Macro command MACR_ASPIC_CALC

1 Drank

To carry out a preset computation of operational or fissured bypasses, as well as the post - associated processing. **The lengths of the mesh produced by** MACR_ASPIC_MAIL **are in millimetres**, it is necessary to take of it account in the units of the characteristics material and the loading.

The main steps of the macro command are:

- assignment of the models mechanical and thermal by the command AFFE_MODELE,
- assignment of the materials by the command AFFE_MATERIAU,
- assignment of the characteristics of discrete elements by the command AFFE_CARA_ELEM (null stiffness),
- definition of the boundary conditions of fixed support of type beam with the connection 3D-beam by the command AFFE_CHAR_MECA,
- definition of the mechanical loading (pressure, basic effect, load vector force, thermal strain of origin) by the command AFFE_CHAR_MECA,
- definition of the thermal loading (temperature of fluid, coefficient of heat exchange) by the command AFFE_CHAR_THER_F,
- realization of linear thermal computation and or not linear linear mechanical computation by commands THER_LINEAIRE and STAT_NON_LINE, then computation of options by CALC_CHAMP,
- realization of the post processing by commands POST_RELEVE_T, or DEFI_FOND_FISS, CALC_THETA, CALC_G and POST_RCCM,
- printing of postprocessing by commands IMPR_RESU and IMPR_TABLE.

