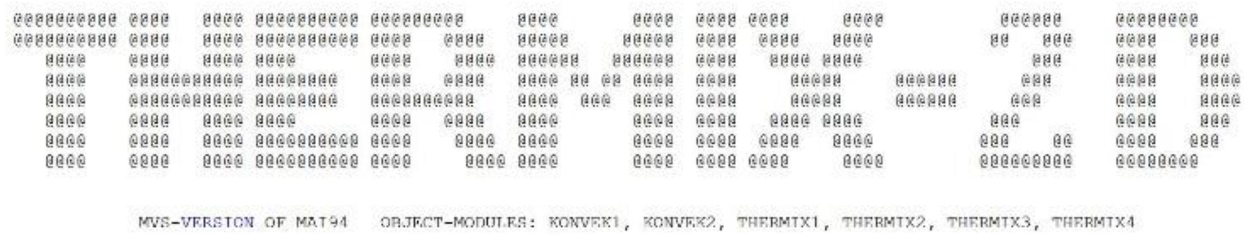

SAMPLE INPUT and MANUAL

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Pusat Teknologi dan Keselamatan Reaktor Nuklir

BATAN

```
 0.      HTR-PM 250MWth  HDG 06/14 9.6% Bypass
-1    0    2    3    0    0    0    02000 500    0   10 500   19    0
250.0     0. 946.    0.01    1.7    0.6 5.E-4    10.     0.      0.
          0.         -236.    0    0    1    1
24   43    0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  3  3  3  3  3  3  4  4  4  4  4  4  0  0  0  0  0
  2  2  2  2  2  2  4  4  4  4  4  4  0  0  0  0  0
  1  1  1  1  1  1  6  6  6  6  6  6  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  1  1  1  1  1  1  4 11  4  4  4 10  0  0  0  0  0
  7  7  7  7  7  7  4 11  4  4  4 10  0  0  0  0  0
  7  7  7  7  7  7  4 11  4  4  4 10  0  0  0  0  0
  7  7  7  7  7  7  4 11  4  4  4 10  0  0  0  0  0
  7  7  7  7  7  7  4 11  4  4  4 10  0  0  0  0  0
  7  7  7  7  7  7  4 11  4  4  4 10  0  0  0  0  0
  7  7  7  7  7  7  4 11  4  4  4 10  0  0  0  0  0
  7  7  7  7  7  7  4 11  4  4  4 10  0  0  0  0  0
  8  8  8  8  8  8  8  8  4  4  4  9  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
  7  7  7  7  7  7  7  7  7  7  7  7  7 11 12 13 19
  3  3  3  3  3  3  4  4  4  4  4  4 10 11 12 13 19
  3  3  3  3  3  3  4  4  4  4  4  4 10 11 12 13 19
  3  3  3  3  3  3  4  4  4  4  4  4 10 11 12 13 19
  2  2  2  2  2  2  4  4  4  4  4  4 10 11 12 13 19
  1  1  1  1  1  1 16 16 16 16 16 16 10 11 12 13 19
  1  1  1  1  1  1  4 22  4  4  4 15 10 11 12 13 19
  1  1  1  1  1  1  4 22  4  4  4 15 10 11 12 13 19
  1  1  1  1  1  1  4 22  4  4  4 15 10 11 12 13 19
  1  1  1  1  1  1  4 22  4  4  4 15 10 11 12 13 19
```

```
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
   1   1   1   1   1   1   4  22   4   4   4  15  10  11  12  13  19
  17  17  17  17  17  17   4  22   4   4   4  15  10  11  12  13  19
  17  17  17  17  17  17   4  22   4   4   4  15  10  11  12  13  19
  18  18  18  18  18  18   4  22   4   4   4  15  10  11  12  13  19
   5   5   5   5   5   5   4  22   4   4   4  15  10  11  12  13  19
   5   5   5   5   5   5   4  22   4   4   4  15  10  11  12  13  19
   5   5   5   5   5   5   4  22   4   4   4  15  10  11  12  13  19
   5   5   5   5   5   5   4  22   4   4   4  15  10  11  12  13  19
   6   6   6   6   6   6   6   6   4   4   4  14  10  11  12  13  19
   8   8   8   8   8   8   8   8   8   8   8   8   8  11  12  13  19
  21  21  21  21  21  21  21  21  21  21  21  21  21  21  21  21  21
HET   1  -1   0  27   0   0   0   .613  3.02  0.         0.    0.0     0.    -1.0    0.
     0.387          6.     5
        5.0    24    17        0.0
        3.0    24    17        1.0
        1.0    24    17        1.0
        0.3    24    17        1.0
        0.0    24    17        1.0
VOI   2  -1   0   0   0   0   0     0. 0.001 .0030     0.     0.     0.     0.     0.
TRF   3   0  13   0   0   0   0    1.0   3.02  0.26     0.     0.     0.     0.     0.
SRI   4   0  13   0   0   0   0    1.0   3.02  0.26     0.     0.     0.     0.     0.
CRF   5  -1  13   0   0   0   0   .965   3.02  0.26     0.     0.     0.     0.     0.
BRF   6  -1  13   0   0   0   0   .965   3.02  0.26     0.     0.     0.     0.     0.
TPL   7   0   0   0   0   0   0     1. 4.212  0.17     0.     0.     0.     0.     0.
