Operators AFFE_CHAR_THER and AFFE_CHAR_THER_F

1 Drank

To affect thermal loadings and boundary conditions on a model.

For the operator AFFE_CHAR_THER, the affected values do not depend on any parameter and are defined by actual values.

For the operator AFFE_CHAR_THER_F, the values are function of one or two parameters to be chosen as a whole (INST, X, Y, Z) or of temperature TEMP in nonlinear thermal.

These functions must be defined beforehand by the call to one of the operators:

- DEFI_CONSTANTE [U4.31.01]
- DEFI_FONCTION [U4.31.02]
- DEFI_NAPPE [U4.31.03]
- CALC_FONC_INTERP [U4.32.01]

the product concept is of char_ther type.

2 General syntax

```
CH  [char_ther]  =AFFE_CHAR_THER

          (  ♦MODELE    =mo   ,
[model]

             ♦  |  TEMP_IMPO =       (see key word TEMP_IMPO         )
                |  FLUX_REP =        (see key word FLUX_REP       )
                |  RAYONNEMENT =     (see key word RAYONNEMENT    )
                |  ECHANGE =         (see key word ECHANGE        )
                |  SOURCE =          (see key word SOURCE         )
                |  PRE_GRAD_TEMP =   (see key word PRE_GRAD_TEMP  )
                |  LIAISON_DDL =     (see key word LIAISON_DDL    )
                |  LIAISON_GROUP =   (see key word LIAISON_GROUP  )
                |  LIAISON_MAIL =    (see key word LIAISON_MAIL      )
                |  ECHANGE_PAROI =   (see key word ECHANGE_PAROI  )
                |  LIAISON_UNIF =    (see key word LIAISON_UNIF      )
                |  LIAISON_CHAMNO=   (see key word LIAISON_CHAMNO )
                |  CONVECTION=       (see key word CONVECTION     )
           )


CH  [char_ther]  =AFFE_CHAR_THER_F

           ( ♦  MODELS =mo   ,
[model]

             ♦  |  TEMP_IMPO =       (see key word TEMP_IMPO         )
                |  FLUX_REP =        (see key word FLUX_REP       )
                |  FLUX_NL =         (see key word FLUX_NL        )
                |  RAYONNEMENT =     (see key word RAYONNEMENT    )
                |  ECHANGE =         (see key word ECHANGE        )
                |  SOURCE =          (see key word SOURCE         )
                |  PRE_GRAD_TEMP=    (see key word PRE_GRAD_TEMP  )
                |  LIAISON_DDL =     (see key word LIAISON_DDL    )
                |  LIAISON_GROUP =   (see key word LIAISON_GROUP  )
                |  ECHANGE_PAROI =   (see key word ECHANGE_PAROI  )
                |  LIAISON_UNIF =    (see key word LIAISON_UNIF      )
                |  CONVECTION =      (see key word CONVECTION     )
                |  SOUR_NL =         (see key word SOUR_NL
          )
```

3 General information

possible Error messages related to command AFFE_CHAR_THER

It arrives sometimes that an ordering of thermal computation (THER_LINEAIRE, THER_NON_LINE,...) during stop in fatal error the computation of the second elementary members due to the loadings defined in the AFFE_CHAR_THER_xx commands.

When the code stops during these elementary computations, important information of the error message is the name of the computation option required by the code. The name of this option is in general unknown to the user and it is thus difficult for him to understand the message.

In the table below, one gives in with respect to the names of the computation options, the name of the command and of the key word factor which make it possible to activate this option.

Elementary computation option	Orders	Key word factor
CHAR_THER_FLUNL	AFFE_CHAR_THER_F	FLUX_NL
CHAR_THER_FLUN_F	AFFE_CHAR_THER_F	FLUX_REP
CHAR_THER_FLUN_R	AFFE_CHAR_THER	FLUX_REP
CHAR_THER_FLUTNL	AFFE_CHAR_THER	CONVECTION
CHAR_THER_FLUTNL	AFFE_CHAR_THER_F	CONVECTION
CHAR_THER_FLUX_F	AFFE_CHAR_THER_F	FLUX_REP
CHAR_THER_FLUX_R	AFFE_CHAR_THER	FLUX_REP
CHAR_THER_GRAI_F	AFFE_CHAR_THER_F	PRE_GRAD_TEMP
CHAR_THER_GRAI_R	AFFE_CHAR_THER	PRE_GRAD_TEMP
CHAR_THER_PARO_F	AFFE_CHAR_THER_F	ECHANGE_PAROI
CHAR_THER_PARO_R	AFFE_CHAR_THER	ECHANGE_PAROI
CHAR_THER_SOUR_F	AFFE_CHAR_THER_F	SOURCE
CHAR_THER_SOUR_R	AFFE_CHAR_THER	SOURCE
CHAR_THER_TEXT_F	AFFE_CHAR_THER_F	ECHANGE
CHAR_THER_TEXT_R	AFFE_CHAR_THER	ECHANGE
CHAR_THER_SOURNL	AFFE_CHAR_THER_F	SOUR_NL