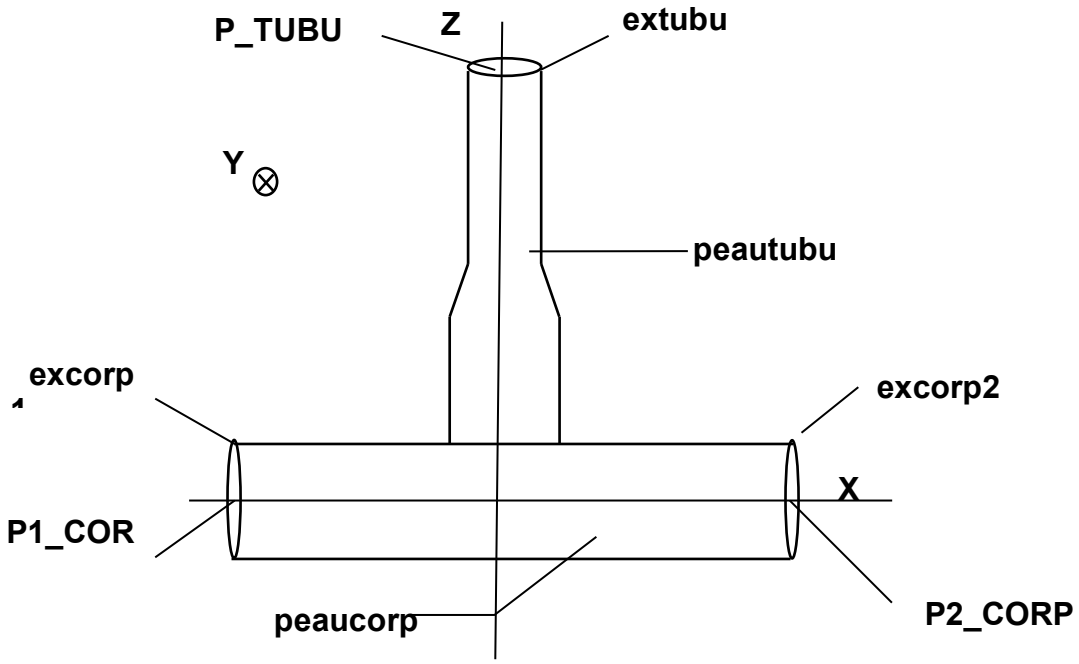
2 Syntax

```
resu [evol_noli]  = MACR_ASPIC_CALC      (

   ♦TYPE_MAILLAGE=/              "SAIN_FIN",                      [TXM]
                          /   "SAIN_GROS",                      [TXM]
                          /   "FISS_COUR_DEB",                  [TXM]
                          /   "FISS_COUR_NONDEB",               [TXM]
                          /   "FISS_LONG_DEB",                  [TXM]
                          /   "FISS_LONG_NONDEB",               [TXM]
                          /   "FISS_AXIS_DEB",                  [TXM]
                          /   "FISS_AXIS_NONDEB",               [TXM]

   ♦TUBULURE=_F             (
                ♦TYPE=/             "TYPE_1",                  [TXM]
                                 /   "TYPE_2",
                   ),

   ♦MAILLAGE=nom_maillage           ,                            [mesh]

   ◊  MODELE=           CO  ("modmec"),                         [TXM]

   ◊  CHAM_MATER=    CO  ("chmat"),                          [TXM]

   ◊  CARA_ELEM=        CO  ("carael"),                         [TXM]

   ◊  FOND_FISS_1=   CO  ("fonfiss1"),                       [TXM]

   ◊  FOND_FISS_2=   CO  ("fonfiss2"),                       [TXM]

   ◊  RESU_THER=        CO  ("resuth"),                         [TXM]

   ♦AFFE_MATERIAU=      _F (                  ♦/TOUT=' OUI',
                            /GROUP_MA     =  "TUBU",
                                            /"CORPS",
                                            /"SOUD",
                                            /"SOUDTUBU",
                                            /"SOUDCORP",
                           ♦MATER=materiau              ,          [to
subdue]
                           ◊TEMP_REF=/           0. ,
[DEFAULT]
                                            /tref  ,          [R]
                           ♦RCCM=/              "OUI',        [TXM]
                                            /"NON",
                      ),

   ♦EQUILIBRE=          _F (  ♦NOEUD=/              "P1_CORPS",
                                            /"P2_CORPS",
                      ),

   ♦PRES_REP=           _F (  ♦PRES=pres                 ,            [R]
                           ◊NOEUD=/             "P1_CORPS",
                                            /"P2_CORPS",
                           ◊EFFE_FOND=/         "OUI',        [DEFAULT]
                                            /"NON",
                           ◊PRES_LEVRE=/        "OUI',
                                            /"NON",          [DEFAULT]
                           ◊FONC_MULT=fmult1            ,     /
   [function]
                                                        /   [formula]
                      ),
```

```
      ◊ECHANGE=          _F (  ♦COEF_H_TUBU=htubu          ,          /
      [function]
                                                                 /   [formula]
                               ♦COEF_H_CORPS=hcorp         ,          /
      [function]
                                                                 /   [formula]
                               ♦TEMP_EXT=chtex             ,          /
      [function]
                                                                 /   [formula]
                            ),

      ◊TORS_CORPS=_F               ( ♦    NOEUD=/                 "P1_CORPS",
                                                          /   "P2_CORPS",
                               ♦   |   FX=fx              ,                  [R]
                                   |   FY=fy              ,                  [R]
                                   |   FZ=fz              ,                  [R]
                                   |   MX=mx              ,                  [R]
                                   |   MY=my              ,                  [R]
                                   |   MZ=mz              ,                  [R]
                               ◊FONC_MULT=fmult2                  ,      /
      [function]
                                                                 /   [formula]
                            ),

      ◊TORS_TUBU=           _F (  ♦   |   FX=fx              ,                  [R]
                                   |   FY=fy              ,                  [R]
                                   |   FZ=fz              ,                  [R]
                                   |   MX=mx              ,                  [R]
                                   |   MY=my              ,                  [R]
                                   |   MZ=mz              ,                  [R]
                               ◊FONC_MULT=fmult3              ,      /
      [function]
                                                                 /   [formula]
                            ),

         |      COMP_ELAS= _F (  ♦RELATION=/              "ELAS",
                                                        /"ELAS_VMIS_TRAC",
                            ),

      ◊THETA_3D=            _F (  ♦R_INF=r_inf                  ,          [R]
                                  ♦   R_SUP=r_sup               ,          [R]
                            ),

      ◊OPTION=/                    "CALC_G_MAX",
                            /   "CALC_G_MAX_LOCAL",

   # If OPTION = CALC_G_MAX or CALC_G_MAX_LOCAL
      ◊BORNES=              _F (
                                  ♦    NUME_ORDRE=num          ,          [I]
                                  ♦    VALE_MIN=qmin           ,          [R]
                                  ♦    VALE_MAX=qmax           ,          [R]
                            ),
   # Finsi

      ◊SOLVEUR=             (see the document [U4.50.01])

      ◊CONVERGENCE=         (see the document [U4.51.03])

      ◊NEWTON=                 (see the document [U4.51.03])

      ◊RECHERCHE_LINEAIRE=        (see the document [U4.51.03])
```

```
    ♦INCREMENT=              (see the document [U4.51.03])

    ◊PAS_AZIMUT=/1                ,                                  [DEFAULT]
                           /pas      ,                                [I]

    ◊IMPRESSION=      _F (  ◊   /FORMAT           =      "RESULTAT",
[DEFAULT]
                                                  /   "ASTER",       [TXM]
                                                  /   "CASTEM",      [TXM]
                                                  /   "IDEAS",       [TXM]


# If FORMAT = "IDEAS" or "CASTEM"
          ◊NOM_CHAM=              | "DEPL",                          [TXM]
                                  | "SIEQ_ELNO",
                                  | "TEMP",
                     ◊TOUT_ORDRE=' OUI'  ,                           [TXM]
          ◊NUMÉRIQUE_ORDRE=lordre          ,                            [l_I]
          ◊INST=linst                     ,                          [l_R]
# Finsi


# If FORMAT = "CASTEM"
                                  ◊NIVE_GIBI=/        3,
                                                    /10,       [DEFAULT]

# If FORMAT = "IDEAS"
                                  ◊VERSION=/          4,
                                                    /5,        [DEFAULT]
                        ),

    ◊TITER=nom_titer                                                 [l_Kn]

    ◊INFO=/                 1   ,
[DEFAULT]
                        /2  ,                                        [I]
                                    )
```

