KfK 3537
Mai 1983

PREPRO
A Preprocessor Code for SSYST Input

H. Borgwaldt
Institut für Neutronenphysik und Reaktortechnik
Projekt Nukleare Sicherheit

Kernforschungszentrum Karlsruhe

KERNFORSCHUNGSZENTRUM KARLSRUHE

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H. Borgwaldt

Kernforschungszentrum Karlsruhe GmbH, Karlsruhe

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ISSN 0303-4003

PREPRO, a Preprocessor Code for SSYST Input.

A global input preprocessor PREPRO has been developed as a support tool for the code-system SSYST. Its purpose is to simplify writing and checking large input decks for the code-system SSYST. The preprocessor has the following capabilities:

Input for programmes only loosely coupled to the code-system SSYST is copied directly to the output file.

Input for all regular, fully integrated SSYST modules is accepted in formatted, free-format or symbolic form and is converted to standard SSYST input formats.

In addition, the input is extensively checked for formal correctness, and the list of required modules for executing the input is evaluated.

The report gives an outline of the way PREPRO operates and instructions how to use it. To demonstrate usage, 2 sample applications have been included in the Appendices A to D.

PREPRO, ein Eingabe-Preprocessor für SSYST.

Zur Unterstützung der Anwendung des Code-Systems SSYST wurde ein globaler Eingabe-Preprocessor PREPRO entwickelt. Seine Aufgabe ist, die Vorbereitung und formale Überprüfung umfangreicher Eingaben für das Code-System SSYST zu erleichtern. Der Preprocessor hat die folgenden Fähigkeiten:

Eingabedaten für mit SSYST nur lose gekoppelte Programme werden unmittelbar in die Ausgabedatei übertragen.

Eingabedaten für voll integrierte SSYST-Module werden in festem und freiem Format sowie in symbolischer Form verarbeitet und in die für SSYST-Eingabe gültigen Standard-Formate gewandelt.

Zusätzlich erfolgt eine weitgehende Formalprüfung der Eingabe und die Erstellung einer Liste der für die Ausführung benötigten SSYST-Module.

Der Bericht beschreibt die Funktionsweise von PREPRO und enthält eine Anleitung zur Anwendung. In den Anhängen A bis D demonstrieren 2 Anwendungsbeispiele die praktische Handhabung.

PREPRO, a Preprocessor Code for SSYST Input.

H. Borgwaldt
Institut für Neutronenphysik und Reaktortechnik

1. Introduction.

A global input preprocessor PREPRO has been developed as a support tool for the code-system SSYST /1,2/. This report intends to outline the way PREPRO operates and instruct the reader how to use it. The reader should to some degree be familiar with the code-system SSYST. For all details, especially regarding its implementation, available modules, valid keywords, and input specifications, the most recent SSYST documentation should be consulted. In its current state, PREPRO can be used with version SSYST-3. Due to the chosen code structure, adaptation to more advanced versions is expected to be very easy. Possibly a few explicit references in PREPRO to SSYST keywords will have to be exchanged.

The preprocessor code PREPRO is intended to simplify writing and checking large input decks for the code-system SSYST. Both codes are operative on IBM/370 and compatible computers. Whereas SSYST-3 is programmed in IBM FORTRAN IV (with a minor contribution of ASSEMBLER), PREPRO has been programmed in PL/I. This language was chosen for its powerful error handling capabilities and its convenience in handling character strings and coding multiple logical decisions. When the development of PREPRO started, FORTRAN 77 was not yet in wider use.

2. Execution logics of SSYST.

SSYST is a code for analizing the transient behaviour of nuclear power-reactor fuel-rods under off-normal conditions. Unlike other codes with similar applications it has not been designed as a monolithic stand-alone code but as a highly modular code-system. It consists of a nucleus (i.e. kernel or driver) and an arbitrary number of so-called modu-

les. These are semi-autonomous programme units performing specific tasks, e.g. modelling a separate physical phenomenon during one time step, or creating a real matrix as a data block in the temporary data base, etc.

During the execution of a SSYST run an input file containing SSYST commands is read sequentially, without backspace or rewind operations. Invocation of specific SSYST modules occurs whenever a keyword related to such module is read from the command language input file.

In the current implementation, SSYST-3, the nucleus itself covers 30 keywords related to the most elementary activities. A group of 18 general purpose modules covers 64 additional keywords related to various, clerical and numerical, activities, but not directly to the modelling of fuel rod behaviour. Finally, a group of 31 physics modules covers 33 application-oriented keywords. With this architecture, for an actual SSYST run only those modules must be loaded from the SSYST load library, together with the nucleus, which are referenced by keywords in the command language input file.

A basic command record in SSYST input files contains a keyword and a set KPARA(5) of integer control parameters in the

FORTRAN format (3X,A9,5I12) FO-1

where the first item is the 9-character keyword, specifying the module involved and the action to be performed. Following the keyword is the field KPARA of 5 integer parameters, which each module accesses as its primary input data.

If the module needs additional data, they are normally obtained from the SSYST data bases via standard interface routines in the nucleus, using chained-list techniques. But, for a number of keywords or modules the basic command record above is followed in the input file by additional records in specific standard formats, as augmentations to the

basic command. Finally, among the application-oriented modules we have programmes, only loosely coupled to SSYST, which after the basic command read subsequent records in their own non-standard formats and following their own input rules.

For the execution logics of SSYST the main distinction between these loosely coupled modules and fully integrated SSYST modules is that only modules of the first group read independently records from the SSYST input file. All basic command records and all input records for standard SSYST modules are read, interpreted and possibly converted by a central section of the nucleus. Data are then passed, by pointer techniques, as arguments to the modules concerned or, in some cases, to subroutines of the systems nucleus.

3. Execution logics of PREPRO.

Thus, it is not too difficult to mimic the central section of SSYST, i.e. the command language interpreter, by a fast stand-alone code PREPRO which, as an input preprocessor for SSYST, can scan a complete input file and perform numerous checks before the actual SSYST run.

The following Job Control Language example shows how to invoke PREPRO:

```
// EXEC PLG,NAME=PREPRO
//G.STEPLIB DD DISP=SHR,DSN=...                              (library)
//G.SYSPRINT DD SYSOUT=U                                     (protocol)
//G.BASIS DD DISP=SHR,DSN=...                                (input)
//G.FILEA DD DISP=SHR,DSN=...                                (input)
//G.FILEB DD DISP=(NEW,KEEP),DCB=BLKSIZE=6000,DSN=...        (output)
```

PREPRO uses 2 input files, BASIS and FILEA, and prepares an output file FILEB. The file BASIS (cf. 6) contains the table of keywords, module names and parameters related to SSYST execution logics. Thus, it is the vital link between PREPRO and the current implementation of SSYST. The file FILEA represents input for an actual SSYST application run. The

data in FILEA may be in standard SSYST input format, in free-format (cf. 4.3), or partly in symbolic notation (cf. 4.4). PREPRO performs the necessary conversions and prepares the output file FILEB as a standard SSYST input file, for which only the block size as a multiple of 80 should be specified.

For demonstrating the capabilities and usage of PREPRO we have included 2 sample cases in the Appendices A to D, to which we will refer repeatedly.

Appendix A lists an input file FILEA for PREPRO; it shows free-format and symbolic input items. Actually, these are line-numbered standard 80-columns input records, with the relevant data to be processed in columns 1 to 72 and the line numbers in columns 73 to 80. In Appendix A the records are printed as seen by a terminal user during full-screen editing, which means: The (truncated) line numbers are on the left, then we see one space (blank), followed by the data in columns 1 to 72.

Appendix B lists an output file FILEB of PREPRO, actually obtained by processing the input of Appendix A. The record format and the mode of printing are the same as above. This file FILEB has the structure of a standard, formatted SSYST input file.

Appendices C and D both show processing protocols (file SYSPRINT) of PREPRO. Appendix C was obtained when PREPRO processed the input file FILEA of Appendix A (with conversion to the output file FILEB of Appendix B), whereas for Appendix D PREPRO has used the formatted data of Appendix B as a new input file FILEA. In this last example only the checking and editing capabilities of PREPRO are used, but no formatting or conversion need be done.

4. Capabilities of PREPRO.

As demonstrated in the sample problems, PREPRO has a number of capabilities:

4.1 Checking input.

Standard, formatted SSYST input is read and checked for formal errors. An edited list of the input is printed, in which each new keyword is marked by a preceding line space. SSYST comment cards are marked (see lines numbered 20/220, 480, 720, etc. in Appendix B and D).

SPEICHER-blocks, which contain a series of SSYST command records (a sort of SSYST macro) and which are generated by the keyword SPEICHER, are marked (see lines 1600/1940 of Appendix B and D for 2 SPEICHER-blocks).

Note: Formal checking of input data does not extend to any loosely coupled module. In such case, only the basic command record is checked. Any subsequent records are copied directly to the output file FILEB, until a new keyword is recognized in its expected position of an input record. With this next basic command record checking recommences. For details of these restrictions, cf. 6.

4.2 Creating a module list.

After successful completion of a PREPRO run a list of the involved SSYST modules is printed. This simplifies writing the appropriate input for the IBM Linkage Editor to include these modules from the SSYST load library into an executable load module. This list is found at the end of Appendix C and D.

4.3 Processing free-format input.

In addition to (and intermixed with) standard formatted input, PREPRO accepts also free-format input and converts it to standard SSYST input records. Examples of free-format conversion are the lines 1060, 1080, and 1090 of Appendix A, which are converted to lines 730, 750/60, and 770, respectively, of Appendix B. PREPRO recognizes free-format by scanning records for delimiters, i.e. commas (normal case) or semicolons (only for lists of data in the special SSYST list input formats REAI, REAG, REAH). In the second

form of free-format input each expression delimited by semicolons may contain 1 or 2 commas as sub-delimiters, as according to SSYST conventions /2/ for this type each format-group may have up to 3 terms (cf. 7 and 8). One example is seen at the end of line 270 of Appendix A, which translates to the end of line 280 of Appendix B.

Following general usage for free-format input, empty fields before the first (sub-)delimiter or between (sub-)delimiters are interpreted as zeros (or blanks). Compare the 2 first items in line 270 of Appendix A and B.
Also, empty fields after the last (sub-)delimiter (considering each record to end with column 72) cause reading continuation records. An example for this are the lines 1150/60 of Appendix A, which are converted to lines 830/50 of Appendix B.

Note 1: Free-format input for the integer field KPARA of a basic command record, including continuation records, must start after column 12, because columns 1 to 12 are reserved for keywords.

Note 2: Within one SSYST input record or a group of records forming a complete list (as in REAI/REAG/REAH-formats) no switching between standard and free-format input mode is allowed.

Note 3: Free-format input is not allowed for any loosely coupled modules, except for the basic command record.

4.4 Processing symbolic input.

In all situations, in which PREPRO accepts free-format input, real or integer data may also be entered as symbols. These symbols are character strings with a maximum length of 16. The string must not include blanks, the delimiters comma and semicolon, or one of the operation signs +, -, *, and /. In addition, the initial character must be non-numeric and must not be a period (point).
Assignment of numeric values to symbols occurs in the PREPRO module SYMBTAB (cf. 5). Whereas for real data only a direct assignment (substitution, indicated by the symbol =) is possible, symbols of integer data may also be assigned the value of a simple integer

arithmetic expression (cf 4.5, assignment indicated by <).
Lines 20/350 of Appendix A and their translation, lines 20/370 of Appendix B, should show clearly how symbolic definition works in practice, with both types of data and assignment.

4.5 Elementary integer arithmetics.

A very important advantage, which PREPRO processing offers versus standard, formatted SSYST input, is the possibility to express integer input data by elementary integer arithmetic expressions, to be evaluated by the preprocessor. PREPRO performs integer arithmetics on simple expressions both for its own module SYMBTAB and also during processing of free-format integer input.
4 forms of expressions are accepted:

INTA , -INTA , INTA Op INTB , -INTA Op INTB.