4 Operands

4.1 General information on the operands

4.1.1 the two forms of operands under a key word factor

the operands under a key word factor are of two forms:

- operands specifying the topological entities where the loadings are affected (key words GROUP_NO and GROUP_MA, etc…). The arguments of these operands are identical for the two operators.
- operands specifying the affected values (TEMP, COEF_H, etc…). The meaning of these operands is the same one for the two operators but the arguments of these operands are all of the real type for operator AFFE_CHAR_THER and of the standard function (created by one of operators DEFI_FONCTION, DEFI_NAPPE, DEFI_CONSTANTE or CALC_FONC_INTERP) for operator AFFE_CHAR_THER _F.

We will thus not distinguish in this document, except fast mention of the opposite, two operators AFFE_CHAR_THER and AFFE_CHAR_THER_F.

4.1.2 Topological entities of assignment of the loadings

In a general way, the topological entities on which values must be affected are defined:

- by nodes and in this case:
  - either by operand GROUP_NO allowing to introduce a list of nodes group,
  - or by the operand NOEUD allowing to introduce one nodes list.
- by mesh and in this case:
  - either by GROUP_MA allowing to introduce a list of mesh groups,
  - or by MESH allowing to introduce a list of meshes.

Regulate:

To define the field of assignment most simply possible, one uses the rule of overload it is the last assignment which precedes.

4.2 MODEL operand

♦MODELE =mo ,

Product concept by the operator AFFE_MODELE [U4.41.01] where definite affected ones on the mesh the are element types finished.

4.3 Key word TEMP_IMPO

4.3.1 to impose

Drank Key word factor usable, on nodes or nodes groups, a temperature.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_THER) or via a concept of type function (AFFE_CHAR_THER_F).

4.3.2 Syntax

- for AFFE_CHAR_THER

```
TEMP_IMPO = _F (♦  |  TOUT = "OUI",
                   |  NOEUD    =       lno,                  [l_noeud]
                   |  GROUP_NO =       lgno,                 [l_gr_noeud]
                   |  NET   =lma       ,                  [l_maille]
                   |  GROUP_MA =lgma      ,
[l_gr_maille]
                ♦/TEMP            =    T,                    [R]
                  /  |  TEMP_MIL =TINF   ,                    [R]
                     |  TEMP_INF =TINF   ,                    [R]
                     |  TEMP_SUP =tsup   ,                    [R]
              )
```

- for AFFE_CHAR_THER_F

```
TEMP_IMPO = _F (♦  |  TOUT = "OUI",
                   |  NOEUD    =       lno,                  [l_noeud]
                   |  GROUP_NO =       lgno,                 [l_gr_noeud]
                   |  NET   =lma       ,                  [l_maille]
                   |  GROUP_MA =lgma      ,
[l_gr_maille]
                ♦/TEMP=tf                 ,
[function]
                  /  |      TEMP_MIL=tf   ,
[function]
                     |      TEMP_INF=tinf,                    [function]
                     |      TEMP_SUP=tsupf   ,
[function]

              )
```

4.3.3 /TEMP

Operands =

Value of **the temperature** imposed on (S) the node (S) specified (S).

/Pour the shell elements thermal only (Modelization: "COQUE"):

| TEMP_MIL

Temperature on the average average imposed on (S) the node (S) specified (S).

| TEMP_INF

Temperature imposed on the lower wall of the shell.

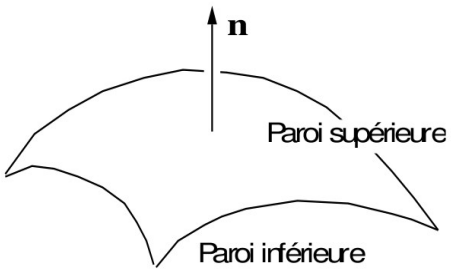
| TEMP_SUP

Temperature imposed on the higher wall of the shell.

These options make it possible to represent a parabolic variation of the temperature in the thickness.