3 Operands



Appears 3-a: Mesh obtained

One notes:

- peautubu : the skin interns pipe,
- peaucorp : the skin interns body,
- excorp1 : the extreme section of the body, located at the dimension X = - Xmax,
- excorp2 : the extreme section of the body, located at the dimension X = +Xmax,
- P1_CORP : the node located at the center of excorp1,
- P2_CORP : the node located at the center of excorp2,
- extubu : the extreme section of the pipe, located at the dimension Z = Zmax,
- P_TUBU : the node located at the center of extubu.

Notice 3-1:

Mesh groups TUBU , CORPS and SOUD are present only in the case of the operational bypass. They are replaced by TUBU and SOUDCORP or by SOUDTUBU and CORPS, according to the type of weld (1 or 2) and the position of crack (right or inclined) (see [§3.11.1]).

3.1 Key word TYPE_MAILLAGE

♦TYPE_MAILLAGE =

/"SAIN_GROS"	computation is carried out on an operational bypass built with the option RAFF_MAIL = "GROS" in MACR_ASPIC_MAIL.
/"SAIN_FIN"	computation is carried out on an operational bypass built with the option RAFF_MAIL = "FIN" in MACR_ASPIC_MAIL.
/"FISS_COUR_DEB"	computation is carried out on a bypass fissured (fracture mechanics) with an emerging short crack.
/"FISS_COUR_NONDEB"	computation is carried out on a bypass fissured (fracture mechanics) with a short crack not emerging.
/"FISS_LONG_DEB"	computation is carried out on a bypass fissured (fracture mechanics) with an emerging long crack.
/"FISS_LONG_NONDEB"	computation is carried out on a bypass fissured (fracture mechanics) with a long crack not emerging.
/"FISS_AXIS_DEB"	computation is carried out on a bypass fissured (fracture mechanics) with an emerging axisymmetric crack.
/"FISS_AXIS_NONDEB"	computation is carried out on a bypass fissured (fracture mechanics) with an axisymmetric crack not emerging.

Information already given by the user in the macro-command of mesh MACR_ASPIC_MAIL must be repeated here to determine the type of computation and of postprocessing to be made.

The table below recapitulates the configuration of the crack tip, and the processing carried out for each crack position in the square, in the case of a bypass with crack.