INTA, INTB are either unsigned integers (i.e. strings of digits) or symbols for integer data, which must have been previously defined. 'Op' stands for one of the arithmetic operators +, -, *, or /. The minus sign in the second and fourth expression must immediately precede the symbol INTA. Otherwise, the use of blanks in expressions is not restricted.

5. Preprocessor module SYMBTAB.

For the interpretation of symbolic input, PREPRO keeps a symbol-table, managed by the module (procedure) SYMBTAB of the preprocessor. In its actual version, the table is limited to 200 entries.

SYMBTAB is invoked (opened) by a basic command record FO-1 with the keyword SYMB-TAB, cf. lines 20, 450, and 3980 of Appendix A. If the index KPARA(1) of this record is positive, the current identification of each symbol is inserted as a SSYST comment record in the output file FILEB (cf. lines 30/160 of Appendix A and B). In each of the subsequent records the assignment text must start after column 12, columns 1 to 12

being reserved for keywords.

SYMBTAB is terminated (closed) by the keyword SYMB-END, cf. lines 170, 810, and 4000 of Appendix A.

Two more keywords are recognized by the SYMBTAB procedure:

TRACE-OFF, to interrupt the protocol of PREPRO processing (cf. line 510 of Appendix A and C), and
TRACE-ON, to resume listing (cf. line 3990 of Appendix A and C).

A percent sign (%) in column 1 of an assignment record produces an additional protocol line, indicating the symbol-assignment (cf. line 490 of Appendix A and C).
A percent sign (%) in column 1 of the SYMB-END record causes listing of the complete current symbol-table in the PREPRO protocol (cf. line 170 of Appendix A and C).

It should be clear that the user of PREPRO has to invoke the module SYMBTAB and care for its input syntax only, if he wants to use any symbolic input. On the other hand, our sample problem shows that SYMBTAB may be invoked repeatedly, and re-assignment of symbols is allowed (cf. line 490 of Appendix A and C).

Note: All SSYST and PREPRO keywords must start in column 4 of a record, cf. FO-1. Records with PREPRO keywords (SYMB-TAB, SYMB-END, TRACE-ON, or TRACE-OFF) are accepted only by PREPRO. If they are passed to the output file FILEB, they are first converted to SSYST comment records.

6. Input file BASIS.

Following is a short section of the file BASIS, which links PREPRO to the current SSYST version:

```
 NEWBASIS       1   100   640     2                                  1000
 STEUMOD              0           0          -1           0            1
....
  28      1    VEKTOR       NUCLEUS      VEKTOR                    9 03021
  29      2    IVEKTOR      NUCLEUS      VEKTOR                   12 03021
  30      0    MATRIX       NUCLEUS      MATRIX                   15 03000
  31      1    GENSTEU      STEUBL       STEUBL                   20 03200
....
 999
```

The first 2 records are skipped by PREPRO, but used by SSYST once, in the stage of system generation, when the FORTRAN direct access file FT13F001 (SSYST library BASIS) is created (Use of the identical input for both purposes is essential to enforce strict consistency between SSYST and its input preprocesor PREPRO).
All the following records have the

FORTRAN format (2I6,4X,A9,3X,A8,4X,A8,12X,I6,1X,5I1) FO-2

The character string data in this format are the keyword, the associated module and subroutine (entry point), respectively. The first integer item is the index in the table of keywords, the following item is used in some modules to specify options (The last table-index > 200 indicates the end of valid data). Of special relevance in our context is the third integer item, LANA, used by SSYST and PREPRO, and the final one-digit integer group LCHCK(5) explained below.

The parameter LANA indicates the organisation of any additional input following the basic command record for this keyword. Important values for LANA are:

0	no additional input, special case of next case.
< 94	organisation of additional input is known to SSYST and its preprocessor. No restrictions for PREPRO. This input class covers all standard SSYST modules.

96 additional input is regular. PREPRO performs checking but does not accept free-format or symbolic input. For SSYST-3, keywords in this class are: RIBDTH, WAK (physics modules) and MODIF, which deserves special attention (cf. 9.2).

99 loosely coupled module. Only the basic command record is fully processed by PREPRO, additional input for modules of this class is copied directly to output file FILEB.

All other valid values for LANA (94, 95, 97, 98) are reserved for special cases.

For new, application-oriented modules, to be included in SSYST, there exist only 2 reasonable choices:

LANA = 0 (preferable for reasons of efficiency), or
LANA = 99.

The one-digit field LCHCK(5) is used exclusively by PREPRO to check the data in the field KPARA(5) of the basic command record FO-1. For each position of KPARA the corresponding position in LCHCK contains a checking criterion, with the following meaning:

0 don't care.
1 corresponding KPARA position must be non-zero.
2 corresponding KPARA position must be positive.
3 corresponding KPARA position must be 0, 1, or 2.

7. Processing REAI/REAG lists with PREPRO.

In SSYST, lists of integer or real data are quite often specified in the REAI or REAG format /2/. A format-group of these types has the

FORTRAN format (A1,I2,I9) or (A1,I2,E9.1) FO-3

The one-character item is an internal format-specification, it may be a

blank or one of the letters A, B, E, F, I, M, Q, R, S, T. The integer item in position 2 is, generally, a repetition count IW. In position 3 we have integer or real data.

PREPRO can handle REAI/REAG format-groups in free-format form, with symbolic input for the repetition count IW and the data. A format-group in free-format must be delimited by semicolons, its terms may be delimited by 1 or 2 commas. For the convenience of users the following rules have been incorporated:

Format-groups with 3 recognizable terms (2 commas) are converted and/or formatted as specified.

In format-groups with 2 terms (1 comma) the second term is interpreted as the repetition count IW, when the format-specification is A, E, I, M, Q, R, or T. In the remaining cases (blank, B, or F) it is treated as data.

Format-groups without subdivision (no comma) are treated as pure data, with 2 exceptions:

Isolated characters F and T are treated as REAI/REAG-format specifications. In the first case the operation becomes filling-up the list with zeroes, this effect is seen in line 280 of Appendix A, which translates to lines 290/300 of Appendix B. In the second case the character T is the terminal symbol for REAI/REAG-input.

Note: For free-format input, the format-specification S is not supported by PREPRO, as in this context it becomes redundant.

8. Processing REAH lists with PREPRO.

Very similar to REAI/REAG lists (cf. 7), also lists of 4-character strings may be defined in SSYST by the (rarely used) REAH format /2/. The corresponding format-group has the

FORTRAN format (A1,I2,A4,5X) FO-4

very similar to FO-3. The selection of meaningful internal format-specifications (first term) is restricted to the blank and the letters E, F, R, S, and T.
PREPRO can also handle REAH format-groups in free-format form. Again, the internal format-specification S is not supported with free-format input. Symbolic input is allowed for the repetition count IW (second term) only. The leading 4 characters (including blanks) of the last term are treated as data.

In format-groups with only 2 recognizable terms (1 comma) the second term is interpreted as the repetition count IW, when the internal format-specification is E, R, or T. In the remaining cases (blank or F) it is treated as character string data.

Format-groups without subdivision (no comma) are treated as pure data.

An isolated character T after the last semicolon, delimiting the last format-group, is recognized as the terminal symbol for REAH-input.

9. Special considerations.

When using PREPRO, a few special cases must be observed. This concerns the keywords DR-SETZ, MODIF, SPEICHER, PLOT, PLOTH, and VARIO.

9.1 Keyword DR-SETZ (simplification, also for SYMB-TAB).

Normally, PREPRO recognizes free-format and/or symbolic input only by meeting a delimiter. If SSYST logics makes certain that a valid record contains a single numeric item, this will also be handled correctly in free-format. If more items are possible, in free-format at least two terms must be written, with appropriate delimiter(s).
This is not necessary for basic command records FO-1 with the keywords DR-SETZ and SYMB-TAB. The only valid data, KPARA(1), may be

placed in any position (after column 12, of course).

9.2 Keyword MODIF (restrictions for free-format input).
The SSYST keyword MODIF is used for modifying SPEICHER-blocks. Use of free-format and symbolic input is restricted. Special input for MODIF, in SSYST standard format, consists of 2 record types. The first type is a specification group (operation, ICA, ICE) in the

FORTRAN format (A4,2X,2I6) FO-5

The character string ('*DEL', '*INS', '*MOD', or '*END') specifies the type of operation. The variables ICA, ICE indicate the position and the number of SSYST records to be deleted, inserted or modified (updated) in the SPEICHER-block. If insertion or update is requested, the specification record is followed by the appropriate number of SSYST records.

PREPRO expects the operation-type in columns 1 to 4 of a specification record. If it detects commas in columns 5 to 72, free-format and symbolic input for the variables ICA, ICE is assumed. If the last variable ICE is followed by another comma, PREPRO looks for a string of 2 or 3 characters. The only valid strings are:

'En', 'Fn', 'Hn', 'Hnn' (with 'n' = digit), and 'KEY'.

The first option, En, indicates to PREPRO that the following free-format (insertion or update) records each contain n real data and have to be converted to the standard SSYST format (6E12.1).
For the next case, Fn, the records contain n data in the long integer format (6I12).
For the option Hn (Hnn) the records contain n (nn) data in the short integer format (12I6). This option is shown by lines 3210/20 of Appendix A which translate into lines 2970/80 of Appendix B.
The option KEY indicates that the following records are to be converted to basic command records FO-1 (An example of this option is

shown by lines 3290/300 of Appendix A, corresponding to lines 3050/60 of Appendix B).

If no such specification is met, the records to be inserted or updated are copied directly, without checking, to the output file FILEB.

9.3 Keyword SPEICHER (treatment in special cases).
PREPRO normally assumes that the contents of a SPEICHER-block consists of valid SSYST command input records and performs all appropriate conversions and checking. If, in a special case, this is not desired, but the SPEICHER-block is to be treated as pure text, the keyword SPEICHER must be prefixed by 'TX.' in columns 1 to 3 of the record FO-1.

9.4 Keywords PLOT, PLOTH (treatment of character strings).
The SSYST modules PLOT and PLOTH are printer-plot utilities. For details of input specifications, cf. /2/. PREPRO can handle free-format input also for these keywords. The plot-format specifications ('DINA 4', 'LONG 3', etc.) have simply to be delimited by commas from the preceding or following numerical input items.
If the last input record for the keyword PLOT is in free-format, then the character immediately following the last comma is taken as the last input item (i.e. the printing character).

9.5 Keyword VARIO (not compatible with PREPRO).
The SSYST module VARIO has been available with SSYST-2 and SSYST-3 for processing symbolic input of a specific format /2/. Handling this type of input by a preprocessor and resolving possible conflicts would be very complicated. Therefore PREPRO does not support the module VARIO. In order to use the capabilities of both programmes, there seem to be 2 alternatives. Either a user may work first with PREPRO and thereafter apply VARIO selectively to the PREPRO output file, or the SSYST input file processed by VARIO could be saved and used as input to PREPRO for checking.