Note:

The shell is directed by the connectivity of the nodes of the mesh associated (cf [U3.01.00]). That is to say n the normal vector directing the shell:



4.4 Key word FLUX_REP

4.4.1 Drank

Key word factor usable to apply **normal flux**, with **a face** of voluminal element or thermal shell defined by one or more meshes or of the mesh groups of type **triangle** or **quadrangle**. This key word also makes it possible to apply a normal flux to an edge (in 2D PLANE or AXIS or AXIS_FOURIER) to meshes of standard segment.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_THER) or via a concept of type function (AFFE_CHAR_THER_F).

4.4.2 Syntax

- for AFFE_CHAR_THER

```
 FLUX_REP = _F    (  ♦/TOUT           =         ' OUI',
                     ◊  |  NET    =lma       ,             [l_maille]
                        |  GROUP_MA =lgma      ,
[l_gr_maille]

                   ♦  /  FLUN        =fl        ,               [R]
                      /  |  FLUN_INF =FLIN      ,            [R]
                         |  FLUN_SUP =flsup     ,            [R]
                )
```

- for AFFE_CHAR_THER_F

```
FLUX_REP = _F (
                  ♦/TOUT          =         ' OUI',
                     ◊  |  NET    =lma       ,             [l_maille]
                        |  GROUP_MA =lgma      ,
[l_gr_maille]

                  ♦/FLUN     =flf               ,             [function]
                     /  |  FLUN_INF =flinf      ,             [function]
                        |  FLUN_SUP =flsupf     ,          [function]
                     /  |  FLUX_X   =flx     ,             [function]
                        |  FLUX_Y   =fly     ,             [function]
                        |  FLUX_Z   =flz     ,             [function]
                )
```

4.4.3 /FLUN

Operands : fl normal flux imposed on the mesh.

This loading applies to the types of meshes and the following modelizations:

Net	Modelization
TRIA3, TRIA6, QUAD4, QUAD8, QUAD9	3D, 3D_DIAG
SEG2, SEG3	PLANE, AXIS, AXIS_FOURIER, PLAN_DIAG, AXIS_DIAG

more precisely the boundary condition applied is: $\lambda(grad\,T\cdot\boldsymbol{n})$ = fl

where λ is thermal conductivity and $\boldsymbol{n}$ is the norm directed in the meaning of the numbers of the nodes of the mesh. The convention of directional sense is that used in AFFE_CHAR_MECA [U4.44.01].

```
/   |   FLUN_INF = flin
    |   FLUN_SUP = flsup
```

normal Flux imposed on the walls lower and higher of a thermal shell.

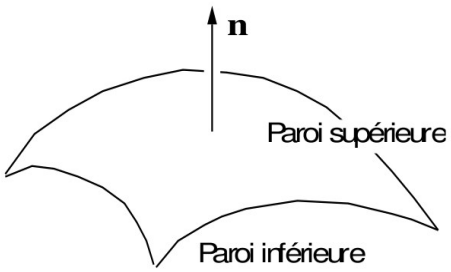
These loadings apply to the types of meshes and the following modelizations:

Net	Modelization
TRIA3, TRIA6	COQUE

$\boldsymbol{n}$ being the norm directing surface [U4.44.01], the boundary condition applied is:

$\lambda(grad\,T\cdot\boldsymbol{n})$ = flin where flin is the normal flux imposed on the lower wall of the shell,

$\lambda(grad\,T\cdot\boldsymbol{n})$ = flsup where flsup is the normal flux imposed on the higher wall of the shell.




```
/   |   FLUX_X = flx
    |   FLUX_Y = fly
    |   FLUX_Z = flz
```

vectorial Flux $\boldsymbol{fl}$ in the total reference (only for AFFE_CHAR_THER_F) which one projects on the norm with the element (for the definition of the norm [U4.44.01]).

$$\lambda(grad\,T\cdot\boldsymbol{n})=\boldsymbol{fl}\cdot\boldsymbol{n}=flx.nx+fly.ny+flz.nz$$

This loading applies to the types of meshes and the modelizations:

Net	Modelization
SEG2, SEG3	PLANE
	PLAN_DIAG

Note: the rule of remanence (see U1.03.00) applies between the various quantities which one can affect: FLUN, FLUN_INF,... FLUX_Z.

4.4.4 Notice

key word simple CARA_TORSION of this factor key word FLUX_REP is not documented here and does not have to be employed by the user. He is used only for macro-command MACR_CARA_POUTRE. This one is used to identify the geometrical characteristics of the sections of beams. For the characteristics

of torsion, the command solves a problem of Laplacian by employing in an indirect way the operators of linear thermal.