BPL   8   0   0   0   0   0   0     1. 4.212  0.17     0.     0.     0.     0.     0.
SHI   9   0   0   4  10   0   0     0. 0.001    0.    90.    0.8     0.     0.     0.
CBL  10   0   0   0   0   0   0    .85 4.017 0.178     0.     0.     0.     0.     0.
SHE  11   0   0   4  10   0   0     0. 0.001    0.    90.   0.85     0.     0.     0.
RPV  12   0   0   0   0   0   0    .85 4.350  0.40     0.     0.     0.     0.     0.
AIR  13   0   0   4  10   0   0     0. 0.001 .0003     1.   0.91     0.     0.     0.
IPL  14  -1  13   0   1   0   0    0.8   3.02  0.26     0.     0.     0.     0.     0.
RCH  15  -1  13   0   0   0   0   .705   3.02  0.26     0.     0.     0.     0.     0.
SRA  16  -1  13   0   0   0   0    0.8   3.02  0.26     0.     0.     0.     0.     0.
BRP  17  -1  13   0   0   0   0   .807   3.02  0.26     0.     0.     0.     0.     0.
HGK  18  -1  13   0   0   0   0    0.8   3.02  0.26     0.    0.0     0.     0.     0.
SBR  19   1   0   0   0   0   0     0.     0.    0.     0.     0.    70.     0.   0.5
TBR  20   1   0   0   0   0   0     0.     0.    0.     0.     0.    20.     0. 1.e-6
BBR  21   1   0   0   0   0   0     0.     0.    0.     0.     0.    20.     0. 1.e-6
```

```
SAS 22 -1 13  0  0  0  0   0.8  3.02  0.26    0.     0.     0.     0.     0.
SR0 23  0 13  0  0  0  0  .942  3.02  0.26    0.     0.     0.     0.     0.
CCH 24  0 13  0  0  0  0  .001  3.02  0.26    0.     0.     0.     0.     0.
    0    6        0.        70.       150.      185.      235.      290.
    0    6     -200.       -50.       600.      800.     1200.     1400.
      280.      280.      280.      280.      280.      280.
      420.      420.      415.      405.      380.      315.
      815.      815.      740.      725.      480.      360.
      990.      995.      920.      880.      480.      360.
     1010.     1010.      960.      860.      485.      360.
      850.      860.      870.      870.      785.      475.
     0  0 37        200.         0.         0.         0.         0.
         10.         1.     1600.         0.         0.       0. 01
     1.E-5     0.01      0.5       1.      0.02 1000 5000    5
        6.    0.390    5190.     0.667    70.0      0
     1     0     1     0     0    0.    0.    1.  0.39    0.    0.    0.
     2    -1     5     0     0   -1.    0.    0.    1.  170.    0.    0.
     3     0     0     0     0    0.    0.    0.    0.    0.    0.    0.
     4     0     0     0     0    0.    0.    0.    0.    0.    0.    0.
     5     0     0     0     0    0.    0.    0.    0.    0.    0.    0.
     6     0     5     0     0   -1.    0.    0.   0.2  33.5    0.    0.
     7     0     2     0     0   -1.    0.    0.   0.2   7.0    0.    0.
     8     0     5     2     0   -1.    0.    0.   0.2  14.4    0.    0.
     9     0     5     0     0   -1.    0.    0.   0.2  33.5  96.0  250.
    10     0     2     0     0   -1.    0.    0.  0.30  17.0    0.    0.
    11     0     2     0     0   -1. .600    0.  0.22  13.0    0.    0.
```

2.5 THERMIX/KONVEK, 2d-Thermal Hydraulics. TX1 - KX5

Cards TX1 - TX23, KX1 - KX5

Card TX1		Format (F4.1,4X,16A4)
1	TXNEW	= 0.: New THERMIX input corresponding to subsequent input cards. = 1.: Old input cards (before the year 1994).
2 : 17	TITLE(I), I=1,16	Literal description.