One will refer to the note of use of the operators of fracture mechanics [U2.05.01] or to the various reference documents [R7.02.01; R7.02.03; R7.02.04; R7.02.05; R7.02.07] for more detail on computation of the G-room.

Emerging cracks or not	Standard crack	Configuration crack tip	Computation of G_Local
emerging Cracks	short	a crack tip **not closed**	Legendre-Legendre
	long	a crack tip **not closed**	Legendre-Legendre
	axisymmetric	a crack tip **closed**	Lagrange-Lagrange
short Cracks not	emerging	a crack tip **closed**	Lagrange-Lagrange
	long	**two** not **closed crack tips**	Legendre-Legendre
	axisymmetric	**two** closed **crack tips**	Lagrange-Lagrange

Table 3.1-1: The various configurations of the crack tip

Notices 3-2:

As soon as a crack is defined in the model, a checking of the interpenetration of the lips is carried out for all time step. If an interpenetration is detected, an alarm message is transmitted to announce it. It is pointed out that the contact is not taken into account in computation. The rate of

refund of energy G is thus positive including where the crack tends to close again, which can lead to too penalizing results.

Notice 3-3:

In the case of long cracks not emerging, two crack tips are netted because the connection at each end is not with a grid.

For the operational bypasses, one calculates in postprocessing the stresses according to the modes of opening IF, software firm and SIII:

	IF	standard	software firm
SIII weld 1 right interface (cylindrical coordinate system)	siXX	siXY	siXZ
standard weld 1 tilted interface (local coordinate system)	siYY	siXY	– siYZ
standard weld 2 right interface (local coordinate system)	siYY	siXY	– siYZ
standard weld 2 tilted interface (local coordinate system)	siYY	siXY	– siYZ

Table 3.1-2: Forced according to the modes of opening

Notices 3-4:

The sign – obtained on SIII in the local coordinate system is explained by the difference between the local coordinate system chosen by the SEPTEN and that of the Code_Aster.

3.2 Key word factor TUBULURE

♦TUBULURE = "TYPE_1", [DEFAULT]
/"TYPE_2", [TXM]

Points out the type of weld defined in MACR_ASPIC_MAIL to define the references of examination of postprocessings.

3.3 Key word MAILLAGE

♦MAILLAGE = mesh

One specifies here the mesh used. This mesh is resulting from MACR_ASPIC_MAIL.

3.4 Key word MODELS

◊ MODELS = CO ("modmec")

This key word makes it possible to name possibly the model mechanical in order to re-use it, for example to do another calculation (not using MACR_ASPIC_CALC) or of postprocessing.

3.5 Key word CHAM_MATER

◊ CHAM_MATER = CO ("chmat")

This key word makes it possible to possibly name the field material corresponding to the mechanical model in order to re-use it, for example to do another calculation (not using MACR_ASPIC_CALC) or of postprocessing.

If it is about a thermomechanical computation, the field of temperature calculated is associated with the field material (command variable, cf [U4.43.03]). Thermal thermal expansion due to the field of temperature is thus taken into account if one re-uses in another computation this field material.

3.6 Key word CARA_ELEM

◊ CARA_ELEM = CO ("carael")

This key word makes it possible to possibly name the concept of the type cara_elem (command AFFE_CARA_ELEM) in order to re-use it, for example to do another calculation (not using MACR_ASPIC_CALC).

3.7 Key word FOND_FISS_1

◊ FOND_FISS1 = CO ("fonfiss1")

This key word makes it possible to possibly name the concept fond_fiss (command DEFI_FOND_FISS) in order to re-use it, for example to do another calculation (not using MACR_ASPIC_CALC) or of postprocessing.

3.8 Key word FOND_FISS_2

◊ FOND_FISS2 = CO ("fonfiss2")

This key word makes it possible to possibly name the concept fond_fiss (command DEFI_FOND_FISS) in order to re-use it, for example to do another calculation (not using MACR_ASPIC_CALC) or of postprocessing. One uses it if the crack comprises two crack tips, (see [§3.1]).