References:

/1/ H. Borgwaldt, W. Gulden: 'SSYST, a Code-System for Analysing Transient LWR Fuel Rod Behaviour under Off-Normal Conditions', report KfK 3359 (1982)

/2/ R. Meyder: 'SSYST-2 Eingabebeschreibung und Handhabung', report KfK 2966 (1980)

Appendix A: Input to PREPRO.

```
000010    LOCA          0   100   640     0    80   500                    4000
000020    SYMB-TAB           1
000030                  REFERENCE = 400000
000040                  LOCA_BLOCK < REFERENCE+600
000050                  ALLOCATION < REFERENCE+ 700
000060               RADII_OLD<REFERENCE+ 800
000070               ELEVATION_OLD<REFERENCE+ 900
000080                  MATERIALS =3
000090                  NRAD = 9
000100                  INNER < NRAD-2
000110                  NAXIAL = 24
000120                 PRESSURE_INT = 70.+5
000130                 CAP=.001
000140                 PLENUM_LOW = .3013
000150                 PLENUM_HIGH = .1798
000160                 DELTA_Z = .195
000170 %  SYMB-END
000180 C
000190 C ***** ATTENTION: THIS IS A SYNTHETIC SSYST-3 INPUT DATA SET, ONLY
000200 C **********       INTENDED TO DEMONSTRATE THE FACILITIES OF THE
000210 C **********       SSYST-3 INPUT PREPROCESSOR 'PREPRO'.
000220 C
000230    DR-SETZ
000240    GENSTEU           , 1, LOCA_BLOCK
000250 SSYST LOCA ANALYSIS, SAMPLE A
000260  MATERIALS +43,12,1
000270 ;;NRAD; NAXIAL; 4;5; ALLOCATION; A,39,100;T
000280 ;1000.;; PRESSURE_INT; .05; .005; F;T
000290 SSYST LOCA ANALYSIS, SAMPLE A
000300    MATRIX            ,1
000310    1,2,NRAD, NAXIAL
000320      ALLOCATION;T
000330 SPECIFICATION OF MATERIAL ZONES
000340 R,NRAD,3;R,NRAD-1,4;3;R,INNER,1;-2;3;Q,NAXIAL-5,NRAD;
000350 R,NRAD-1,5;R,NRAD+1,3;T
000360    MATRIX             ,1
000370    1,0, NRAD+1, NAXIAL
000380      RADII_OLD;T
000390 INITIAL RADIAL NODES, ROOM TEMPERATURE (M)
000400   ; 1.2046E-3 ; 2.2238E-3;  3.0576E-3;  3.7061E-3 ; 4.1693E-3;
000410   4.45E-3;  4.54E-3;  4.65E-3;  5.37E-3; Q,NAXIAL-1, NRAD+1; T
000420    VEKTOR       ,1,,ELEVATION_OLD, NAXIAL+1
000430 INITIAL AXIAL NODES, ROOM TEMPERATURE (M)
000440 ;CAP; A,1,PLENUM_LOW; A,NAXIAL-4, DELTA_Z;A,1,PLENUM_HIGH; A,1,CAP;T
000450    SYMB-TAB
000460                  UO2 = 2301
000470                  HE70 = 2302
000480                  ZRY = 2303
000490 %                NAXIAL < NAXIAL/2
000500                  DECAY = 4300
000510    TRACE-OFF
000520                  PRINT_RESULTS = 300000
000530                  INITIALIZE= 310000
000540                  PLOTTER =  320000
000550                  BLOW_DOWN =330000
```

```
000560                  SEGMENT =340000
000570                  REFLOOD =350000
000580                  TEMP_OLD <  REFERENCE+1000
000590              TEMP_SRF_OLD < TEMP_OLD+100
000600              TEMPERATURE < TEMP_OLD+200
000610              TEMP_SRF <  TEMP_SRF_OLD+200
000620              RADII<REFERENCE+1500
000630              ELEVATION<REFERENCE+1600
000640              TIME_VECTOR < REFERENCE+1700
000650              LEFT_BOUND <REFERENCE+1800
000660              RIGHT_BOUND < LEFT_BOUND+100
000670              DECAY_POWER < REFERENCE+2200
000680              HEAT_CONDUCTION< REFERENCE+2300
000690                   RANDM <  REFERENCE+3000
000700                   SPAGAD < REFERENCE+3200
000710                EMISSION < REFERENCE+3500
000720               ALPHA_GAP < REFERENCE+3600
000730                   STADEF < REFERENCE+3800
000740                   ZIRKOX < REFERENCE+4000
000750                   WAK < REFERENCE+4100
000760                   ZONES =5
000770                   TEMP_INIT = 300.
000780               ALPHA_INIT =6000.
000790                EM_UO2 = .5
000800                EM_ZRY = .25
000810    SYMB-END
000820    MATRIX              1           1
000830      1,,NRAD,NAXIAL
000840      TEMP_OLD;T
000850 INITIAL TEMPERATURES (K)
000860 F,TEMP_INIT;T
000870    MATRIX           ,  1
000880      1,  0, NAXIAL, 3
000890   TEMP_SRF_OLD;T
000900 INITIAL TEMPERATURES, CLADDING AND GAP (K)
000910 F, TEMP_INIT;T
000920    NUMKOR              1           1
000930      4     1
000940 RADII_OLD;      ELEVATION_OLD; TEMP_SRF_OLD; TEMP_OLD;T
000950 RADII;          ELEVATION;  TEMP_SRF; TEMPERATURE;T
000960 UPDATED RADIAL NODES (M)
000970 UPDATED AXIAL NODES (M)
000980 UPDATED TEMPERATURES, CLADDING AND GAP (K)
000990 UPDATED TEMPERATURES (K)
001000    VEKTOR     ,1,,ALPHA_GAP,NAXIAL
001010 GAP CONDUCTANCE ALPHA
001020 F, ALPHA_INIT;T
001030    GENSTEU         ,1,STADEF
001040 CONTROL-BLOCK FOR STADEF (ROD DEFORMATION)
001050 C   CONTROL BLOCK FOR STADEF  (AT OFFSET 40: EFFECTIVE STRESS)
001060   6 , 9
001070      STADEF+10;  STADEF+20;REFERENCE+4001; STADEF+40;F;T
001080      1.08E-5; .316 ; .6E-5;  .4; 1.; 1.; .0135; 1.;;T
001090    WERBL           ,1,1,2
001100     STADEF+20,0
001110 MATERIAL PROPERTIES FOR STADEF (ROD DEFORMATION)
001120     13,1
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001130      13;T
001140      2;T
001150   290.; 500.; 700.; 900.; 1100.; 1300.; 1500.; 1700.; 1900.; 2100.;
001160   2300.; 2500.; 2700.; T
001170   0.1962E+12  0.1739E+12  0.1516E+12  0.1293E+12  0.1071E+12  0.8478E+11
001180   0.6251E+11  0.4023E+11  0.1795E+11  0.9807E+10  0.9807E+10  0.9807E+10
001190   0.9807E+10T
001200      2     1
001210            2T
001220            4T
001230      6.66E-4      3.33E-3T
001240    8.418E-28    1.692E-73T
001250    VEKTOR      ,1,,ZIRKOX + 1, NAXIAL
001260 WIDTH OF OXIDIZED CLADDING LAYER
001270 F; T
001280 C     PREFACE: SET INITIAL STATES
001290    RIBDTH           ,1,DECAY,SPAGAD-100, -2
001300 RIBDTH-OUTPUT
001310      2.2E-03        10.0        0.02
001320        0.193       582.0     1.0E-10       200.0
001330            0           0
001340         1.         1.
001350  8.640E4 1.296E5 1.728E5 2.160E5 2.592E5 3.024E5 3.456E5 3.888E5 4.320E5
001360    SPAGAD              1, 1, LOCA_BLOCK
001370    IVEKTOR      ,1,,RANDM ,7
001380 BLOCK-NUMBERS OF RANDM-INPUT
001390    RANDM+1; A,6,1;T
001400    MATRIX            ,1
001410      1,0, NRAD, NAXIAL
001420      RANDM+1; T
001430 POWER DENSITY (W/M**3)
001440 R,2*NRAD;R,INNER,2.65E+08; ;; R,INNER, 3.36E+08; ;;
001450 R,INNER,4.02E+08;;; R,INNER,4.62E+08;;; R,INNER,5.16E+08;;;
001460 R,INNER,5.61E+08;;; R,INNER,5.99E+08;;; R,INNER,6.28E+08;;;
001470 R,INNER,6.47E+08;;; R,INNER,6.58E+08;;; R,INNER,6.57E+08;;;
001480 R,INNER,6.47E+08; ;; R,INNER,6.28E+08;;; R,INNER,5.99E+08;;;
001490 R,INNER,5.61E+08;;; R,INNER,5.16E+08;;; R,INNER,4.62E+08;;;
001500 R,INNER,4.02E+08;;; R,INNER,3.36E+08;;; R,INNER,2.65E+08;F;T
001510    IVEKTOR      ,1,,RANDM+7,NAXIAL
001520 DISTRIBUTION OF BOUNDARY CONDITIONS
001530            1;1; A, NAXIAL-3, 1; 22; T
001540    RANDM               2,1, LOCA_BLOCK,1
001550    STADEF              1 , 1, LOCA_BLOCK, -1
001560 C     STAGE 1:  EVALUATION OF THE THERMAL AND MECHANICAL INITIAL,
001570 C               EQUILIBRIUM CONDITIONS
001580    MISCH-UBI           3
001590  UO2; HE70; ZRY; T
001600 C   TRANSFER MATERIAL DATA BLOCKS FROM DISK TO CORE
001610    BLMOD      1,1
001620 REPLICATION OF RADIAL NODES (COLD)
001630      1, 1, 1, NRAD-1, NRAD-1, 1, NAXIAL ,, 1
001640  F;T
001650  RADII; T
001660  RADII+20; T
001670 RADIAL AREAS (COLD) INCL. INCREMENT FOR RELOCATION
001680    POWER      1,1,RADII+20, RADII+20,2
001690    MATRIX    ,1
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001700      1,, NAXIAL,3
001710   LEFT_BOUND;T
001720 BOUNDARY CONDITIONS (LEFT BOUNDARY)
001730 R,NAXIAL; R,NAXIAL,1.;F;T
001740     GENSTEU       ,1,HEAT_CONDUCTION
001750 CONTROL-BLOCK FOR HEAT CONDUCTION MODULES (ZET-1D/2D, STT-1D/2D)
001760  ZONES+10, 4, 1
001770  ZONES; UO2; HE70; ZRY; R,2,HE70; 10;5;5;9;10;10;1;F;T
001780  R,3, 10.;.01;T
001790   CONTROL-BLOCK FOR HEAT CONDUCTION MODULE ZET-1D
001800    MATRIX     ,1
001810   1,0,NAXIAL,2
001820  EMISSION;T
001830 EMISSIVITIES OF PELLETS AND CLADDING
001840 R,NAXIAL,EM_UO2; R,NAXIAL,EM_ZRY;T
001850     SPEICHER      ,1,, PRINT_RESULTS
001860 PRINT INTERMEDIATE RESULTS
001870     DR-SETZ              1
001880     DRUCKE               1                          3
001890       LOCA_BLOCK;TEMPERATURE ;RADII ; T
001900     DR-SETZ
001910     SZAEHL               1           0
001920 ***
001930     SPEICHER       ,1,,INITIALIZE
001940 MACRO-BLOCK TO GET INITIAL EQUILIBRIUM CONDITIONS
001950     LSCH-UBI             2
001960       RADII+10;  DECAY_POWER; T
001970     BLMOD                1           1
001980 CROSS SECTION OF ACTUAL RADIAL NODES