Card TX2		Format (18I4)
		Steering of the calculation:
1	IFKON	= 0: THERMIX calculation only, no KONVEK. **Note:** The input of KONVEK is needed anyway. ≠ 0: THERMIX-KONVEK coupling: =-1: Coupling between the temperatures of gas and solid material by heat transfer coefficient α. Recommended for steady state calculations, not valid in transient runs. = 1: Coupling via the source/sink distribution. = 2: Internal decision of coupling (not recommendable).
2	IHMAX	= 0: Temperature calculation in fuel elements by matrix-elimination (Gauss). > 0: Approach by iteration (Gauss-Seidel). Not valid for graphite spheres in transient runs.
3	IPRINT	=-2: Minimum output. = 1: Recommendable output. = 2: Maximum output. ≥ 3: In addition distribution of heat sources.
4	IPUN	= 0: No effect.

		= 3: Write restart on the data set no. IREST.
5	IFRSTA	= 0: No restart. > 0: Restart. Starting temperature distribution is read from data set IREST. (In case IREST = 0 the code requires the former input cards TH20 - TH22). Homogenized structure of fuel elements: = 1: Time starts at T = 0. = 2: Time scale continues. Heterogeneous structure of fuel elements: = 3: Time starts at T = 0. = 4: Time scale continues.
6	INTVAL	= 0: Steady state run. > 0: Number of time steps for the transient run. (≤ 50) = 1: Coupling with VSOP: The time steps are given by the VSOP-burnup scheme (JNSTOP, DELDAY on card R14).
7	KOMVAR	= 0: Normal.
8	IFRED	= 0: Power distribution independent of the time. = 3: Explicite calculation of the decay heat according to the explicite life history of the fuel elements and to the DIN 25485. = 1: Decay heat function of OTTO scheme. = 2: Decay heat function of MEDUL or implicite formular $0.0622 * (T^{-0.2} - (T+T_0)^{-0.2})$.
		Iterations:
9	MITMAX	> 0: Maximum number of iterations of temperature calculation. = 0: Default value = 2000
10	IKORM	> 0: Maximum number of changes of the relaxiation factor. = 0: Default value = 100
11	IFREL	= 0: Inner iteration in radial direction (I). = 1: Inner iteration in axial direction (N).
12	ITLAM	> 0: Drop recalculation of temperature dependent material data for ITLAM−1 time steps (only for steady state THERMIX-KONVEK iteration). = 0: Default value = 10

13	NLOOP	> 0: Maximum number of THERMIX-KONVEK ("Loop") iterations (steady state). = 0: Default value = 100
		Datasets:
14	IREST	= 0: No effect. > 0: Data set no. for storing the temperature field of steady state THERMIX runs. Must also be defined in transient THERMIX run, starting from this temperature field.
15	IEXPR	= 0: No effect. > 0: Data set no. for temperature field for the 2D-plots.

Card TX3		Format (12F6.1)
1	QNORM	> 0.: Total power (MW). Input power field is normalized to QNORM. In transient run the QNORM defines the reactor power to which the decay heat is related. = 0.: Drop normalization.
2	ZO	Axial position of the upper edge of the reactor fuel zone (cm). (Normally = 0.)
3	ZU	Axial position of the lower edge of the reactor fuel zone (cm). (Height of the core)
4	ETHA	> 0.: Convergence criterium for local THERMIX temperature field. (°C) = 0.: Default value = 0.01
5	OVMAX	> 0.: Maximum relaxiation factor. = 0.: Default value = 1.7
6	OVMIN	> 0.: Minimum relaxiation factor. = 0.: Default value = 0.6
7	TDIFF	> 0.: Relative convergence criterium of the time independent THERMIX-KONVEK iteration. = 0.: Default value = 0.0005
8	EFAK	> 0.: Multiplication factor for maximum allowable error le-

		vel, which stops the run. = 0.: Default value = 1.
9	DTVOR	> 0.: Maximum of the relative temperature change ΔT / T < DTVOR in a time interval Δt of a transient run. The time intervals Δt are correspondingly adapted. = 0.: Default value = 0.05
10	ZEITMI	Minimum length of the time intervals Δt in the transient run.