3.9 Key word RESU_THER

◊ RESU_THER= CO ("resuth")

This key word makes it possible to name possibly result thermal computation, for example to do another calculation (not using MACR_ASPIC_CALC) or of postprocessing.

3.10 Key word factor AFFE_MATERIAU

♦AFFE_MATERIAU = F (

Key word factor allowing to affect various materials on parts of the mesh.

3.10.1 Operands TOUT, GROUP_MA

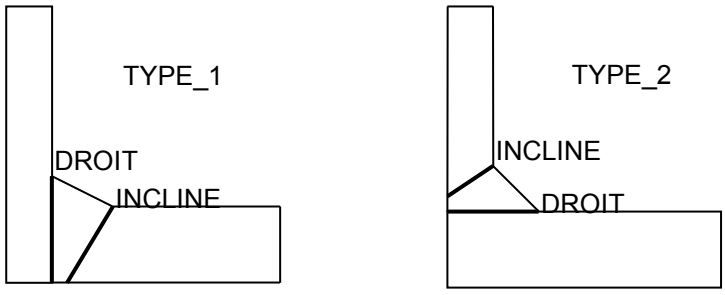
```
                  ♦/TOUT=' OUI',
/GROUP_MA          =  "TUBU"   ,
                     /"CORPS"  ,
                     /"SOUD"   ,
                     /"SOUDTUBU"  ,
                     /"SOUDCORP"  ,
```

These keys key make it possible to affect the material on all meshes mesh (TOUT), or on part of mesh (GROUP_MA).

For the "operational" bypasses, one can affect:
"TUBU" : the pipe,
"CORPS" : the body,
"SOUD" : the weld.

For the bypasses with right crack if the weld is of type 1 or with tilted crack if the weld is of type 2, one can affect:
"TUBU" : the pipe,
"SOUDCORP" : the group weld - body.

For the bypasses with tilted crack if the weld is of type 1 or with right crack if the weld is of type 2, one can affect:
"CORPS" : the body,
"SOUDTUBU" : the group weld - pipe.



Appears 3.11.1-a: Definition of the position of a crack according to the type of the weld

3.10.2 Operand MATER

♦MATER

Name of the material which one wants to affect.

3.10.3 Operand RCCM

```
♦RCCM   =          "OUI',
                /   "NON",
```

Is used to specify if one wants to make a postprocessing of type POST_RCCM. **Attention** if the characteristics material necessary to POST_RCCM are not defined in a command DEFI_MATERIAU preceding MACR_ASPIC_CALC (key keys factor RCCM or RCCM_FO,) computation will stop in **fatal error** at the time to carry out POST_RCCM.

3.10.4 Operand TEMP_REF

◊TEMP_REF

Reference temperature for which there is no thermal strain (cf orders AFFE_MATERIAU).

3.11 Key word factor BALANCES

♦EQUILIBRE

One defines a fixed support of type beam in the one of two ends (P1_CORPS or P2_CORP). The 6 degrees of freedom of the discrete point are thus blocked.

Note:

There exists a connection 3D-beam between the discrete nodes P1_CORP , P2_CORP and P_TUBU and respectively excorp1 , excorp2 and extubu which is the sections ends of the body and the pipe.

3.11.1 Operand NOEUD

```
♦NOEUD  =      "P1_CORPS",
              /   "P2_CORPS",
```

Node of application of the fixed support.

3.12 Key word factor PRES_REP

3.12.1 Operands NEAR

♦PRES=pres

One indicates here the value of the pressure which applies to the internal skin.

3.12.2 Operands NOEUD / EFFE_FOND

```
◊NOEUD=/          "P1_CORPS",
          /   "P2_CORPS",
```

the face of application of the basic effect Determines on the body.
An operand is compulsory in the event of taking into account of the basic effect.

Note:

If the equilibrium is applied to node P1_CORP then the basic effect will be applied to the face associated with P2_CORP , and reciprocally. The macro-command checks that the position chosen for the equilibrium is different from the position of the basic effect on the body.

```
◊EFFE_FOND=/            "OUI',      [DEFAULT]
                      /"NON",
```

Indicator of taking into account of the basic effect.