4.5 Key word FLUX_NL

4.5.1 Drank

Factor key word usable to apply **normal flux** functions of the temperature, with **a face** of voluminal element defined by one or more meshes or of the mesh groups of type **triangle** or **quadrangle**. This key word also makes it possible to apply a normal flux to an edge (in 2D PLANE or AXIS) to meshes of standard segment. One can thus model a condition of radiation of the standard model of STEPHAN. This kind of flux is used only by commands THER_NON_LINE [U4.54.02] and THER_NON_LINE_MO [U4.54.03].

The values are provided by a concept of type function.

4.5.2 Syntax

- For AFFE_CHAR_THER_F

```
 FLUX_NL = _F  (
                  ♦/TOUT          =         ' OUI',
                     ◊   |   NET    =lma       ,              [l_maille]
                         |   GROUP_MA =lgma      ,
[l_gr_maille]

                     ♦FLUN          =fl        ,                  [function]
                )
```

4.5.3 Operands

FLUN: normal flux imposed on the mesh.

This loading applies to the types of meshes and the following modelizations:

Net	Modelization
TRIA3, TRIA6, QUAD4, QUAD8, QUAD9	3D, 3D_DIAG
SEG2, SEG3	PLANE, AXIS PLAN_DIAG, AXIS_DIAG

more precisely the boundary condition applied is:

$\lambda\left(grad\,T\cdot\boldsymbol{n}\right)$ = fl

where $\boldsymbol{n}$ is the norm directed in the meaning of the numbers of the nodes of the mesh. Directional sense used in AFFE_CHAR_MECA document [U4.44.01].

4.6 Key word RAYONNEMENT

4.6.1 Drank

Key word making it possible to define flux radiated ad infinitum according to the formula:

$$\Phi_{ray}=\sigma\,\epsilon\left([T+273,15]^4-[T_\infty+273,15]^4\right)$$

by the data of emissivity ε, the Boltzmann constant σ and the temperature ad infinitum T_∞ expressed into Centigrade. The temperature T will be also expressed into Centigrade, it is thus necessary to take care, by coherence, to use only degrees Celsius for all the study.

4.6.2 Syntax

- for AFFE_CHAR_THER

```
RAYONNEMENT = _F  (
                      ♦/TOUT          =         ' OUI',
                         ◊   |  NET    =lma       ,          [l_maille]
                             |  GROUP_MA =lgma      ,
[l_gr_maille]
                          ♦     SIGMA    =sigma          ,             [R8]
                          ♦     EPSILON =epsilon        ,          [R8]
                          ♦     TEMP_EXT=tex            ,          [R8]
                    )
```

- for AFFE_CHAR_THER_F

```
 RAYONNEMENT = _F     (
                      ♦/TOUT          =         ' OUI',
                         ◊   |  NET    =lma       ,          [l_maille]
                             |  GROUP_MA =lgma      ,
[l_gr_maille]
                      ♦SIGMA       =sigma        ,             [function]
                      ♦EPSILON      =epsilon       ,          [function]
                      ♦TEMP_EXT=tex               ,          [function]
                    )
```

4.6.3 Operands

♦SIGMA =sigma
♦EPSILON =epsilon
♦TEMP_EXT =tex

This loading applies to the following modelizations:

Net	Modelization
TRIA3, TRIA6, QUAD4, QUAD8, QUAD9	3D, 3D_DIAG
SEG2, SEG3	PLANE, AXIS PLAN_DIAG, AXIS_DIAG

sigma : Boltzmann constant, $\sigma=5.6710^{-8}$ in units IF ($W/m^2.K^4$) (attention with this value if the units of mesh change),
epsilon : emissivity,
tex : temperature ad infinitum in degrees Celsius.

4.7 Key word ECHANGE

4.7.1 Drank

Factor key word usable to apply **conditions of exchange** with an outside temperature with **a face** of voluminal elements or shells, defined by one or more meshes or of the mesh groups of type **triangle** or **quadrangle**. This key word also makes it possible to apply conditions of exchange to an edge (in 2D PLANE or AXIS or AXIS_FOURIER) to meshes of standard segment.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_THER) or via a concept of type function (AFFE_CHAR_THER_F).