Card TX4 only when INTVAL > 0 on card TX2.

Card TX4		Format (3(F6.1,2I2,E10.3))
1	DZEIT(1)	Length of the first little time interval. (sec)
2	NPRIN(1)	> 0: Print the fields of temperature and streaming for all NPRIN little time steps. = 0: Default value = 50
3	NKONV(1)	> 0: Run the KONVEK every NKONV little time step (only when IFKON ≠ 0 on card TX2). = 0: Default value = 1
4	ZEI(1)	End of this 1. large time interval. (hours)
		Same for the next large time interval:
5	DZEIT(M)	= 0.: Free choice of the little intervals. < 0.: Also free choice, but maximum = |DZEIT(M)|. (sec) > 0.: Constant length of the little time intervals. (sec)
6	NPRIN(M)	As above.
7	NKONV(M)	As above.
8	ZEI(M) M = 2,INTVAL	As above. **Note:** In coupling with VSOP (INTVAL = 1) only the first large time interval must be defined, and DZEIT(2) holds for the further time history, which is steered by the VSOP burn-up time steps.

Card TX5		Format (2E12.5,12I4)
1	RAD0	Position of the first radial mesh point I = 1. (cm) (Normal = 0.).
2	PHI0	Position of the first axial mesh point N = 1. (cm) (Normal = –height of compositions above the core). **Note:** The upper edge of the core must be located at the position 0. The axial core dimension is counted from top to bottom.
3	IFRFI	= 0: Normal. = 1: Adiabatic boundary condition in the first radial mesh.
4	IFRFA	= 0: Normal. = 1: Adiabatic boundary condition in the last radial mesh.
5	IFRFL	= 0: Normal. = 1: Adiabatic boundary condition in the first axial mesh.
6	IFRFR	= 0: Normal. = 1: Adiabatic boundary condition in the last axial mesh.

Card TX6		Format (18I4)
1	KMAX	Number of compositions to be defined on cards TX10. (≤ 31)
2	NTHX	Data set no. of BIRGIT-library (see Section 2.3, card B11).
3	IFTEST	= 0: Normal. = 1: Testoption. For checking the input, the code runs without iterations.

Cards TX7 - TX9 define the coarse mesh grid, a subdivision of the fine grid, and the positions of KONVEK- and THERMIX-compositions in the coarse grid.

Card TX7		Format (6(I3,F9.0))
1	IC(1)	Number of fine mesh intervals in the 1. coarse radial interval.

2	C(1)	Width of the 1. coarse radial interval. (cm)
.	.	
.	.	
	IC(I)	> 0: Number of fine mesh intervals in the I. coarse radial interval. = 0: End of radial mesh definition.
	C(I)	Width of the I. coarse radial interval. (cm)

Card TX8		Format (6(I3,F9.0))
1	NC(1)	Number of fine mesh intervals in the 1. coarse axial interval.
2	C(1)	Width of the 1. coarse axial interval. (cm)
.	.	
.	.	
	NC(I)	> 0: Number of fine mesh intervals in the I. coarse axial interval. = 0: End of axial mesh definition.
	C(I)	Width of the I. coarse axial interval. (cm)

Two sets of cards TX9:
First set with KONVEK compositions as defined on cards KX3. One card TX9 is required for each axial coarse mesh "N" (even when no KONVEK composition is present in this mesh).
Second set of cards TX9 is to be given subsequently, containing THERMIX compositions as defined on cards TX10 - TX13.

Card TX9		Format (24I3)
1	KOC(1,N)	> 0: Id. no. of composition in the 1. radial coarse mesh. = 0: No composition is present.
.	.	
.	.	
I	KOC(I,N)	> 0: Id. no. of composition in the I. radial coarse mesh.

		= 0: No composition is present.

One card TX10 (optionally followed by TX11 - TX13) for each of the KMAX different THERMIX compositions.