The basic effect is applied to the face associated with node P_TUBU and the one with the two sides ends with the body (partner to node P1_CORP or P2_CORP). It is calculated in an automatic way according to the pressure exerted on the internal wall, according to the formula and is applied below with PRES_REP. $Tfond = pres * \frac{R_i^2}{R_e^2 - R_i^2}$

Note:

For the pipe, one will take radius corresponding to the part located at the top of the chamfer.

3.12.3 Operand PRES_LEVRE

◊PRES_LEVRE

Makes it possible to activate or not the application of the pressure, evoked with [§3.13.1] of this document, on the lips of crack when this one emerges in intern skin. By default PRES_LEVRE is worth "NON".
Attention to be used PRES_LEVRE = "OUI' only for the cracks which emerge in intern skin.

3.12.4 Operand FONC_MULT

◊FONC_MULT=fmult1

multiplying Function of the time of the loading of pressure. By default: fmult1 = 1.

3.13 Key word factor ECHANGE

◊ECHANGE = F (

This factor key word makes it possible to apply conditions of exchange to the internal skin of the bypass (cf orders AFFE_CHAR_THER_F) and to carry out a linear thermal computation (with THER_LINEAIRE) preliminary to mechanical computation. For the thermal, one uses the solver by default, the value of the parm_theta by default and the initial temperature temp_init is calculated from a steady computation and is worth the temperature of the fluid at initial time (TEMP_EXT).

3.13.1 Operands COEF_H_TUBU and COEF_H_CORP

♦COEF_H_TUBU=htubu ,
♦ COEF_H_CORP=hcorp ,

Value of the coefficient of heat exchange on the skin intern pipe (PEAUTUBU) and body (PEAUCORP), given in the form of function.

3.13.2 Operand TEMP_EXT

♦TEMP_EXT=chtex

Value of the temperature of the fluid inside the bypass, data in the form of function.

3.14 Key word factor TORS_CORP

◊TORS_CORPS

This key word is used to take into account the load vector force on the body.

3.14.1 Operand NOEUD

♦NOEUD = "P1_CORPS",
/ "P2_CORPS",

One indicates the position of the torsor here. If the equilibrium is given for P1_CORP (key word BALANCES) the torsor then will be applied to P2_CORP. The macro-command checks that the position chosen for the equilibrium is different from the position of the load vector force on the body.

3.14.2 Operands FX, FY, FZ, MX, MY, MZ

♦ | FX =FX , [R]
| FY =FY , [R]
| FZ =FZ , [R]
| MX =MX , [R]
| MY =MY , [R]
| MZ =mz , [R]

One informs the load vector force here. The components must be provided in the reference of the mesh. At least one of the components must be indicated.

3.14.3 Operand FONC_MULT

◊FONC_MULT=fmult2

multiplying Function of the time of loading TORS_CORP. By default: fmult2 = 1.

3.15 Key word factor TORS_TUBU

◊TORS_TUBU

This key word is used to take into account the load vector force on the pipe. It is applied at the end of the pipe to node P_TUBU.

3.15.1 Operands FX, FY, FZ, MX, MY, MZ

♦ | FX =FX , [R]
| FY =FY , [R]
| FZ =FZ , [R]
| MX =MX , [R]
| MY =MY , [R]
| MZ =mz , [R]

One informs the load vector force here. The components must be provided in the reference of the mesh. At least one of the components must be indicated.

3.15.2 Operand FONC_MULT

◊FONC_MULT=fmult3

multiplying Function of the time of loading TORS_TUBU. By default: fmult3 = 1.

3.16 Key word factor COMP_ELAS

♦RELATION =

Standard of elastic behavior model used to carry out mechanical computation with STAT_NON_LINE.

/ Linear "ELAS " Behavior elastic.

/ "ELAS_VMIS_TRAC" Nonlinear elastic behavior of Von Mises with nonlinear isotropic hardening.

3.17 Operand THETA_3D

◊THETA_3D

For postprocessing in fracture mechanics, this key word defines radius the contours surrounding the crack tip and used in the method theta. This key word is répétable as many times as one wants. The choice of several couples of radius makes it possible to check the stability of the method.