4.7.2 Syntax

- for AFFE_CHAR_THER

```
ECHANGE = _F  (
                  ♦/TOUT         =         ' OUI',
                     /  |  NET   =lma       ,             [l_maille]
                        |  GROUP_MA =lgma      ,
[l_gr_maille]

                  ♦/♦COEF_H          =h        ,             [R]
                        ♦TEMP_EXT  =tex        ,          [R]

                     /  |  ♦COEF_H_INF=hin        ,          [R]
                           ♦TEMP_EXT_INF=texin       ,          [R]
                        |  ♦COEF_H_SUP=hsup       ,          [R]
                           ♦  TEMP_EXT_SUP=texsup    ,       [R]
               )
```

- for AFFE_CHAR_THER_F

```
ECHANGE = _F  (
                  ♦/TOUT         =         ' OUI',
                     /  |  NET   =lma       ,             [l_maille]
                        |  GROUP_MA =lgma      ,
[l_gr_maille]

                  ♦/♦COEF_H          =hf       ,             [function]
                        ♦TEMP_EXT  =texf       ,          [function]

                     /  |  ♦COEF_H_INF     =hinf  ,          [function]
                           ♦TEMP_EXT_INF =texinf  ,       [function]
                        |  ♦COEF_H_SUP     =hsupf ,          [function]
                           ♦TEMP_EXT_SUP =texsupf ,       [function]
               )
```

4.7.3 Operands

/ ♦ COEF_H = H,
♦ TEMP_EXT = tex,

This loading applies to the types of meshes and the following modelizations:

Net	Modelization
TRIA3, TRIA6, QUAD4, QUAD8, QUAD9	3D, 3D_DIAG
SEG2, SEG3	PLANE, PLAN_DIAG AXIS, AXIS_FOURIER, AXIS_DIAG

more precisely the boundary condition applied is:

$$\lambda(grad\,T\cdot\boldsymbol{n})=h(tex-T)\quad(h>0)$$

where $\boldsymbol{n}$ is the norm directed in the meaning of the numbers of the nodes tops (directional sense used in AFFE_CHAR_MECA [U4.44.01]).

/ | ♦ COEF_H_INF= hin,
♦ TEMP_EXT_INF= texin,
| ♦ COEF_H_SUP= hsup,
♦ TEMP_EXT_SUP= texsup,

This loading applies to the types of meshes and the following modelizations:

Net	Modelization
TRIA3, TRIA6	COQUE

$\boldsymbol{n}$ being the norm directing surface [U2.03.03], the boundary condition applied is:

$$\lambda(grad\,T\cdot\boldsymbol{n})=hin(texin-T)$$

where hin and texin: coefficient of heat exchange on the lower wall of the shell, outside temperature, with dimensions lower wall.

$$\lambda(grad\,T\cdot\boldsymbol{n})=hsup(texsup-T)$$

where hsup and texsup: coefficient of heat exchange on the higher wall of the shell, outside temperature, with dimensions external wall.

Note: the rule of remanence (see U1.03.00) applies between the various quantities which one can affect: COEF_H, COEF_H_INF,... TEMP_EXT_SUP.

4.8 Key word SOURCE

4.8.1 Drank

Factor key word usable to apply **volumic sources** (2D or 3D) to **a field** defined by one or more meshes or of the mesh groups of the voluminal **type**.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_THER) or via a concept of type function (AFFE_CHAR_THER_F).

4.8.2 Syntax

- for AFFE_CHAR_THER

```
SOURCE=_F  (
                  ♦/TOUT          =         ' OUI',
                     /  |   NET    =lma       ,       [l_maille]
                        |   GROUP_MA =lgma      ,       [l_gr_maille]

                   ♦ ..... /SOUR             =s        ,       [R]
                     /SOUR_CALCULEE    =chs         ,    [cham_elem]
            )
```

- for AFFE_CHAR_THER_F

```
SOURCE=_F  (
               ♦/TOUT          =         ' OUI',
                  /  |   NET    =lma       ,          [l_maille]
                     |   GROUP_MA =lgma      ,          [l_gr_maille]

               ♦SOUR           =sf            ,             [function]
            )
```

4.8.3 Operands

This loading applies to the types of meshes and the following modelizations:

Net	Modelization
HEX A8, HEXA20, HEXA27 PYRA5, PYRA13, PENTA6, PENTA15 TETRA4, TETRA10	3D, 3D_DIAG
TRIA3, TRIA6, QUAD4, QUAD8, PLANE	QUAD9, PLAN_DIAG, AXIS, AXIS_FOURIER AXIS_DIAG

/♦SOUR = S,

Value of the presumedly constant source on the element.