001990     1, 1, 1, NRAD-1, NRAD-1, 1, NAXIAL, , 1
002000   ;T
002010    RADII; T
002020    RADII+10;T
002030 ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN
002040     MATMAL          1,1,RADII+10,RADII+10,RADII+10
002050 ACTUAL RADIAL AREAS
002060     MATTEIL         1,1,RADII+20,RADII+10,RADII+10
002070 CORRECTIONS FOR ACTUAL POWER DENSITY IN THE FUEL
002080     MATMSP          1,1,RANDM+1,  RADII+10, DECAY_POWER
002090 CORRECTED ACTUAL POWER DENSITY IN THE FUEL
002100     WUEZ                1, 1, LOCA_BLOCK
002110     DR-SETZ             1
002120     STT-1D              1, 1, LOCA_BLOCK
002130     DR-SETZ
002140     SPAGAD              1, 1, LOCA_BLOCK
002150     STADEF              1, 1, LOCA_BLOCK
002160     ZAEHL       1, 20,  1
002170     START                1, ,   INITIALIZE
002180     START      1,, PRINT_RESULTS
002190 ***
002200     MODSTEU      1,1,LOCA_BLOCK, LOCA_BLOCK
002210 SSYST LOCA ANALYSIS, SAMPLE A
002220       1     1     1
002230    1;T
002240 999999
002250     SZAEHL         1,0
002260     START                1 , ,    INITIALIZE
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002270    ZWERG        1,1,PLOTTER, -3
002280 RELAP4 / SSYST-3 SIMULATION OF PWR-LOCA
002290            3
002300   LOCA_BLOCK, 1, LOCA_BLOCK+1
002310           -1 ,  1
002320 TIME-VECTOR
002330  TEMPERATURE, NAXIAL-2, TEMPERATURE+1
002340     1, 2, NAXIAL-3
002350 CENTRAL TEMPERATURES, AXIAL ZONES 2 TO TOP-1
002360  TEMPERATURE, NAXIAL-4, TEMPERATURE+2
002370            4 , 3 , NAXIAL-5
002380 FUEL TEMPERATURES IN RING ZONE 4, AXIAL ZONES 3 TO TOP-2
002390    GENSTEU           , 1, ZIRKOX
002400 CONTROL-BLOCK FOR ZIRKOX (CLADDING OXIDATION)
002410      1,8
002420      REFERENCE+4001; T
002430     39.66E-6 ;  2.6E+4;   5.966E+3;  6600.;  5820. ;  0.02;F;T
002440    SPEICHER        , 1 ,,     BLOW_DOWN
002450 MACRO SET UP FOR THE BLOW-DOWN CALCULATION
002460    ZAEHL              1         100          -1
002470 C   **** HERE ARBITRARY COUNTING INTERVALS *****
002480    START         1, , PRINT_RESULTS
002490    LSCH-UBI           1
002500  RADII +10;T
002510    BLMOD              1          1
002520 TRANSFER ACTUAL PELLET-RADII
002530      1     1     1     8     8     1    24     0     1
002540            0T
002550   RADII; T
002560  RADII +10;T
002570 ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN
002580    MATMAL       1,1,RADII+10,RADII+10,RADII+10
002590 ACTUAL RADIAL AREAS
002600    MATTEIL      1,1,RADII+20,RADII+10,RADII+10
002610 CORRECTIONS FOR ACTUAL FUEL POWER DENSITY
002620    RANDM          1, 1, LOCA_BLOCK , 1,1
002630    MATMSP        1,1,DECAY_POWER, RADII+10,DECAY_POWER
002640 CORRECTED ACTUAL FUEL POWER DENSITY
002650    WUEZ           1,1,LOCA_BLOCK
002660    ZIRKOX         1,1,LOCA_BLOCK
002670    ZET-1D         1,1,LOCA_BLOCK,60
002680    SPAGAD         1,1,LOCA_BLOCK
002690    STADEF         1,1,LOCA_BLOCK
002700    ZWERG          1,1,PLOTTER, 3
002710    START              1  ,,    BLOW_DOWN
002720    START         1, , PRINT_RESULTS
002730 ***
002740    SPEICHER     , 1,,  SEGMENT
002750 MODIF. LOCA CONTROL-BLOCK, BOUNDARY CONDITIONS, TRANSIENT SEGMENT 1
002760    MODSTEU       1, 1, LOCA_BLOCK, LOCA_BLOCK
002770 MODIF. LOCA CONTROL-BLOCK, BOUNDARY CONDITIONS, TRANSIENT SEGMENT 1
002780      1     1     1
002790  0 ; T
002800 999999
002810    LSCH-UBI           5
002820  REFERENCE+3003;A,3,1; TIME_VECTOR; T
002830    BLMOD              , 1
```

```
002840 BOUNDARY CONDITIONS
002850      3 , 1, 1 , 1 ,22, 2 ,  61
002860  F;T
002870  REFERENCE+3004;A,2,1;T
002880  REFERENCE+3004;A,2,1;T
002890    BLMOD               0           1
002900 TRANSIENT POWER
002910      1     1     1     1     1     2    61     0     0
002920      ;T
002930  REFERENCE+3003;T
002940  REFERENCE+3003;T
002950    BLMOD               0           1
002960 NEW TIME-VECTOR
002970      1, 1, 1, 1, 1, 1, 61
002980   ;T
002990   TIME_VECTOR; T
003000   TIME_VECTOR; T
003010 ***
003020    MODSTEU        1, 1, LOCA_BLOCK, LOCA_BLOCK
003030 ZERO TIME AND MACRO-STEP
003040      2     1     2.
003050  F;T
003060 999999
003070    START       1,, SEGMENT
003080    SZAEHL              1          -1
003090    START               1 ,,     BLOW_DOWN
003100    DR-SETZ             1
003110    DRUCKE           1,,1
003120     REFERENCE+1900;T
003130    DR-SETZ
003140 C     STAGE 2:  BLOWDOWN ANALYSIS
003150    MODIF               1 ,  1,    SEGMENT, SEGMENT
003160 BLOW-DOWN TRANSIENT, SEGMENT 3
003170 *MOD      10 ,  10
003180      3     1     1     1    22   122   181     0     0
003190 *MOD      16  , 16
003200      1     1     1     1     1   122   181     0     0
003210 *MOD      22 ,  22 , H9
003220      1 ,   1 ,   1 ,   1 ,   1 , 121 , 181
003230 *END
003240    START       1,, SEGMENT
003250    SZAEHL              1          -1
003260    START            1 ,,    BLOW_DOWN
003270    MODIF            1 , 1, BLOW_DOWN, BLOW_DOWN
003280 BLOW-DOWN TRANSIENT, SEGMENT 8. CHANGE IN LOOOP REPETITIONS
003290 *MOD      21 ,  21 , KEY
003300    ZET-1D              1,1,LOCA_BLOCK,30
003310 *END
003320    START       1,, SEGMENT
003330    SZAEHL              1          -1
003340    START            1 ,,    BLOW_DOWN
003350 C    STAGE 3A: REFILL- AND FLOOD ANALYSIS
003360    MODSTEU        1, 1, LOCA_BLOCK, LOCA_BLOCK
003370 ZERO POSITION 1 OF THE INTEGER FIELD
003380      1     1     1
003390    ;T
003400 999999
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003410    LSCH-UBI            3
003420  REFERENCE+3003; REFERENCE+3006; TIME_VECTOR;T
003430    GENSTEU         1, 1, WAK
003440 CONTROL-BLOCK FOR WAK (FLOODING)
003450       6 , 6 ,1
003460 REFERENCE+1700;RANDM+3; RANDM+1; WAK+1; RANDM+6; WAK+2;T
003470    20.;  400.;  .3;   2000.;  20.;  1.;T
003480 REFILL/FLOODING PHASE OF A PWR LOCA MODELLED WITH WAK
003490    WAK           1,1,WAK
003500 SIMULATION OF BIBLIS-B
003510            3           4           2       45548          66           3
003520         500.          .5
003530          3.9        13.9        9.31        4.64         6.0         0.8
003540         3.71        0.01
003550          25.          .8        11.5        1.06     3.733E9         7.5
003560          .29         1.2          1.          1.          0.          .1
003570           0.          0.        16.0          0.         21.        830.
003580          32.          0.         44.          0.         46.        300.
003590          68.        550.        100.        450.        136.        400.
003600           0.          0.         16.          0.         21.          0.
003610          32.          0.         44.          0.         46.          0.
003620           0.          0.         16.          0.         21.        470.
003630           0.      1.E-10        0.25      1.E-10       0.398       0.175
003640       0.593       0.305
003650           0.     15.8E+6          1.      8.8E+6         10.      5.0E+6
003660           0.        6000.       0.25        6000.
003670         1.5         1.0          0.         2.5         1.5          0.
003680           0.          0.          0.          0.          0.          0.
003690    2.000E+01   3.700E+01   2.250E+01   0.0         5.000E-01   0.0
003700    3.600E+00   2.600E+01
003710 C    STAGE 3B: SINGLE ROD ANALYSIS FOR THE REFILL- AND FLOOD PHASE
003720    SPEICHER        , 1 ,,   REFLOOD
003730 MACRO FOR THE FLOODING CALCULATION
003740    ZAEHL               1 , 50, -1
003750    START          1, , PRINT_RESULTS
003760    LSCH-UBI            1
003770 RADII+10; T
003780    BLMOD               1           1
003790 TRANSFER ACTUAL PELLET RADII
003800       1,    1,    1 ,   8 ,   8 ,   1, NAXIAL,, 1
003810       ;T
003820       RADII;T
003830       RADII+10; T
003840 ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN
003850    MATMAL    1,1,RADII+10,RADII+10,RADII+10
003860 ACTUAL RADIAL AREAS
003870    MATTEIL   1,1,RADII+20,RADII+10,RADII+10
003880 CORRECTIONS FOR ACTUAL POWER DENSITY IN THE FUEL
003890    RAWAK               1,1,LOCA_BLOCK,,1
003900    MATMSP   1,1,DECAY_POWER, RADII+10, DECAY_POWER
003910 CORRECTED ACTUAL POWER DENSITY IN THE FUEL
003920    WUEZ                1,1,LOCA_BLOCK
003930    ZIRKOX              1,1,LOCA_BLOCK
003940    ZET-1D              1,1,LOCA_BLOCK,500
003950    SPAGAD              1,1,LOCA_BLOCK
003960    STADEF              1,1,LOCA_BLOCK
003970    ZWERG               1,1,PLOTTER,3
```

