Operator CALC_MAC3COEUR

1 Goal

Macro-order dedicated to the fuel assemblies. The goal is to evaluate:

- that is to say deformation of the fuel assemblies subjected to loadings thermics, hydraulics and neutronics;
- that is to say water interassemblies blades at the beginning of cycle of an engine.

2 Syntax

```
U = CALC_MAC3COEUR   (

♦  TYPE_COEUR    =  type of heart to be treated                    [K]
                    / 'MONO',
                    / 'MONO_COLD',
                    / 'TEST',
                    / '900',
                    / '1300',
                    / 'N4',
                    / 'LINE900 ',
                    / 'LINE1300 ',
                    / 'LINEN4',

    If TYPE_COEUR is of type ' LINE '
   ♦  /  NB_ASSEMBLAGE    =  nbass                    [I]


Table containing information of the engine to the cycle N
♦  /  TABLE_N       =                                  [table]

Grid of the engine to the cycle N
♦  /  MAILLAGE_N    =                                  [grid]

Contractual fluence by "last" cycle
♦  /  FLUENCE_CYCLE=                                   [R]

Standard deformation
 ◊ /  TYPE_DEFORMATION =   / 'RIGI_GEOM'              [ DEFECT ]
                           / 'PETIT'
                           / 'GROT_GDEP'

Result on initial grid
◊  /  RESU_DEF  =                                      [CO]

◊  ETAT_INITIAL =_F (

                  Unit of the file containing loading THYC
                  ♦  /  UNITE_THYC       =           [I]

                  Value of the fluence to be reached
                  ♦  /  NIVE_FLUENCE     =  /  0. ,                  [DEFECT]
                                            /  R,                    [R]

                  Type of the effort of maintenance
                  ◊  /  TYPE_MAINTIEN    =  /  'DEPL_PSC'          [DEFECT]

                  Taking into account of the push of Archimedes
                  ◊  /  ARCHIMEDES       =  /  'YES'                [DEFECT]

           ),


 ◊ DEFORMATION  =_F (

                  Result containing the initial state
```

◊ / RESU_INIT = [result]
Unit of the file containing loading THYC
♦ / UNITE_THYC = [I]

◊ / TEMP_IMPO = [R]

Value of the fluence to be reached
♦ / NIVE_FLUENCE = [R]
option of blocking of the grids
◊ / MAINTIEN_GRILLE = / 'NON' [DEFECT]
/ 'OUI'

1. case of a heart multi-assembly (TYPE_COEUR ≠ 'MONO')
Type of the effort of maintenance
◊ / TYPE_MAINTIEN = / 'DEPL_PSC' [DEFECT]

Taking into account of the push of Archimedes
◊ / ARCHIMEDES = / 'YES' [DEFECT]

2. cases of a heart mono-assembly (TYPE_COEUR = 'MONO')
Type of the effort of maintenance
♦ / TYPE_MAINTIEN = / 'DEPL_PSC'
/ 'FORCE'
Value of the gripping force if TYPE_MAINTIEN = 'FORCE'
♦ / FORCE_MAINTIEN = [R]

Taking into account of the push of Archimedes
♦ / ARCHIMEDES = / 'YES'
/ 'NOT'

),

◊ BLADE =_F (

Unit of the file containing loading THYC
♦ / UNITE_THYC = [I]

♦ / COEF_MULT_THV = /1, [DEFECT]
coeff, [R]

♦ / COEF_MULT_THT = /1, [DEFECT]
coeff, [R]

)

U is of type evol_noli .

3 Operands

3.1 Operand TYPE_COEUR

Name of the type of heart to be treated.

The case 'TEST' represent a fictitious heart with five fuel assemblies, laid out in cross.
The case 'MONO' represent an assembly alone (either a fictitious heart mono-assembly, without taking into account of the contact with the interns of tank) in temperature "hot heart" .
The case 'MONO_COLD' represent an assembly alone (either a fictitious heart mono-assembly, without taking into account of the contact with the interns of tank) with room temperature.
Cases 'LIGNEXXX' (with XXX=' 900 ','1300' or 'N4') represent a calculation of line for each design of stage.
One will refer to the reference material [R7.06.01], in particular for all that relates to the loadings and the various reference marks used.

3.2 Operand NB_ASSEMBLAGE

In the case of one heart of type 'LIGNEXXX' (with XXX=' 900 ','1300' or 'N4'), this keyword allows to specify the length of the line.

3.3 Operand TABLE_N

Table (with format DAMAC) containing the information of the assemblies (position, design and deformation mainly).
For a calculation 'DEFORMATION' , it is the composition heart simulated cycle. For a calculation 'BLADE' , it is a question of the DAMAC from which one wants to calculate the water blades. For a calculation 'ETAT_INITIAL' , it is the DAMAC which one seeks to reproduce.

3.4 Operand MAILLAGE_N

Grid corresponding to the description of the heart: the design of the assemblies in the grid must correspond to the design provided in 'TABLE_N'.

3.5 Operand FLUENCE_CYCLE

"Contractual" fluence to take into account the initial irradiation of the assemblies: the initial irradiation of each assembly is taken equal to N time 'FLUENCE_CYCLE' with N the number of last cycles of the assembly, given in 'TABLE_N'.
With a value of FLUENCE_CYCLE=0, all the assemblies will thus have a worthless initial irradiation.
Note: CE keyword is not taken into account for a calculation DEFORMATION with RESU_INIT, because in this case the initial irradiation of each assembly is resulting from the result given in RESU_INIT.