The contact is not taken into account in computation, but an alarm message is transmitted if the two lips of crack interpenetrate. In this case, the rate of refund of energy G will remain positive including where the crack tends to close again, which can lead to too penalizing results.

3.17.1 Operands R_INF/R_SUP

```
◊R_INF=r_inf                    [R8]
◊R_SUP=r_sup                    [R8]
```

r_inf and r_sup are respectively radius the lower and superiors of contours defining the field theta, cf [U4.82.03].

3.18 Operand OPTION

```
◊OPTION=/              "CALC_G_MAX"        ,
        /   "CALC_G_MAX_LOCAL"  ,
```

This option relates to only the maximization of G (total or local) under stresses limits [R7.02.01]. It is then necessary also to provide the value of the stresses limits behind the key word factor BORNES. Attention, this option does not make it possible to distinguish the loadings leading to an opening or a closing from crack.
The fields theta and G (S) are defined with a lissage of the type Lagrange (cf [U4.82.03]).

3.19 Factor key word BORNES

```
◊    BORNES=_F     (
        ♦  NUME_ORDRE    =num        ,    [I]
        ♦VALE_MIN        = qmin   ,    [R]
        ♦VALE_MAX        = qmax   ,    [R]
              )
```

This key word factor is compulsory if one uses option "CALC_G_MAX" or option "CALC_G_MAX_LOCAL". The syntax of this key word is described in the document [U4.82.03], with in particular an example of maximization of G in the presence of signed and not signed stresses.

3.20 Operand solver

One defines the solver retained for mechanical computation. The syntax of this key word is described in the document [U4.50.01]. It is used only for mechanical computation.

3.21 Operand CONVERGENCE

Specifies the convergence criteria of mechanical computation. The syntax of this key word is described in the document [U4.51.03]. It is used only for mechanical computation.

3.22 Operand NEWTON

Specifies the characteristics of the method of resolution of the nonlinear incremental mechanical problem. The syntax of this key word is described in the document [U4.51.03]. It is used only for mechanical computation.

3.23 Operand RECH_LINEAIRE

Specifies the linear mode of search of the solver. The syntax of this key word is described in the document [U4.51.03]. It is used only for mechanical computation.

3.24 Operand INCREMENT

during Defines the intervals of time taken in the incremental method a linear or mechanical thermal computation nonlinear. Time step used for computations thermal and mechanics are identical. The syntax of this key word is described in the document [U4.51.03].

3.25 Key word PAS_AZIMUT

```
◊PAS_AZIMUT=          /1     ,                          [DEFAULT]
                      /pas       ,                        [I]
```

This key word makes it possible to limit the examinations in the case of the operational bypasses. In the case of the refinement of coarse/fine mesh: one strips by default on 40 azimuts/48 azimuths with the 2 interfaces right and tilted.

3.26 Operand PRINTING

```
◊IMPRESSION=_F          ( ◊/FORMAT=/                "RESULTAT"    ,
[DEFAULT]
                                          /  "ASTER"       ,   [TXM]
                                          /  "CASTEM"      ,   [TXM]
                                          /  "IDEAS"       ,   [TXM]

# If FORMAT = "IDEAS" or "CASTEM"
          ◊NOM_CHAM=              | "DEPL"            ,          [TXM]
                                  | "SIEQ_ELNO",
                                  | "TEMP"            ,
                    ◊TOUT_ORDRE=' OUI'  ,                        [TXM]
          ◊NUMÉRIQUE_ORDRE=lordre          ,                     [l_I]
          ◊INST=linst                      ,                     [l_R]
# Finsi

# If FORMAT = "CASTEM"
                                  ◊NIVE_GIBI=/        3,
                                                    /10,          [DEFAULT]

# If FORMAT = "IDEAS"
                                  ◊VERSION=/          4,
                                                    /5,         [DEFAULT]
                        )
```

Makes it possible to define a format for the printing of the results, "RESULTAT", "ASTER", "CASTEM" or "IDEAS", (see the user's documentation of the command IMPR_RESU).