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003980     SYMB-TAB
003990     TRACE-ON
004000     SYMB-END
004010     START                 1,, REFLOOD
004020     START           1, , PRINT_RESULTS
004030 ***
004040     SZAEHL                1          -1
004050     START                 1,, REFLOOD
```

Appendix B: Output from PREPRO.

```
000010    LOCA          0   100   640     0    80   500                    4000
000020 C  SYMB-TAB            1           0          0            0           0
000030 C                       REFERENCE          =      400000
000040 C                       LOCA_BLOCK         <      400600
000050 C                       ALLOCATION         <      400700
000060 C                       RADII_OLD          <      400800
000070 C                       ELEVATION_OLD      <      400900
000080 C                       MATERIALS          =           3
000090 C                       NRAD               =           9
000100 C                       INNER              <           7
000110 C                       NAXIAL             =          24
000120 C                       PRESSURE_INT       =        70.+5
000130 C                       CAP                =         .001
000140 C                       PLENUM_LOW         =         .3013
000150 C                       PLENUM_HIGH        =         .1798
000160 C                       DELTA_Z            =         .195
000170 C  SYMB-END
000180 C
000190 C ***** ATTENTION: THIS IS A SYNTHETIC SSYST-3 INPUT DATA SET, ONLY
000200 C ****************  INTENDED TO DEMONSTRATE THE FACILITIES OF THE
000210 C ****************  SSYST-3 INPUT PREPROCESSOR 'PREPRO'.
000220 C
000230    DR-SETZ             0           0          0            0           0
000240    GENSTEU             0           1     400600            0           0
000250 SSYST LOCA ANALYSIS, SAMPLE A
000260     46    12     1
000270            0           0          9          24           4           5
000280       400700A39      100T
000290           0.       1000.          0.       70.+5         .05        .005
000300 F         0.T
000310 SSYST LOCA ANALYSIS, SAMPLE A
000320    MATRIX              0           1          0            0           0
000330      1     2     9    24
000340       400700T
000350 SPECIFICATION OF MATERIAL ZONES
000360 R 9        3R 8        4          3R 7        1           -2           3
000370 Q19        9R 8        5R10       3T
000380    MATRIX              0           1          0            0           0
000390      1     0    10    24
000400       400800T
000410 INITIAL RADIAL NODES, ROOM TEMPERATURE (M)
000420           0.   1.2046E-3   2.2238E-3   3.0576E-3   3.7061E-3   4.1693E-3
000430      4.45E-3     4.54E-3     4.65E-3     5.37E-3Q23       10T
000440    VEKTOR              0           1          0      400900          25
000450 INITIAL AXIAL NODES, ROOM TEMPERATURE (M)
000460           0.        .001A 1    .3013A20     .195A 1    .1798A 1     .001
000470 T
000480 C  SYMB-TAB            0           0          0            0           0
000490    MATRIX              1           1
000500      1     0     9    12
000510       401000T
000520 INITIAL TEMPERATURES (K)
000530 F       300.T
000540    MATRIX              0           1          0            0           0
000550      1     0    12     3
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000560       401100T
000570 INITIAL TEMPERATURES, CLADDING AND GAP (K)
000580 F       300.T
000590    NUMKOR              1           1
000600      4     1
000610       400800      400900      401100      401000T
000620       401500      401600      401300      401200T
000630 UPDATED RADIAL NODES (M)
000640 UPDATED AXIAL NODES (M)
000650 UPDATED TEMPERATURES, CLADDING AND GAP (K)
000660 UPDATED TEMPERATURES (K)
000670    VEKTOR              0           1           0      403600          12
000680 GAP CONDUCTANCE ALPHA
000690 F      6000.T
000700    GENSTEU             0           1      403800           0           0
000710 CONTROL-BLOCK FOR STADEF (ROD DEFORMATION)
000720 C   CONTROL BLOCK FOR STADEF  (AT OFFSET 40: EFFECTIVE STRESS)
000730      6     9     0
000740       403810      403820      404001      403840F          0T
000750      1.08E-5        .316       .6E-5           .4          1.          1.
000760        .0135          1.          0.T
000770    WERBL               0           1           1           2           0
000780       403820
000790 MATERIAL PROPERTIES FOR STADEF (ROD DEFORMATION)
000800     13     1
000810           13T
000820            2T
000830         290.        500.        700.        900.       1100.       1300.
000840        1500.       1700.       1900.       2100.       2300.       2500.
000850        2700.T
000860   0.1962E+12  0.1739E+12  0.1516E+12  0.1293E+12  0.1071E+12  0.8478E+11
000870   0.6251E+11  0.4023E+11  0.1795E+11  0.9807E+10  0.9807E+10  0.9807E+10
000880   0.9807E+10T
000890      2     1
000900            2T
000910            4T
000920      6.66E-4     3.33E-3T
000930    8.418E-28   1.692E-73T
000940    VEKTOR              0           1           0      404001          12
000950 WIDTH OF OXIDIZED CLADDING LAYER
000960 F         0.T
000970 C     PREFACE: SET INITIAL STATES
000980    RIBDTH              0           1        4300      403100          -2
000990 RIBDTH-OUTPUT
001000      2.2E-03        10.0        0.02
001010        0.193       582.0     1.0E-10       200.0
001020            0           0
001030          1.          1.
001040  8.640E4 1.296E5 1.728E5 2.160E5 2.592E5 3.024E5 3.456E5 3.888E5 4.320E5
001050    SPAGAD              1           1      400600           0           0
001060    IVEKTOR             0           1           0      403000           7
001070 BLOCK-NUMBERS OF RANDM-INPUT
001080       403001A 6        1T
001090    MATRIX              0           1           0           0           0
001100      1     0     9    12
001110       403001T
001120 POWER DENSITY (W/M**3)
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001130 R18       0.R 7 2.65E+08          0.          0.R 7 3.36E+08          0.
001140           0.R 7 4.02E+08          0.          0.R 7 4.62E+08          0.
001150           0.R 7 5.16E+08          0.          0.R 7 5.61E+08          0.
001160           0.R 7 5.99E+08          0.          0.R 7 6.28E+08          0.
001170           0.R 7 6.47E+08          0.          0.R 7 6.58E+08          0.
001180           0.R 7 6.57E+08          0.          0.R 7 6.47E+08          0.
001190           0.R 7 6.28E+08          0.          0.R 7 5.99E+08          0.
001200           0.R 7 5.61E+08          0.          0.R 7 5.16E+08          0.
001210           0.R 7 4.62E+08          0.          0.R 7 4.02E+08          0.
001220           0.R 7 3.36E+08          0.          0.R 7 2.65E+08F         0.
001230 T
001240    IVEKTOR              0          1          0      403007          12
001250 DISTRIBUTION OF BOUNDARY CONDITIONS
001260             1          1A 9       1         22T
001270    RANDM                2          1      400600           1          0
001280    STADEF               1          1      400600          -1          0
001290 C     STAGE 1:  EVALUATION OF THE THERMAL AND MECHANICAL INITIAL,
001300 C               EQUILIBRIUM CONDITIONS
001310    MISCH-UBI            3
001320         2301        2302        2303T
001330 C   TRANSFER MATERIAL DATA BLOCKS FROM DISK TO CORE
001340    BLMOD                1          1          0           0          0
001350 REPLICATION OF RADIAL NODES (COLD)
001360      1     1     1     8     8     1    12     0     1
001370 F          0T
001380       401500T
001390       401520T
001400 RADIAL AREAS (COLD) INCL. INCREMENT FOR RELOCATION
001410    POWER                1          1      401520      401520          2
001420    MATRIX               0          1          0           0          0
001430      1     0    12     3
001440       401800T
001450 BOUNDARY CONDITIONS (LEFT BOUNDARY)
001460 R12       0.R12       1.F         0.T
001470    GENSTEU              0          1      402300           0          0
001480 CONTROL-BLOCK FOR HEAT CONDUCTION MODULES (ZET-1D/2D, STT-1D/2D)
001490     15     4     1
001500             5        2301        2302        2303R 2     2302          10
001510             5           5           9          10          10           1
001520 F          0T
001530 R 3      10.          .01T
001540   CONTROL-BLOCK FOR HEAT CONDUCTION MODULE ZET-1D
001550    MATRIX               0          1          0           0          0
001560      1     0    12     2
001570       403500T
001580 EMISSIVITIES OF PELLETS AND CLADDING
001590 R12       .5R12      .25T
001600    SPEICHER             0          1          0      300000          0
001610 PRINT INTERMEDIATE RESULTS
001620    DR-SETZ              1          0          0           0          0
001630    DRUCKE               1                     3
001640       400600      401200      401500T
001650    DR-SETZ              0          0          0           0          0
001660    SZAEHL               1          0
001670 ***
001680    SPEICHER             0          1          0      310000          0
001690 MACRO-BLOCK TO GET INITIAL EQUILIBRIUM CONDITIONS
```

```
001700    LSCH-UBI            2
001710       401510      402200T
001720    BLMOD               1           1
001730 CROSS SECTION OF ACTUAL RADIAL NODES
001740       1     1     1     8     8     1    12     0     1
001750             0T
001760       401500T
001770       401510T
001780 ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN
001790    MATMAL              1           1      401510      401510      401510
001800 ACTUAL RADIAL AREAS
001810    MATTEIL             1           1      401520      401510      401510
001820 CORRECTIONS FOR ACTUAL POWER DENSITY IN THE FUEL
001830    MATMSP              1           1      403001      401510      402200
001840 CORRECTED ACTUAL POWER DENSITY IN THE FUEL
001850    WUEZ                1           1      400600           0           0
001860    DR-SETZ             1           0           0           0           0
001870    STT-1D              1           1      400600           0           0
001880    DR-SETZ             0           0           0           0           0
001890    SPAGAD              1           1      400600           0           0
001900    STADEF              1           1      400600           0           0
001910    ZAEHL               1          20           1           0           0
001920    START               1           0      310000           0           0
001930    START               1           0      300000           0           0
001940 ***
001950    MODSTEU             1           1      400600      400600           0
001960 SSYST LOCA ANALYSIS, SAMPLE A
001970       1     1     1
001980             1T
001990 999999
002000    SZAEHL              1           0           0           0           0
002010    START               1           0      310000           0           0
002020    ZWERG               1           1      320000          -3           0
002030 RELAP4 / SSYST-3 SIMULATION OF PWR-LOCA
002040             3
002050       400600            1      400601
002060           -1            1           0
002070 TIME-VECTOR
002080       401200           10      401201
002090            1            2           9
002100 CENTRAL TEMPERATURES, AXIAL ZONES 2 TO TOP-1
002110       401200            8      401202
002120            4            3           7
002130 FUEL TEMPERATURES IN RING ZONE 4, AXIAL ZONES 3 TO TOP-2
002140    GENSTEU             0           1      404000           0           0
002150 CONTROL-BLOCK FOR ZIRKOX (CLADDING OXIDATION)
002160       1     8     0
002170       404001T
002180     39.66E-6      2.6E+4    5.966E+3       6600.       5820.       0.02
002190 F          0.T
002200    SPEICHER            0           1           0      330000           0
002210 MACRO SET UP FOR THE BLOW-DOWN CALCULATION
002220    ZAEHL               1         100          -1
002230 C   **** HERE ARBITRARY COUNTING INTERVALS ******
002240    START               1           0      300000           0           0
002250    LSCH-UBI            1
002260       401510T
```

```
002270    BLMOD                1           1
002280 TRANSFER ACTUAL PELLET-RADII
002290      1     1     1     8     8     1    24     0     1
002300            0T
002310       401500T
002320       401510T
002330 ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN
002340    MATMAL               1           1      401510      401510      401510
002350 ACTUAL RADIAL AREAS
002360    MATTEIL              1           1      401520      401510      401510
002370 CORRECTIONS FOR ACTUAL FUEL POWER DENSITY
002380    RANDM                1           1      400600           1           1
002390    MATMSP               1           1      402200      401510      402200
002400 CORRECTED ACTUAL FUEL POWER DENSITY
002410    WUEZ                 1           1      400600           0           0
002420    ZIRKOX               1           1      400600           0           0
002430    ZET-1D               1           1      400600          60           0
002440    SPAGAD               1           1      400600           0           0
002450    STADEF               1           1      400600           0           0
002460    ZWERG                1           1      320000           3           0
002470    START                1           0      330000           0           0
002480    START                1           0      300000           0           0
002490 ***
002500    SPEICHER             0           1           0      340000           0
002510 MODIF. LOCA CONTROL-BLOCK, BOUNDARY CONDITIONS, TRANSIENT SEGMENT 1
002520    MODSTEU              1           1      400600      400600           0
002530 MODIF. LOCA CONTROL-BLOCK, BOUNDARY CONDITIONS, TRANSIENT SEGMENT 1
002540      1     1     1
002550            0T
002560 999999
002570    LSCH-UBI             5
002580       403003A 3         1      401700T
002590    BLMOD                0           1           0           0           0
002600 BOUNDARY CONDITIONS
002610      3     1     1     1    22     2    61     0     0
002620 F          0T
002630       403004A 2         1T
002640       403004A 2         1T
002650    BLMOD                0           1
002660 TRANSIENT POWER
002670      1     1     1     1     1     2    61     0     0
002680            0T
002690       403003T
002700       403003T
002710    BLMOD                0           1
002720 NEW TIME-VECTOR
002730      1     1     1     1     1     1    61     0     0
002740            0T
002750       401700T
002760       401700T
002770 ***
002780    MODSTEU              1           1      400600      400600           0
002790 ZERO TIME AND MACRO-STEP
002800      2     1     2
002810 F         0.T
002820 999999
002830    START                1           0      340000           0           0
```