3.6 Operand TYPE_DEFORMATION

Allows to choose a taking into account of kinematics 'RIGI_GEOM' (SMALL with option RIGI_GEOM=' OUI'), 'SMALL' or 'GROT_GDEP' who will have passed to STAT_NON_LINE in calculation.

3.7 Operand DEFORMATION

Keyword factor which specifies that the macro-order is used here to calculate the deformations of the fuel assemblies in configuration heart.

3.7.1 Operand RESU_INIT

Possibility of giving a result in initial state. This keyword is useful in the case of realization of several cycles of irradiation.

3.7.2 Operand UNITE_THYC

Logical unit in which file THYC as starter is given of CALC_MAC3COEUR containing the axial and transverse hydraulic loadings.

3.7.3 Operand TEMP_IMPO

Value of constant temperature. Activate the simple calculation of dilation of the engine (without hydraulic contacts/frictions nor loadings).

3.7.4 Operand NIVE_FLUENCE

Value of the fluence received by the assemblies at the time of the cycle (in $10^{24} neutrons/m^2$).

3.7.5 Operand MAINTIEN_GRILLE

Allows to activate the option of blocking of the grids

3.7.6 Operand TYPE_MAINTIEN

In the case of hearts multi-assemblies (different from ' MONO ' or 'MONO_FROID'), this keyword is optional and only the value authorizes 'DEPL_PSC' (value by default) clarified below. The effort of maintenance is then generated by the displacement imposed by the Plate Superior of Heart (PSC) on the system of maintenance of each assembly. The value of this displacement is indicated in the file geometrical data (datg) of each heart considered.

In the case mono-assembly ('MONO' or 'MONO_FROID'), the keyword TYPE_MAINTIEN is obligatory, without value by default, and can take the values 'DEPL_PSC' or 'FORCE' :

- 'DEPL_PSC' : the effort of maintenance is then generated by one displacement imposed as described above; in this case the keyword FORCE_MAINTIEN is not expected;
- 'FORCE' : the effort of maintenance is then introduced by a force imposed fixes whose value is given by the keyword FORCE_MAINTIEN. This option makes it possible to accurately reproduce the experimental tests which are in particular used to readjust the model.

3.7.7 Operand FORCE_MAINTIEN

In the case mono-assembly ('MONO' or 'MONO_FROID'), this keyword makes it possible to provide the value (in Newtons) gripping force in the case TYPE_MAINTIEN=' FORCE'.

3.7.8 Operand ARCHIMEDES

In the case mono-assembly, the keyword ARCHIMEDES is obligatory, without value by default, and can take the values 'YES'or'NOT'. This keyword makes it possible to choose if the push of Archimedes is activated or not.
In the case of hearts multi-assemblies (different from 'MONO' or 'MONO_FROID'), this keyword is optional and authorizes only the value 'YES' (value by default): the push of Archimedes is always activated.

3.8 Operand BLADE

Keyword factor which specifies that the macro-order is used here to determine the water blades starting from a heart made up of deformed assemblies. For a calculation of water blade “end of cycle” (English EOC), it is

enough to provide the DAMAC measured in 'TABLE_N'. For a calculation of water blade "beginning of cycle" (English BOC), it is necessary to provide a DAMAC "reconstituted" starting from the known DAMAC and plan of heart; this "reconstituted" DAMAC is with the load of the user, and must be provided in 'TABLE_N'. The hydraulic efforts are taken into account by the loading defined in 'UNITE_THYC'.

3.8.1 Operand UNITE_THYC

Logical unit in which file THYC as starter is given of CALC_MAC3COEUR containing the axial and transverse hydraulic loadings.

3.8.2 OperandS COEF_MULT_THV and COEF_MULT_THT

Multiplicative coefficients for axial and transverse hydraulic loadings.

3.9 Operand ETAT_INITIAL

Keyword factor which specifies that the macro-order is used here to reconstitute the mechanical state starting from the observation of the deformations at the end of the cycle: this mechanical state can then be used as initial state in a posterior calculation.

3.9.1 Operand UNITE_THYC

Even use that in §3.8.1

3.9.2 Operand NIVE_FLUENCE

Even use that in §3.7.4.

3.9.3 Operand TYPE_MAINTIEN

Even use that in §3.7.6 in the case different from 'MONO'.

3.9.4 Operand ARCHIMEDES

Even use that in §3.7.8 in the case different from 'MONO'.

3.10 Operand RESU_DEF

In the case of the use of the operand 'BLADE', the result is provided on the grid deformed initially by the data of the deformations (Cf [R7.06.01] for the details of this operation) : the displacements provided by the concept result are thus to understand like displacement relative to this deformed grid and like displacement relating to the grid provided with the "right" assemblies. In practice, it is thus complicated to use such displacements. CALC_MAC3COEUR/BLADE thus propose L'operand 'RESU_DEF' who allows to recover a concept result which contains displacement on the initial grid not deformed, what makes it possible post-to treat displacements easily.
On the other hand, for postprocessings of type "blade of water", the results provided by the concept result of CALC_MAC3COEUR are perfectly usable.
The recommendation with a calculation of water blade is thus to as follows proceed:

```
RESU = CALC_MAC3COEUR (
    [...]
     RESU_DEF = CO ('RESUDEPL'),
    LAME=_F (
            [...]
        )
    )
```

```
# postprocessing of the water blades on RESU
POST_MAC3COEUR (
    RESULT = RESU ,
    […]
     BLADE =_F (
        […]
        ),
    )


# postprocessing of displacements on RESUDEPL
POST_MAC3COEUR (
    RESULT = RESUDEPL ,
    […]
     DEFORMATION =_F (
        […]
        ),
    )
```