Note:

In the cases of a cracked mesh or healthy, following postprocessings are carried out:

1 Cracked mesh

- Printing in the results file of the field of temperature in crack tip for each time step calculated, (if it were calculated and if there is only one crack tip, cf [§ 3.1]);
- Printing in the results file of the table of total rate of energy restitution in crack tip (option CALC_G_GLOB of CALC_G) and, if requested, of maximum rate of energy restitution under stresses limits;
- Printing, at the request of the user, format CASTEM or IDEAS of the mesh and the following fields:

  "DEPL"
  "SIEQ_ELNO"
  "TEMP"

2 Sane mesh

- Printing in the results file of the stress fields principal IF, software firm, SIII (SIEQ_ELNO) for all time step and all lines of examination requested by the user;
- Printing in the results file of the field of temperature (if it were calculated) for all time step and all lines of examination requested by the user;
- Printing in the results file of the stress fields Pm and Pm+Pb (POST_RCCM) for all the lines of examination requested by the user;
- Printing in the results file of the parameters characterizing the distribution of temperature (if it were calculated) in the thickness of the ligament for all time step and all the lines of examination requested by user (POST_RELEVE_T, OPERATION = "AVERAGE").

3.27 Operand TITER

Titrates data structure result [U4.03.01].

3.28 Operand INFO

◊INFO=

Indicates the level of printing of the results of the operator:

1: no printing,
2: printing of relative information to the mesh.

To have the detail of the operators called by the macro-command in the message file, it is necessary to specify IMPR_MACRO=' OUI' in the command debut.

4 Examples

Besides the example of thermomechanical computation elastic describes here, one will be able to consult the command files (fichier.comm) of the cases tests. The latter are in the /aster/STA9/astest directory and bear the names aspic *. RESU

```
=MACR_ASPIC_CALC (TYPE_MAILLAGE=' FISS_AXIS_DEB', TUBULURE
                    =_F (TYPE=' TYPE_1',), MAILLAGE
                    =MA, MODEL
                    =CO ("MOMEC"), CHAM
                    _MATER=CO ("CHMAT"), CARA
                    _ELEM=CO ("CARAEL"), BOTTOM
                    _FISS_1=CO ("FD_FISS"), CHARGE
                    =CO ("CHMETH"), RESU
                    _THER=CO ("RESUTH"), AFFE
                    _MATERIAU=_F (TOUT=' OUI', MATER
                                    =TU42C, RCCM
                                    = ' NON', TEMP
                                    _REF=220.0,), EQUILIBRE
                    =_F (NOEUD=' P1_CORPS',), NEAR
                    _REP=_F (PRES=7.45, NOEUD
                                = ' P2_CORPS', EFFE
                                _FOND=' OUI',), ECHANGE
                    =_F (COEF_H_TUBU=COEFHTUB, COEF
                               _H_CORPS=COEFHCOR, TEMP
                               _EXT=VARTEMP,), TWISTED
                    _CORPS=_F (NOEUD=' P2_CORPS', FX
                                 =-1789.0, FY
                                 =120.0, FZ
                                 =480.0, MX
                                 =-7.3E5, MY
                                 =7.01E5, MZ
                                 =3.25E5, FONC
                                 _MULT=VARP,), TWISTED
                    _TUBU=_F (FX=3.5450E4, FY
                                 =5984.0, FZ
                                 =-9496.0, MX
                                 =8.985E6, MY
                                 =-2.3797E7, MZ
                                 =-1.699E7, FONC
                                 _MULT=VARP,), COMP
                    _ELAS=_F (RELATION=' ELAS',), THETA
                    _3D= (_F (R_INF=0.2, R_
                                 SUP=1.0,), _F
                              (R_INF=0.5, R_
                                 SUP=1.5,),), NEWTON
                    =_F (REAC_INCR=50, MATRICE
                               = ' ELASTIQUE', REAC
                               _ITER=10,), INCREMENT
                    =_F (LIST_INST=LISTE,), PRINTING
                    =_F (FORMAT = "CASTEM", NOM_CHAM
                                  = ("DEPL", "SIEQ_ELNO", "TEMP
                                                "), INST
                                  = (1.0, 20.0),),)
```