```
002840    SZAEHL              1          -1
002850    START               1           0       330000           0           0
002860    DR-SETZ             1           0            0           0           0
002870    DRUCKE              1           0            1           0           0
002880       401900T
002890    DR-SETZ             0           0            0           0           0
002900 C     STAGE 2:  BLOWDOWN ANALYSIS
002910    MODIF               1           1       340000      340000           0
002920 BLOW-DOWN TRANSIENT, SEGMENT 3
002930 *MOD       10    10
002940      3     1     1     1    22   122   181      0      0
002950 *MOD       16    16
002960      1     1     1     1     1   122   181      0      0
002970 *MOD       22    22
002980      1     1     1     1     1   121   181      0      0
002990 *END
003000    START               1           0       340000           0           0
003010    SZAEHL              1          -1
003020    START               1           0       330000           0           0
003030    MODIF               1           1       330000      330000           0
003040 BLOW-DOWN TRANSIENT, SEGMENT 8. CHANGE IN LOOOP REPETITIONS
003050 *MOD       21    21
003060    ZET-1D              1           1       400600          30           0
003070 *END
003080    START               1           0       340000           0           0
003090    SZAEHL              1          -1
003100    START               1           0       330000           0           0
003110 C    STAGE 3A: REFILL- AND FLOOD ANALYSIS
003120    MODSTEU             1           1       400600      400600           0
003130 ZERO POSITION 1 OF THE INTEGER FIELD
003140      1     1     1
003150            0T
003160 999999
003170    LSCH-UBI            3
003180       403003      403006      401700T
003190    GENSTEU             1           1       404100           0           0
003200 CONTROL-BLOCK FOR WAK (FLOODING)
003210      6     6     1
003220       401700      403003      403001      404101      403006      404102
003230 T
003240          20.         400.          .3        2000.          20.          1.
003250 T
003260 REFILL/FLOODING PHASE OF A PWR LOCA MODELLED WITH WAK
003270    WAK                 1           1       404100           0           0
003280 SIMULATION OF BIBLIS-B
003290            3           4           2        45548          66           3
003300         500.          .5
003310          3.9        13.9        9.31         4.64         6.0         0.8
003320         3.71        0.01
003330          25.          .8        11.5         1.06    3.733E9          7.5
003340          .29         1.2          1.           1.          0.          .1
003350           0.          0.        16.0           0.         21.        830.
003360          32.          0.         44.           0.         46.        300.
003370          68.        550.        100.         450.        136.        400.
003380           0.          0.         16.           0.         21.          0.
003390          32.          0.         44.           0.         46.          0.
003400           0.          0.         16.           0.         21.        470.
```

```
003410           0.      1.E-10        0.25      1.E-10       0.398       0.175
003420        0.593       0.305
003430           0.     15.8E+6          1.       8.8E+6         10.      5.0E+6
003440           0.       6000.        0.25        6000.
003450          1.5         1.0          0.         2.5          1.5          0.
003460           0.          0.          0.          0.           0.          0.
003470    2.000E+01   3.700E+01   2.250E+01   0.0         5.000E-01   0.0
003480    3.600E+00   2.600E+01
003490 C    STAGE 3B: SINGLE ROD ANALYSIS FOR THE REFILL- AND FLOOD PHASE
003500    SPEICHER            0           1           0      350000           0
003510 MACRO FOR THE FLOODING CALCULATION
003520    ZAEHL               1          50          -1           0           0
003530    START               1           0      300000           0           0
003540    LSCH-UBI            1
003550       401510T
003560    BLMOD               1           1
003570 TRANSFER ACTUAL PELLET RADII
003580      1     1     1     8     8     1    12     0     1
003590            0T
003600       401500T
003610       401510T
003620 ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN
003630    MATMAL              1           1      401510      401510      401510
003640 ACTUAL RADIAL AREAS
003650    MATTEIL             1           1      401520      401510      401510
003660 CORRECTIONS FOR ACTUAL POWER DENSITY IN THE FUEL
003670    RAWAK               1           1      400600           0           1
003680    MATMSP              1           1      402200      401510      402200
003690 CORRECTED ACTUAL POWER DENSITY IN THE FUEL
003700    WUEZ                1           1      400600           0           0
003710    ZIRKOX              1           1      400600           0           0
003720    ZET-1D              1           1      400600         500           0
003730    SPAGAD              1           1      400600           0           0
003740    STADEF              1           1      400600           0           0
003750    ZWERG               1           1      320000           3           0
003760 C  SYMB-TAB            0           0           0           0           0
003770    START               1           0      350000           0           0
003780    START               1           0      300000           0           0
003790 ***
003800    SZAEHL              1          -1
003810    START               1           0      350000           0           0
```

```
                                PREPROCESSOR FOR SSYST-INPUT

                                     PREPRO, VERSION 0.A

                                  INPUT-RECORDS , COLUMNS

 73 - 80 #                                  1 - 72                                  # RECORD

00000010 #   LOCA          0   100   640     0    80   500                4000#       1

00000020 #   SYMB-TAB          1                                                    #       2
00000030 #                  REFERENCE = 400000                                    #       3
00000040 #                  LOCA_BLOCK < REFERENCE+600                            #       4
00000050 #                  ALLOCATION < REFERENCE+ 700                           #       5
00000060 #                RADII_OLD<REFERENCE+ 800                                #       6
00000070 #                ELEVATION_OLD<REFERENCE+ 900                            #       7
00000080 #                  MATERIALS =3                                          #       8
00000090 #                  NRAD = 9                                              #       9
00000100 #                  INNER < NRAD-2                                        #      10
00000110 #                  NAXIAL = 24                                           #      11
00000120 #                PRESSURE_INT = 70.+5                                    #      12
00000130 #                CAP=.001                                                #      13
00000140 #                PLENUM_LOW = .3013                                      #      14
00000150 #                PLENUM_HIGH = .1798                                     #      15
00000160 #                DELTA_Z = .195                                          #      16
00000170 #%  SYMB-END                                                            #      17

                                UPDATED LIST OF SYMBOLS

                #   1          REFERENCE        =        400000
                #   2          LOCA_BLOCK       =        400600
                #   3          ALLOCATION       =        400700
                #   4          RADII_OLD        =        400800
                #   5          ELEVATION_OLD    =        400900
                #   6          MATERIALS        =             3
                #   7          NRAD             =             9
                #   8          INNER            =             7
                #   9          NAXIAL           =            24
                #  10          PRESSURE_INT     =        70.+5
                #  11          CAP              =          .001
                #  12          PLENUM_LOW       =         .3013
                #  13          PLENUM_HIGH      =         .1798
                #  14          DELTA_Z          =          .195
```

```
00000180 #C                                                                    * COMM.
00000190 #C ***** ATTENTION: THIS IS A SYNTHETIC SSYST-3 INPUT DATA SET, ONLY  * COMM.
00000200 #C ***************  INTENDED TO DEMONSTRATE THE FACILITIES OF THE     * COMM.
00000210 #C ***************  SSYST-3 INPUT PREPROCESSOR 'PREPRO'.              * COMM.
00000220 #C                                                                    * COMM.

00000230 #   DR-SETZ                                                           #     18

00000240 #   GENSTEU          , 1, LOCA_BLOCK                                  #     19
00000250 #SSYST LOCA ANALYSIS, SAMPLE A                                        #     20
00000260 # MATERIALS +43,12,1                                                 #     21
00000270 #;;NRAD; NAXIAL; 4;5; ALLOCATION; A,39,100;T                          #     22
00000280 #;1000.;; PRESSURE_INT; .05; .005; F;T                                #     23
00000290 #SSYST LOCA ANALYSIS, SAMPLE A                                        #     24

00000300 #   MATRIX           ,1                                               #     25
00000310 #   1,2,NRAD, NAXIAL                                                  #     26
00000320 #     ALLOCATION;T                                                    #     27
00000330 #SPECIFICATION OF MATERIAL ZONES                                      #     28
00000340 #R,NRAD,3;R,NRAD-1,4;3;R,INNER,1;-2;3;Q,NAXIAL-5,NRAD;                #     29
00000350 #R,NRAD-1,5;R,NRAD+1,3;T                                              #     30

00000360 #   MATRIX           ,1                                               #     31
00000370 #   1,0, NRAD+1, NAXIAL                                               #     32
00000380 #     RADII_OLD;T                                                     #     33
00000390 #INITIAL RADIAL NODES, ROOM TEMPERATURE (M)                           #     34
00000400 #  ; 1.2046E-3 ; 2.2238E-3;  3.0576E-3;  3.7061E-3 ; 4.1693E-3;       #     35
00000410 #  4.45E-3;  4.54E-3;  4.65E-3;  5.37E-3; Q,NAXIAL-1, NRAD+1; T       #     36

00000420 #   VEKTOR       ,1,,ELEVATION_OLD, NAXIAL+1                         #     37
00000430 #INITIAL AXIAL NODES, ROOM TEMPERATURE (M)                            #     38
00000440 #;CAP; A,1,PLENUM_LOW; A,NAXIAL-4, DELTA_Z;A,1,PLENUM_HIGH; A,1,CAP;T #     39

00000450 #   SYMB-TAB                                                          #     40
00000460 #                UO2 = 2301                                          #     41
00000470 #                HE70 = 2302                                         #     42
00000480 #                ZRY = 2303                                          #     43
00000490 #%               NAXIAL < NAXIAL/2                                   #     44
         SYMBOL:               NAXIAL          <          12
00000500 #                DECAY = 4300                                        #     45
00000510 #   TRACE-OFF                                                         #     46

00003990 #   TRACE-ON                                                          #    385
00004000 #   SYMB-END                                                          #    386        350000
```

```
00004010 #    START                1,, REFLOOD                                  #    387          350000

00004020 #    START          1, , PRINT_RESULTS                                 #    388          350000
00004030 #***                                                                   #    389    ***** END *****

00004040 #    SZAEHL               1           -1                               #    390

00004050 #    START                1,, REFLOOD                                  #    391
```

17 ACTIVE MODULES:

NUCLEUS	STEUBL	WERBL	PRGSP	BLOCKM	MATMAN	RSYFKT	ZWERG	ZET1D	SPAGAD
WUEZ	STADEF	ZIRKOX	RANDM	RIBDTH	WAK	RAWAK			

```
                                PREPROCESSOR FOR SSYST-INPUT

                                    PREPRO, VERSION 0.A

                                  INPUT-RECORDS , COLUMNS

 73 - 80 #                                  1 - 72                                  # RECORD

00000010 #   LOCA          0   100   640     0    80   500                  4000#       1

00000020 #C  SYMB-TAB            1            0          0          0          0 * COMM.
00000030 #C                       REFERENCE          =      400000                * COMM.
00000040 #C                       LOCA_BLOCK         <      400600                * COMM.
00000050 #C                       ALLOCATION         <      400700                * COMM.
00000060 #C                       RADII_OLD          <      400800                * COMM.
00000070 #C                       ELEVATION_OLD      <      400900                * COMM.
00000080 #C                       MATERIALS          =           3                * COMM.
00000090 #C                       NRAD               =           9                * COMM.
00000100 #C                       INNER              <           7                * COMM.
00000110 #C                       NAXIAL             =          24                * COMM.
00000120 #C                       PRESSURE_INT       =        70.+5               * COMM.
00000130 #C                       CAP                =         .001               * COMM.
00000140 #C                       PLENUM_LOW         =         .3013              * COMM.
00000150 #C                       PLENUM_HIGH        =         .1798              * COMM.
00000160 #C                       DELTA_Z            =          .195              * COMM.
00000170 #C  SYMB-END                                                             * COMM.
00000180 #C                                                                       * COMM.
00000190 #C ***** ATTENTION: THIS IS A SYNTHETIC SSYST-3 INPUT DATA SET, ONLY     * COMM.
00000200 #C ***************  INTENDED TO DEMONSTRATE THE FACILITIES OF THE        * COMM.
00000210 #C ***************  SSYST-3 INPUT PREPROCESSOR 'PREPRO'.                 * COMM.
00000220 #C                                                                       * COMM.

00000230 #   DR-SETZ             0          0          0          0          0#       2

00000240 #   GENSTEU             0          1     400600          0          0#       3
00000250 #SSYST LOCA ANALYSIS, SAMPLE A                                           #       4
00000260 #    46    12     1                                                      #       5
00000270 #           0          0          9         24          4          5#       6
00000280 #      400700A39     100T                                               #       7
00000290 #          0.       1000.         0.       70.+5        .05       .005#       8
00000300 #F         0.T                                                         #       9
00000310 #SSYST LOCA ANALYSIS, SAMPLE A                                           #      10

00000320 #   MATRIX              0          1          0          0          0#      11
```

```
00000330 #     1     2     9    24                                                  #     12
00000340 #      400700T                                                           #     13
00000350 #SPECIFICATION OF MATERIAL ZONES                                         #     14
00000360 #R 9         3R 8         4          3R 7         1          -2          3#     15
00000370 #Q19         9R 8         5R10       3T                                  #     16

00000380 #   MATRIX              0          1          0          0          0#     17
00000390 #     1     0    10    24                                               #     18
00000400 #      400800T                                                         #     19
00000410 #INITIAL RADIAL NODES, ROOM TEMPERATURE (M)                            #     20
00000420 #           0.   1.2046E-3   2.2238E-3   3.0576E-3   3.7061E-3   4.1693E-3#     21
00000430 #     4.45E-3     4.54E-3     4.65E-3     5.37E-3Q23       10T          #     22

00000440 #   VEKTOR              0          1          0      400900          25#     23
00000450 #INITIAL AXIAL NODES, ROOM TEMPERATURE (M)                             #     24
00000460 #           0.        .001A 1    .3013A20     .195A 1    .1798A 1     .001#     25
00000470 #T                                                                     #     26

00000480 #C  SYMB-TAB            0          0          0          0          0 * COMM.

