6.68138091E-04 -7.45776902E-07
 5.80918901E-02  3.57782919E-05  1.13375625E-02  7.57624048E-06  5.83328791E-02
 3.93339615E-05  1.13311671E-02  6.98565691E-06  5.82920983E-02  3.86814791E-05
 2.21330188E-02  1.27013163E-05  5.81715927E-02  3.75578384E-05
    2  'NJJA 1      '       1       17
        2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2
        2
    2  'IJJA 1      '       1       17
        2          2          2          2          2          2          2          2
        2          2          2          2          2          2          2          2
        2
    2  'IPOA 1      '       1       17
        1          3          5          7          9         11         13         15
       17         19         21         23         25         27         29         31
       33
    1  'DIFFB1HOM   '       2        2
 1.08401728E+00  7.80927718E-01
    1  'B2  B1HOM   '       2        1
-1.10733790E-05
    1  'FGWITHUPSCAT'       1       34
        1          1          1          1          1          1          1          1
        1          1          1          1          1          1          1          1
        1          1          1          1          1          1          1          1
        1          1          1          1          1          1          1          1
        1          1
    1  'STATE-VECTOR'       1       20
        2         17          2          1          2          2          0          0
```

```
        2           0           0           0           0           0           0           0
        0           0           0           0
     1  'SIGNATURE   '        3      12
L_MACROLIB
     1  'ENERGY      '        2       3
  1.00000000E+07  6.25000000E-01  1.99999995E-04
     1  'DELTAU      '        2       2
  1.65880985E+01  8.04718971E+00
     1  'VOLUME      '        2      17
  8.11500320E+01  6.45050232E+02  1.29118005E+03  2.13990942E+03  2.59509326E+03
  8.11500320E+01  6.45050232E+02  1.29118005E+03  2.13990942E+03  2.59509326E+03
  6.37293906E+04  2.98873768E+01  1.18453955E+03  8.86981354E+01  4.70572968E+02
  2.53466446E+02  1.62420776E+03
     1  'MATCOD      '        1      17
        1           2           3           4           5           6           7           8
        9          10          11          12          13          14          15          16
       17
     1  'KEYFLX      '        1      17
        1           2           3           4           5           6           7           8
        9          10          11          12          13          14          15          16
       17
     1  'K-EFFECTIVE '        2       1
  9.99999344E-01
     1  'FLUXDISAFACT'        2       2
  1.63893628E+00  5.96549273E-01
```

Appendix C

ASCII interpretation of a DRAGON data structure

The interpretation on the information produced in the ASCII files generated by the automatic export of any DRAGON data structure is generally straight forward. In fact, to illustrate the relation between the contents of the ASCII file and a general data structure, it is useful to study the following set of instructions which can be used to read the ASCII file (identified here by NUNIT) and re-import it into a LINKED_LIST or XSM_FILE (identified here by IDDS).

```
      IUP=1
      IDOWN=2
      ILEVEL=1
 100  CONTINUE
      READ(NUNIT,'(1X,I5,3H  ',A12,1H',2I8)',END=105)
     >  JLEVEL,NAMT,ITYLCM,ILONG
      DO 110 ID=1,ILEVEL-JLEVEL
        CALL LCMSIX(IDDS,NAMT,IDOWN)
 110  CONTINUE
      IF(ITYLCM.EQ.0) THEN
C----
C  DIRECTORY DATA.
C----
        CALL LCMSIX(IDDS,NAMT,IUP)
      ELSE IF(ITYLCM.EQ.1) THEN
C----
C  INTEGER DATA.
C----
        READ(NUNIT,'(8I10)') (III(J),J=1,ILONG)
        CALL LCMPUT(IDDS,NAMT,III,ITYLCM,ILONG)
      ELSE IF(ITYLCM.EQ.2) THEN
C----
C  SINGLE PRECISION DATA.
C----
        READ(NUNIT,'(1P,5E16.8)') (RRR(J),J=1,ILONG)
        CALL LCMPUT(IDDS,NAMT,RRR,ITYLCM,ILONG)
      ELSE IF(ITYLCM.EQ.3) THEN
C----
C  CHARACTER*4 DATA.
C----
        READ(NUNIT,'(20A4)') (AAA(J),J=1,ILONG/4)
        CALL LCMPUT(IDDS,NAMT,AAA,ITYLCM,ILONG/4)
      ELSE IF(ITYLCM.EQ.4) THEN
C----
C  DOUBLE PRECISION DATA.
C----
        READ(NUNIT,'(1P,4D20.12)') (DDD(J),J=1,ILONG/2)
        CALL LCMPUT(IDDS,NAMT,DDD,ITYLCM,ILONG/2)
      ELSE IF(ITYLCM.EQ.5) THEN
C----
C  LOGICAL DATA.
```

```
C----
        READ(NUNIT,'(8L10)') (LLL(J),J=1,ILONG)
        CALL LCMPUT(IDDS,NAMT,LLL,ITYLCM,ILONG)
     ELSE IF(ITYLCM.EQ.6) THEN
C----
C  COMPLEX DATA.
C----
        READ(NUNIT,'(1P,5E16.8)') (CCC(J),J=1,ILONG/2)
        CALL LCMPUT(IDDS,NAMT,LLL,ITYLCM,ILONG/2)
      ENDIF
      GO TO 100
 105  CONTINUE
```

The first observation here is that all the data arrays and directory are identified by 4 variables on a record of the ASCII file:

- `ILEVEL` describing the subdirectory level. A value of `ILEVEL`=1 means that the current information is to be stored on the main directory while a value `ILEVEL`$>$ 1 means that the information is stored on a sub-directory of the current directory. Note that if the level associated with the current record or directory is smaller than the level of the previous record, then one assumes that the information to be stored in the current sub-directory is complete. The data structure is re-positioned to a sub-directory that contains the current sub-directory. The positioning of the data structure in a specific sub-directory of the current directory is controlled by the variable `ITYLCM`.
- `NAMT` is the name of the data array or sub-directory to be processed.
- `ITYLCM` is the type of record to be processed. We will have:
  - `ITYLCM`=0 for a sub-directory of the current directory.
  - `ITYLCM`=1 for an integer data array;
  - `ITYLCM`=2 for a real data array;
  - `ITYLCM`=3 for a character data array;
  - `ITYLCM`=4 for a double precision data array;
  - `ITYLCM`=5 for a logical data array;
  - `ITYLCM`=6 for a complex data array;
- `ILONG` length of the array to be stored on the data structure.

Once a data array has been identified, one can read the information associated with this array on the ASCII file and store it in the data structure. On the other hand, a record that identifies a sub-directory will always be followed by a new record (as indicated by the fact that `ILONG`= -1 for records identifying sub-directory).

As an example let us consider the `geometry` data structure associated with G21F2DZ4 and presented in Appendix B.4. To each sub-geometry in the dragon input file is associated a subdirectory of the same name. All these geometry contain a level 2 record called `MESHX` which contain a array of real numbers. The fact that a given `MESHX` record is associated with the sub-directory `c1` rather than `c2` can be identified using the following logic. Since sub-directory `c1` is at level 1, all the records at level 2 immediately following `c1` will be included into the sub-directory. The presence of a level 1 record (here the sub-directory `c2`, but the presence of an record containing an array would have the same effect) indicates that the remaining records are not to be included in sub-directory `c1`.