Card TX10		Format (A3,7I3,8E6.0)
1	BEM	XYZ: Literal description of this composition. HET: Temperatures are calculated in the inner of the fuel elements. Analysis of temperature/volume. COR: Analysis of temperature/volume for this composition.
2	II	Id. no. of this composition.
3	IFTV	= -1: "Solid material zone". Temperature calculation comprises the heat exchange with the coolant of KONVEK by source/sink heat transfer. = 0: "Solid material zone". No heat exchange with the coolant is involved. = 1: "Fluid zone". No temperature calculation is performed for this zone. Coupled with the neighbours by the heat transfer coefficient ALP on this card. **Note:** For instance these zones are used as the heat sink of the liner. At the top and right of the reactor one mesh is sufficient for this zone. At the bottom two meshes are required.
4	IFWKT	= 0: Heat capacity given by C on this card. > 0: Identification no. of the material function for temperature dependent heat capacity (see Tab. VIII).
5	IFLT	= 0: Thermal conductivity λ given by LAM on this card. > 0: Identification no. of the material function for temperature and dose dependent λ (see Tab. IX). = 7: The temperature dependent function of id.no. = 7 uses LAM0 of this card as $\lambda(T = 0°C)$. = 4: In case of EPS > 0. (see below) the function uses LAM0 of this card as pressure (bar) of the gas in the gap. In case of EPS = 0. the function uses helium at the pressure 1 bar.
6	IDIR	Only when EPS > 0.:

		= 0: Radiation in radial direction. = 10: Exclusively in radial direction. = 1: Radiation in axial direction. = 11: Exclusively in axial direction.
7	NTVAR	= 0: No effect. > 0: In case of fluid zone (IFTV = 1) provide time dependent temperatures on card TX13.
8	IDUM	Dummy.
9	RHO	Volumetric fraction of solid material in this composition. RHO is used for calculation of the heat capacity.
10	C	= 0.: When IFWKT > 0. > 0.: Heat capacity of the solid material. ($J/cm^3/°K$)
11	LAM	= 0.: When IFLT > 0. > 0.: Thermal conductivity in solid material zones (only when IFTV = 0 or -1). (W/cm/°K)
12	LAM0	= 0.: Normal. > 0.: When IFLT = 7, LAM0 is $\lambda(T = 0°C)$. When IFLT = 4 and EPS > 0., LAM0 is the pressure of the gas in this composition.
13	EPS	= 0.: No heat radiation. > 0.: Coefficient of emission for the heat radiation between the side walls of the composition. (Maximum number of compositions with heat radiation = 19).
14	TVOR	= 0.: Start up temperature field results from the input temperature field of the cards TX14 - TX16. > 0.: Start up temperature of this composition (°C) superior to the startup temperatures of the cards TX14 - TX16.
15	WPRR	= -1.: Field of power density results from VSOP. It will be normalized to QNORM (card TX3). ≥ 0.: Power density of this composition. (W/cm^3)
16	ALP	= 0.: No effect. > 0.: Heat transfer coefficient in fluid zones ($W/cm^2/°K$) (only when IFTV = 1). **Note:** ALP ≃ 0.5: Temperature at the boundary close to that of this fluid zone. ALP ≃ 0.01: Temperature at the boundary close to that of the adjacent zone.

Cards TX11, TX12 only when BEM = "HET" on card TX10.

Card TX11 Format (2E10.3,I5)

1	HEPS	> 0.: Void fraction in the pebble bed. = 0.: Default value = 1 - RHO (on card TX10).
2	HKUG	Diameter of the spherical fuel element. (cm)
3	NHZON	Number of radial mesh intervals in the sphere. (≤ 5)

I = 1,NHZON cards TX12.

Card TX12 Format (E10.3,2I5,E10.3)

1	DI(I)	Inner diameter of the Ith radial mesh interval. (cm) **Caution:** I = 1 ... counts from the outer shell towards the inner!
2	NH1(I)	Id.no. of temperature dependent thermal conductivity (see IFLT on card TX10).
3	NH2(I)	Id.no. of temperature dependent heat capacity (see IFWKT on card TX10).
4	XFW(I)	Shielding factor of the power density in the Ith shell (in the fuel shells normally = 1.).

Card TX13 only when NTVAR > 0 on card TX10.