00000490 #   MATRIX              1          1                                    #     27
00000500 #     1     0     9    12                                               #     28
00000510 #      401000T                                                         #     29
00000520 #INITIAL TEMPERATURES (K)                                              #     30
00000530 #F       300.T                                                         #     31

00000540 #   MATRIX              0          1          0          0          0#     32
00000550 #     1     0    12     3                                               #     33
00000560 #      401100T                                                         #     34
00000570 #INITIAL TEMPERATURES, CLADDING AND GAP (K)                            #     35
00000580 #F       300.T                                                         #     36

00000590 #   NUMKOR              1          1                                    #     37
00000600 #     4     1                                                         #     38
00000610 #      400800      400900      401100      401000T                     #     39
00000620 #      401500      401600      401300      401200T                     #     40
00000630 #UPDATED RADIAL NODES (M)                                              #     41
00000640 #UPDATED AXIAL NODES (M)                                               #     42
00000650 #UPDATED TEMPERATURES, CLADDING AND GAP (K)                            #     43
00000660 #UPDATED TEMPERATURES (K)                                              #     44

00000670 #   VEKTOR              0          1          0      403600          12#     45
00000680 #GAP CONDUCTANCE ALPHA                                                 #     46
00000690 #F      6000.T                                                         #     47
```

```
00000700 #   GENSTEU              0            1      403800            0            0#      48
00000710 #CONTROL-BLOCK FOR STADEF (ROD DEFORMATION)                                  #      49

00000720 #C   CONTROL BLOCK FOR STADEF  (AT OFFSET 40: EFFECTIVE STRESS)             * COMM.

00000730 #     6     9     0                                                        #      50
00000740 #      403810       403820       404001       403840F          0T        #      51
00000750 #     1.08E-5         .316        .6E-5           .4          1.        1.#      52
00000760 #       .0135           1.           0.T                                 #      53

00000770 #   WERBL                0            1            1            2            0#      54
00000780 #      403820                                                             #      55
00000790 #MATERIAL PROPERTIES FOR STADEF (ROD DEFORMATION)                         #      56
00000800 #    13     1                                                             #      57
00000810 #           13T                                                          #      58
00000820 #            2T                                                          #      59
00000830 #         290.         500.         700.         900.        1100.        1300.#      60
00000840 #        1500.        1700.        1900.        2100.        2300.        2500.#      61
00000850 #        2700.T                                                          #      62
00000860 #  0.1962E+12  0.1739E+12  0.1516E+12  0.1293E+12  0.1071E+12  0.8478E+11#      63
00000870 #  0.6251E+11  0.4023E+11  0.1795E+11  0.9807E+10  0.9807E+10  0.9807E+10#      64
00000880 #  0.9807E+10T                                                          #      65
00000890 #     2     1                                                          #      66
00000900 #           2T                                                          #      67
00000910 #           4T                                                          #      68
00000920 #     6.66E-4     3.33E-3T                                             #      69
00000930 #   8.418E-28   1.692E-73T                                             #      70

00000940 #   VEKTOR               0            1            0       404001          12#      71
00000950 #WIDTH OF OXIDIZED CLADDING LAYER                                         #      72
00000960 #F          0.T                                                         #      73

00000970 #C     PREFACE: SET INITIAL STATES                                       * COMM.

00000980 #   RIBDTH               0            1         4300       403100          -2#      74
00000990 #RIBDTH-OUTPUT                                                            #      75
00001000 #     2.2E-03         10.0         0.02                                 #      76
00001010 #       0.193        582.0      1.0E-10        200.0                     #      77
00001020 #           0            0                                             #      78
00001030 #         1.           1.                                              #      79
00001040 # 8.640E4 1.296E5 1.728E5 2.160E5 2.592E5 3.024E5 3.456E5 3.888E5 4.320E5#      80

00001050 #   SPAGAD               1            1       400600            0            0#      81

00001060 #   IVEKTOR              0            1            0       403000            7#      82
```

```
00001070 #BLOCK-NUMBERS OF RANDM-INPUT                                          #     83
00001080 #      403001A 6        1T                                             #     84

00001090 #   MATRIX              0          1          0          0           0#     85
00001100 #     1     0     9    12                                            #     86
00001110 #      403001T                                                       #     87
00001120 #POWER DENSITY (W/M**3)                                              #     88
00001130 #R18        0.R 7 2.65E+08          0.         0.R 7 3.36E+08       0.#     89
00001140 #           0.R 7 4.02E+08          0.         0.R 7 4.62E+08       0.#     90
00001150 #           0.R 7 5.16E+08          0.         0.R 7 5.61E+08       0.#     91
00001160 #           0.R 7 5.99E+08          0.         0.R 7 6.28E+08       0.#     92
00001170 #           0.R 7 6.47E+08          0.         0.R 7 6.58E+08       0.#     93
00001180 #           0.R 7 6.57E+08          0.         0.R 7 6.47E+08       0.#     94
00001190 #           0.R 7 6.28E+08          0.         0.R 7 5.99E+08       0.#     95
00001200 #           0.R 7 5.61E+08          0.         0.R 7 5.16E+08       0.#     96
00001210 #           0.R 7 4.62E+08          0.         0.R 7 4.02E+08       0.#     97
00001220 #           0.R 7 3.36E+08          0.         0.R 7 2.65E+08F      0.#     98
00001230 #T                                                                   #     99

00001240 #   IVEKTOR             0          1          0      403007         12#    100
00001250 #DISTRIBUTION OF BOUNDARY CONDITIONS                                 #    101
00001260 #           1          1A 9       1         22T                     #    102

00001270 #   RANDM               2          1      400600          1          0#    103

00001280 #   STADEF              1          1      400600         -1          0#    104

00001290 #C     STAGE 1:  EVALUATION OF THE THERMAL AND MECHANICAL INITIAL,      * COMM.
00001300 #C               EQUILIBRIUM CONDITIONS                                 * COMM.

00001310 #   MISCH-UBI           3                                             #    105
00001320 #       2301        2302        2303T                                #    106

00001330 #C   TRANSFER MATERIAL DATA BLOCKS FROM DISK TO CORE                   * COMM.

00001340 #   BLMOD               1          1          0          0           0#    107
00001350 #REPLICATION OF RADIAL NODES (COLD)                                  #    108
00001360 #     1     1     1     8     8     1    12     0     1              #    109
00001370 #F          0T                                                       #    110
00001380 #      401500T                                                       #    111
00001390 #      401520T                                                       #    112
00001400 #RADIAL AREAS (COLD) INCL. INCREMENT FOR RELOCATION                  #    113

00001410 #   POWER               1          1      401520      401520          2#    114
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00001420 #   MATRIX              0           1           0           0          0#    115
00001430 #     1     0    12     3                                              #    116
00001440 #      401800T                                                        #    117
00001450 #BOUNDARY CONDITIONS (LEFT BOUNDARY)                                  #    118
00001460 #R12       0.R12       1.F         0.T                                #    119

00001470 #   GENSTEU             0           1      402300           0          0#    120
00001480 #CONTROL-BLOCK FOR HEAT CONDUCTION MODULES (ZET-1D/2D, STT-1D/2D)     #    121
00001490 #     15     4     1                                                  #    122
00001500 #            5        2301        2302        2303R 2     2302       10#    123
00001510 #            5           5           9          10          10       1#    124
00001520 #F           0T                                                       #    125
00001530 #R 3      10.          .01T                                          #    126
00001540 #  CONTROL-BLOCK FOR HEAT CONDUCTION MODULE ZET-1D                    #    127

00001550 #   MATRIX              0           1           0           0          0#    128
00001560 #     1     0    12     2                                              #    129
00001570 #      403500T                                                        #    130
00001580 #EMISSIVITIES OF PELLETS AND CLADDING                                 #    131
00001590 #R12       .5R12       .25T                                           #    132

00001600 #   SPEICHER            0           1           0      300000          0#    133   **** MACRO ***
00001610 #PRINT INTERMEDIATE RESULTS                                           #    134         300000

00001620 #   DR-SETZ             1           0           0           0          0#    135         300000

00001630 #   DRUCKE              1                       3                      #    136         300000
00001640 #      400600      401200      401500T                                 #    137         300000

00001650 #   DR-SETZ             0           0           0           0          0#    138         300000

00001660 #   SZAEHL              1           0                                  #    139         300000
00001670 #***                                                                  #    140   ***** END ****

00001680 #   SPEICHER            0           1           0      310000          0#    141   **** MACRO ***
00001690 #MACRO-BLOCK TO GET INITIAL EQUILIBRIUM CONDITIONS                     #    142         310000

00001700 #   LSCH-UBI            2                                              #    143         310000
00001710 #      401510      402200T                                             #    144         310000

00001720 #   BLMOD               1           1                                  #    145         310000
00001730 #CROSS SECTION OF ACTUAL RADIAL NODES                                  #    146         310000
00001740 #     1     1     1     8     8     1    12     0     1                #    147         310000
00001750 #           0T                                                        #    148         310000
00001760 #      401500T                                                        #    149         310000
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00001770 #      401510T                                                          #     150         310000
00001780 #ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN               #     151         310000

00001790 #   MATMAL              1          1      401510      401510      401510#     152         310000
00001800 #ACTUAL RADIAL AREAS                                                    #     153         310000

00001810 #   MATTEIL             1          1      401520      401510      401510#     154         310000
00001820 #CORRECTIONS FOR ACTUAL POWER DENSITY IN THE FUEL                       #     155         310000

00001830 #   MATMSP              1          1      403001      401510      402200#     156         310000
00001840 #CORRECTED ACTUAL POWER DENSITY IN THE FUEL                             #     157         310000

00001850 #   WUEZ                1          1      400600           0          0#     158         310000

00001860 #   DR-SETZ             1          0           0           0          0#     159         310000

00001870 #   STT-1D              1          1      400600           0          0#     160         310000

00001880 #   DR-SETZ             0          0           0           0          0#     161         310000

00001890 #   SPAGAD              1          1      400600           0          0#     162         310000

00001900 #   STADEF              1          1      400600           0          0#     163         310000

00001910 #   ZAEHL               1         20           1           0          0#     164         310000

00001920 #   START               1          0      310000           0          0#     165         310000

00001930 #   START               1          0      300000           0          0#     166         310000
00001940 #***                                                                    #     167   ***** END ****

00001950 #   MODSTEU             1          1      400600      400600          0#     168
00001960 #SSYST LOCA ANALYSIS, SAMPLE A                                          #     169
00001970 #     1     1     1                                                     #     170
00001980 #           1T                                                          #     171
00001990 #999999                                                                 #     172

00002000 #   SZAEHL              1          0           0           0          0#     173

00002010 #   START               1          0      310000           0          0#     174

00002020 #   ZWERG               1          1      320000          -3          0#     175
00002030 #RELAP4 / SSYST-3 SIMULATION OF PWR-LOCA                                #     176
00002040 #           3                                                           #     177
00002050 #      400600           1      400601                                   #     178
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00002060 #          -1          1          0                                  #    179
00002070 #TIME-VECTOR                                                         #    180
00002080 #      401200         10     401201                                  #    181
00002090 #           1          2          9                                  #    182
00002100 #CENTRAL TEMPERATURES, AXIAL ZONES 2 TO TOP-1                        #    183
00002110 #      401200          8     401202                                  #    184
00002120 #           4          3          7                                  #    185
00002130 #FUEL TEMPERATURES IN RING ZONE 4, AXIAL ZONES 3 TO TOP-2            #    186

00002140 #   GENSTEU            0          1     404000          0          0#    187
00002150 #CONTROL-BLOCK FOR ZIRKOX (CLADDING OXIDATION)                       #    188
00002160 #     1     8     0                                                  #    189
00002170 #      404001T                                                      #    190
00002180 #    39.66E-6      2.6E+4    5.966E+3       6600.       5820.      0.02#    191
00002190 #F          0.T                                                     #    192

00002200 #   SPEICHER           0          1          0      330000          0#    193   **** MACRO ***
00002210 #MACRO SET UP FOR THE BLOW-DOWN CALCULATION                          #    194        330000

00002220 #   ZAEHL              1        100         -1                       #    195        330000

00002230 #C   **** HERE ARBITRARY COUNTING INTERVALS *****                      * COMM.