Card TX13 Format (14F5.2)

1	TKV(I)	Temperature. (°C)
2 .	ZEIV(I) I = 1,NTVAR	Time. (h)

Card TX14		Format (2I5,6E10.3 / 7E10.3)
1	IPOLI	= 0: Linear interpolation of temperature input of cards TX16. = 1: Logarithmic interpolation (radial).
2	IE	= 0: Drop reading of cards TX15, TX16. > 0: Number of radial mesh points for startup temperature input.
3 .	RE(I), I = 1,IE	Radial mesh points for startup temperature input on cards TX16. Continuation cards according to given FORMAT.

Cards TX15 - TX16 only when IE > 0 on card TX14.

Card TX15		Format (2I5,6E10.3 / 7E10.3)
1	IPOLN	= 0: Linear interpolation of temperature input of cards TX16. = 1: Logarithmic interpolation (axial).
2	NE	Number of axial mesh points for startup temperature input.
3 .	PHE(I), I = 1,NE	Axial mesh points for startup temperature input on cards TX16. Continuation cards according to given FORMAT.

One card TX16 for each of the N = 1,NE axial mesh points.

Card TX16		Format (7E10.3)
1 : IE	T(I,N), I = 1,IE	Startup temperature at mesh point I,N.

Card TX17		Format (I6,2I3,5E12.5)
1	MZNORM	= 0: No effect. > 0: Start the time counting from the present THERMIX-restart.
2	MC2	= 0: No effect. > 0: Read card TX18 with definition of Thermix-compositions for time dependent output of the "heat storage".
3	NGEOM	Data set no. of CITATION geometry input as prepared in BIRGIT (normally 37).
4	CIZETO	Difference between the axial zero points of CITATION and THERMIX.
5	SIG	= 0.: Default value = 1. > 0.: Factor to be multiplied with the explicitely evaluated decay heat function.
6	RL	Avg. power density. (MW/m^3)
7	SM	Avg. heavy metal content per fuel element (incl. graphite spheres). (g/sphere)
8	BURN	Avg. burnup of spent fuel. (MWd/kg_{HM})

Card TX18 only when MC2 > 0 on card TX17.

Card TX18		Format (31I1)
1 : KMAX	IKO(I), I=1,KMAX	"Heat storage" id.-no. to which the heat of THERMIX-composition I shall be added up. Possible "heat store" id.numbers: 5, 6, 7, 8, 9.

Card TX19		Format (5E12.5,E10.3,2I1)
1	DELTAT	Desired temperature interval (ΔT) for the numerical integra-

		tion inside the fuel elements (°C). Up to 200 intervals are possible between TU and TO.
2	TU	Lowest surface temperature of fuel elements.
3	TO	Highest temperature at center of the fuel elements.
4	WRIT	≥ 0.: Program uses standard data of the thermal conductivity as a function of fast neutron dose and temperature. > 0.: Various test output of temperature integration inside of the fuel elements. < 0.: Thermal conductivity as a function of fast neutron dose and temperature will be given on the cards TX20-TX23.
5	R0	= 0.: No effect. > 0.: Inner radius of the fuel matrix (if shell ball is considered).
6	A0	Initial enrichment of the fuel. (%)
7	ISTANZ	= 0: No effect. > 0: Punch T and relative fuel matrix volume in the corresponding ΔT averaged over the total core.
8	IFUGRA	= 0: Fuel element temperature calculation by direct integration. > 0: Fuel element temperature calculation from THERMIX.

Cards TX20 - TX23 only when WRIT < 0. on card TX19.

Card TX20		Format (12I6)
1	NSCH	Number of different functions of the thermal conductivity. (≤ 2)
2 .	KTEM(N), N=1,NSCH	Number of temperature mesh points for which the thermal conductivity will be given. (≤ 10)
. .	LFAD(N), N=1,NSCH	Number of fast neutron dose mesh points for which the thermal conductivity will be given. (≤ 10)

For each thermal conductivity function one set of cards TX21 - TX23.

Card TX21		Format (6E12.5)
1 .	TSTUE(K), K = 1,KTEM	Temperature mesh points.

Card TX22		Format (6E12.5)
1 .	DSTUE(L), L = 1,LFAD	Mesh points of fast neutron dose.

For each of the LFAD mesh points of the fast neutron dose one card TX23.