00002240 #   START              1          0      300000          0          0#    196        330000

00002250 #   LSCH-UBI           1                                             #    197        330000
00002260 #      401510T                                                      #    198        330000

00002270 #   BLMOD              1          1                                  #    199        330000
00002280 #TRANSFER ACTUAL PELLET-RADII                                        #    200        330000
00002290 #     1     1     1     8     8     1    24     0     1             #    201        330000
00002300 #           0T                                                      #    202        330000
00002310 #      401500T                                                      #    203        330000
00002320 #      401510T                                                      #    204        330000
00002330 #ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN            #    205        330000

00002340 #   MATMAL             1          1     401510     401510     401510#    206        330000
00002350 #ACTUAL RADIAL AREAS                                                 #    207        330000

00002360 #   MATTEIL            1          1     401520     401510     401510#    208        330000
00002370 #CORRECTIONS FOR ACTUAL FUEL POWER DENSITY                           #    209        330000

00002380 #   RANDM              1          1     400600          1          1#    210        330000

00002390 #   MATMSP             1          1     402200     401510     402200#    211        330000
```

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00002400 #CORRECTED ACTUAL FUEL POWER DENSITY                                  #    212        330000
00002410 #   WUEZ                1          1      400600          0          0#    213        330000
00002420 #   ZIRKOX              1          1      400600          0          0#    214        330000
00002430 #   ZET-1D              1          1      400600         60          0#    215        330000
00002440 #   SPAGAD              1          1      400600          0          0#    216        330000
00002450 #   STADEF              1          1      400600          0          0#    217        330000
00002460 #   ZWERG               1          1      320000          3          0#    218        330000
00002470 #   START               1          0      330000          0          0#    219        330000
00002480 #   START               1          0      300000          0          0#    220        330000
00002490 #***                                                                  #    221   ***** END ****
00002500 #   SPEICHER            0          1           0     340000          0#    222   **** MACRO ***
00002510 #MODIF. LOCA CONTROL-BLOCK, BOUNDARY CONDITIONS, TRANSIENT SEGMENT 1  #    223        340000
00002520 #   MODSTEU             1          1      400600     400600          0#    224        340000
00002530 #MODIF. LOCA CONTROL-BLOCK, BOUNDARY CONDITIONS, TRANSIENT SEGMENT 1  #    225        340000
00002540 #     1     1     1                                                   #    226        340000
00002550 #           0T                                                        #    227        340000
00002560 #999999                                                               #    228        340000
00002570 #   LSCH-UBI            5                                             #    229        340000
00002580 #      403003A 3        1      401700T                                #    230        340000
00002590 #   BLMOD               0          1           0          0          0#    231        340000
00002600 #BOUNDARY CONDITIONS                                                  #    232        340000
00002610 #     3     1     1     1    22     2    61     0     0               #    233        340000
00002620 #F          0T                                                        #    234        340000
00002630 #      403004A 2        1T                                            #    235        340000
00002640 #      403004A 2        1T                                            #    236        340000
00002650 #   BLMOD               0          1                                 #    237        340000
00002660 #TRANSIENT POWER                                                      #    238        340000
00002670 #     1     1     1     1     1     2    61     0     0               #    239        340000
00002680 #           0T                                                        #    240        340000
00002690 #      403003T                                                        #    241        340000
00002700 #      403003T                                                        #    242        340000
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00002710 #   BLMOD                0          1                                  #    243          340000
00002720 #NEW TIME-VECTOR                                                       #    244          340000
00002730 #     1     1     1     1     1     1    61     0     0               #    245          340000
00002740 #           0T                                                        #    246          340000
00002750 #      401700T                                                        #    247          340000
00002760 #      401700T                                                        #    248          340000
00002770 #***                                                                  #    249    ***** END ****

00002780 #   MODSTEU              1          1       400600       400600      0#    250
00002790 #ZERO TIME AND MACRO-STEP                                              #    251
00002800 #     2     1     2                                                    #    252
00002810 #F         0.T                                                        #    253
00002820 #999999                                                               #    254

00002830 #   START                1          0       340000            0      0#    255

00002840 #   SZAEHL               1         -1                                  #    256

00002850 #   START                1          0       330000            0      0#    257

00002860 #   DR-SETZ              1          0            0            0      0#    258

00002870 #   DRUCKE               1          0            1            0      0#    259
00002880 #      401900T                                                        #    260

00002890 #   DR-SETZ              0          0            0            0      0#    261

00002900 #C     STAGE 2:  BLOWDOWN ANALYSIS                                      * COMM.

00002910 #   MODIF                1          1       340000       340000      0#    262
00002920 #BLOW-DOWN TRANSIENT, SEGMENT 3                                        #    263
00002930 #*MOD      10    10                                                    #    264
00002940 #     3     1     1     1    22   122   181     0     0               #    265
00002950 #*MOD      16    16                                                    #    266
00002960 #     1     1     1     1     1   122   181     0     0               #    267
00002970 #*MOD      22    22                                                    #    268
00002980 #     1     1     1     1     1   121   181     0     0               #    269
00002990 #*END                                                                 #    270

00003000 #   START                1          0       340000            0      0#    271

00003010 #   SZAEHL               1         -1                                  #    272

00003020 #   START                1          0       330000            0      0#    273
```

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00003030 #   MODIF                1          1      330000      330000          0#    274
00003040 #BLOW-DOWN TRANSIENT, SEGMENT 8. CHANGE IN LOOOP REPETITIONS             #    275
00003050 #*MOD      21    21                                                      #    276
00003060 #   ZET-1D               1          1      400600          30          0#    277
00003070 #*END                                                                   #    278

00003080 #   START                1          0      340000           0          0#    279

00003090 #   SZAEHL               1         -1                                   #    280

00003100 #   START                1          0      330000           0          0#    281

00003110 #C    STAGE 3A: REFILL- AND FLOOD ANALYSIS                                * COMM.

00003120 #   MODSTEU              1          1      400600      400600          0#    282
00003130 #ZERO POSITION 1 OF THE INTEGER FIELD                                   #    283
00003140 #     1     1     1                                                     #    284
00003150 #           0T                                                        #    285
00003160 #999999                                                                 #    286

00003170 #   LSCH-UBI             3                                            #    287
00003180 #      403003      403006      401700T                                 #    288

00003190 #   GENSTEU              1          1      404100           0          0#    289
00003200 #CONTROL-BLOCK FOR WAK (FLOODING)                                       #    290
00003210 #     6     6     1                                                    #    291
00003220 #      401700      403003      403001      404101      403006      404102#    292
00003230 #T                                                                      #    293
00003240 #         20.         400.          .3       2000.         20.         1.#    294
00003250 #T                                                                      #    295
00003260 #REFILL/FLOODING PHASE OF A PWR LOCA MODELLED WITH WAK                  #    296

00003270 #   WAK                  1          1      404100           0          0#    297
00003280 #SIMULATION OF BIBLIS-B                                                 #    298
00003290 #         3           4          2       45548          66          3#    299
00003300 #       500.          .5                                              #    300
00003310 #       3.9        13.9       9.31        4.64        6.0        0.8#    301
00003320 #      3.71        0.01                                              #    302
00003330 #        25.          .8       11.5        1.06    3.733E9        7.5#    303
00003340 #       .29         1.2         1.          1.          0.         .1#    304
00003350 #        0.          0.       16.0          0.         21.      830.#    305
00003360 #       32.          0.        44.          0.         46.      300.#    306
00003370 #       68.         550.      100.        450.        136.      400.#    307
00003380 #        0.          0.        16.          0.         21.        0.#    308
00003390 #       32.          0.        44.          0.         46.        0.#    309
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00003400 #          0.          0.         16.          0.         21.        470.#    310
00003410 #          0.      1.E-10       0.25      1.E-10      0.398      0.175#    311
00003420 #       0.593       0.305                                              #    312
00003430 #          0.     15.8E+6         1.      8.8E+6         10.     5.0E+6#    313
00003440 #          0.      6000.       0.25       6000.                       #    314
00003450 #         1.5         1.0         0.         2.5        1.5         0.#    315
00003460 #          0.          0.         0.          0.         0.         0.#    316
00003470 #   2.000E+01   3.700E+01  2.250E+01   0.0         5.000E-01   0.0     #    317
00003480 #   3.600E+00   2.600E+01                                              #    318

00003490 #C    STAGE 3B: SINGLE ROD ANALYSIS FOR THE REFILL- AND FLOOD PHASE       * COMM.

00003500 #   SPEICHER            0          1          0      350000          0#    319   **** MACRO ***
00003510 #MACRO FOR THE FLOODING CALCULATION                                       #    320        350000

00003520 #   ZAEHL               1         50         -1           0          0#    321        350000

00003530 #   START               1          0      300000          0          0#    322        350000

00003540 #   LSCH-UBI            1                                                #    323        350000
00003550 #      401510T                                                         #    324        350000

00003560 #   BLMOD               1          1                                    #    325        350000
00003570 #TRANSFER ACTUAL PELLET RADII                                            #    326        350000
00003580 #     1     1     1     8     8     1    12     0     1                 #    327        350000
00003590 #           0T                                                         #    328        350000
00003600 #      401500T                                                         #    329        350000
00003610 #      401510T                                                         #    330        350000
00003620 #ACTUAL RADIAL NODES, INCL. RELOCATION AND THERMAL STRAIN                #    331        350000

00003630 #   MATMAL              1          1     401510      401510     401510#    332        350000
00003640 #ACTUAL RADIAL AREAS                                                     #    333        350000

00003650 #   MATTEIL             1          1     401520      401510     401510#    334        350000
00003660 #CORRECTIONS FOR ACTUAL POWER DENSITY IN THE FUEL                        #    335        350000

00003670 #   RAWAK               1          1     400600           0          1#    336        350000

00003680 #   MATMSP              1          1     402200      401510     402200#    337        350000
00003690 #CORRECTED ACTUAL POWER DENSITY IN THE FUEL                              #    338        350000

00003700 #   WUEZ                1          1     400600           0          0#    339        350000

00003710 #   ZIRKOX              1          1     400600           0          0#    340        350000
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00003720 #    ZET-1D          1          1      400600        500          0#    341        350000
00003730 #    SPAGAD          1          1      400600          0          0#    342        350000
00003740 #    STADEF          1          1      400600          0          0#    343        350000
00003750 #    ZWERG           1          1      320000          3          0#    344        350000
00003760 #C   SYMB-TAB        0          0           0          0          0 * COMM.
00003770 #    START           1          0      350000          0          0#    345        350000
00003780 #    START           1          0      300000          0          0#    346        350000
00003790 #***                                                                #    347   ***** END ****
00003800 #    SZAEHL          1         -1                                   #    348
00003810 #    START           1          0      350000          0          0#    349
```

17 ACTIVE MODULES:

NUCLEUS	STEUBL	WERBL	PRGSP	BLOCKM	MATMAN	RSYFKT	ZWERG	ZET1D	SPAGAD
WUEZ	STADEF	ZIRKOX	RANDM	RIBDTH	WAK	RAWAK			