Card TX23		Format (6E12.5)
1 .	WLSTUE(K), K = 1,KTEM	Thermal conductivity at the temperature mesh points. (W / cm / °C)

Card KX1		Format (5E10.3,4I5)
1	EPSI1	> 0.: Relative criterion of convergency for gas temperature. = 0.: Default value = 1.E-5
2	EPSI2	> 0.: Criterion of convergency for mass flow. = 0.: Default value = 0.01
3	OVM1	> 0.: Extrapolation factor for iterations on mass flow (every 10 iterations an extrapolation is provided with 1 + OVM1). = 0.: Default value = 0.5
4	OVM2	> 0.: Relaxation factor for iterations on mass flow. = 0.: Default value = 1.0
5	EPSI4	> 0.: Relative criterion of convergency of the avg. gas tem-

		peratureure in the outer iterations between gas temperature and mass flow. = 0.: Default value = 0.02
6	ITM1	> 0: Maximum number of iterations for gas temperature. = 0: Default value = 100
7	ITM2	> 0: Maximum number of iterations for mass flow. = 0: Default value = 200
8	ITM3	> 0: Maximum number of outer iterations between gas temperature and mass flow. = 0: Default value = 5

Card KX2		Format (5E10.3,4I5)
1	DKUG	> 0.: Diameter of the spheres. (cm) = 0.: Default value = 6.0
2	EPSI	> 0.: Void fraction in the core. = 0.: Default value = 0.39
3	CP	> 0.: Specific heat capacity of the gas. (J/Kg/°K) = 0.: Default value = 5195.
4	PRAN	> 0.: Prandtl-constant of the gas. = 0.: Default value = 0.66
5	DRUCK	> 0.: Pressure of the gas. (bar)
6	IFZDR	= 0: Pressure of the system is constant. = 2: Pressure changes according to temperature. Gas inventory is constant.

One card KX3 for each of the KONVEK compositions as defined on the first set of cards TX9.

Card KX3		Format (5I6,7E6.0)
1	KR	Id.no. of this composition.

2	IFBQ	= 0: When IFTV = -1 on card TX10. Convective heat source is computed in the meshes of this composition. = -1: No convective heat source evaluation (e.g. in voids).
3	IFBR	Type of composition: = 0: No gas streaming. = 1: Pebble bed. = 2: Vertical pipes. (≤ 8) = 5: Horizontal void (no more than one mesh over its thickness).
4	IFZST	= 0: No time dependent mass flow. = 1: Given by input on cards KX4, KX5. = 2: Mass flow according to conservation law.
5	IFZTF	= 0: No time dependent gas inlet temperature. = 1: Given by input on cards KX4, KX5.
6	PVOR	> 0.: Pressure at beginning of iterations. (bar) = -1.: Pressure = pressure of the gas (see DRUCK on card KX2).
7	XKON	Additional pressure drop relative to computed pressure drop over the length of the channel (only when IFBR = 2). (1/cm)
8	ALPHA	> 0.: Coefficient of heat transition between gas and solid material (W/cm^2K). In pebble beds α is internally calculated, use ALPHA = 1. as an internal multiplication factor. = 0.: Internal calculation of α. In voids (IFBR = 5) use $\alpha = 0$.
9	EPSIL	Volumetric fraction of void in this composition.
10	DHYD	Hydraulic diameter (cm). Only when IFBR $\geq$ 2.
11	STZUK	Source of mass flow. (kg/s)
12	TFLVOR	Temperature of inlet gas. (°C)

Cards KX4, KX5 only when at least one of the IFZST and/or IFZTF = 1 on cards KX3.
Up to 100 time steps can be defined by cards KX5. Linear interpolation is provided between the time steps.

Card KX4		Format (4I10)
1	IZK1	Number of compositions with time dependent input of mass flow and/or gas inlet temperature. (≤ 3)
2 .	IZKOM(I), I = 1,IZK1	Id.no. of the I-th composition.

Card KX5		Format (8F9.3)
1	ZVOR	> 0.: Time. (min) = 0.: End of the input of cards KX5.
2	ZDR	Pressure. (bar)
3	ZST(I)	Source of mass flow of the composition no. IZKOM(I). (kg/s) (Only when IFZST(I) = 1).
4 . .	ZTF(I) I = 1,IZK1	Temperature of inlet gas of the composition no. IZKOM(I). (°C) (Only when IFZTF(I) = 1).