/♦SOUR_CALCULEE = chs,

Name of the cham_elem_sour_R containing on each element the values of the source discretized with Gauss points (1st family).

4.9 Key word PRE_GRAD_TEMP

4.9.1 Drank

Factor key word usable to apply to an element 3D or 2D (PLANE, AXIS) a variation in presumedly uniform temperature in the element. This "initial" variation in temperature is usable for example to solve the elementary problems determining the correctors of steady linear thermal in the basic cell (2D, 3D), in periodic homogenization.

The conductance coefficients homogenized are obtained by calculating by the operator POST_ELEM [U4.81.22] key word ENER_POT the energy dissipated thermically with the equilibrium in linear thermal starting from the correctors.

Because of the thermal analogy, this approach can be exploited to obtain the correctors in elasticity antiplane in the basic cell 2D, as well as in electric conduction.

The assignment can be done on one or more meshes, one or more mesh groups or on all the elements of the model.

4.9.2 Syntax

- for AFFE_CHAR_THER

```
PRE_GRAD_TEMP = _F   (
                  ♦/TOUT          =         ' OUI',
                    /  |   NET    =lma       ,              [l_maille]
                       |   GROUP_MA =lgma      ,
[l_gr_maille]

                  ♦  |   FLUX_X =FLX         ,                 [R]
                     |   FLUX_Y =FLY         ,                 [R]
                     |   FLUX_Z =flz         ,                 [R]
                     )
```

4.9.3 Operands

This loading applies to the types of meshes and the following modelizations:

Net	Modelization
TRIA3, TRIA6, QUAD4, QUAD8, PLANE	QUAD9, AXIS, PLAN_DIAG, AXIS_DIAG
HEXA8, HEXA20, HEXA27 PENTA6, PENTA15, TETRA4, TETRA10 PYRA5, PYRA13	3D, 3D_DIAG

♦ | FLUX_X = flx (flxf)
| FLUX_Y = fly (flyf)
| FLUX_Z = flz (flzf) (in 3D only)

Component of the variation in temperature $grad\,T_{ini}$ in the total reference.

The second calculated elementary member is: $\int_{V_e} grad\,T_{ini}\,K\,grad\,T^{*}\,dV_e$ where K is the tensor of thermal conductivities.

The gradients can be a function of the geometry and/or time.

- for AFFE_CHAR_THER_F

```
PRE_GRAD_TEMP = _F    (
                        ♦/TOUT          =      ' OUI',
                          /MAILLE       =lma       ,           [l_maille]
                          /GROUP_MA  =lgma     ,          [l_gr_maille]

                        ♦ |   FLUX_X =flxf         ,           [function]
                          |   FLUX_Y =flyf         ,           [function]
                          |   FLUX_Z =flzf         ,           [function]
                      )
```

4.10 Key word LIAISON_DDL

4.10.1 Drank

Factor key word usable to define a linear relation between degrees of freedom of two or several nodes.

According to the name of the operator called, the values are provided directly (AFFE_CHAR_THER) or via a concept function (AFFE_CHAR_THER_F).

4.10.2 Syntax

- for AFFE_CHAR_THER

```
LIAISON_DDL = _F  (♦/NOEUD         =lno      ,              [l_noeud]
                     /GROUP_NO     =lgno     ,              [l_gr_noeud]

                   ◊ DDL =       |            "TEMP",        [DEFAULT]
                                 |            "TEMP_MIL",
                                 |            "TEMP_INF",
                                 |            "TEMP_SUP",

                   ♦ COEF_MULT =               have  ,           [l_R]
                   ♦ COEF_IMPO =               B  ,          [R]
                )
```

- for AFFE_CHAR_THER_F

```
LIAISON_DDL = _F  ( ♦/NOEUD           =lno      ,           [l_noeud]
                       /GROUP_NO      =lgno     ,           [l_gr_noeud]

                   ◊ DDL =       |            "TEMP",        [DEFAULT]
                                 |            "TEMP_MIL",
                                 |            "TEMP_INF",
                                 |            "TEMP_SUP",

                  ♦   COEF_MULT =ai               ,          [l_R]
                  ♦COEF_IMPO    =bf                 ,          [function]
                )
```

4.10.3 Operands

the list of the nodes N_i ($i=1,r$) defined by GROUP_NO or NOEUD is ordered in a natural way:

- in the order of the list of nodes group, and for each nodes group, in the order of definition of the group by GROUP_NO.
- in the order of nodes list for NOEUD.

The argument of DDL must be a list of degrees of freedom T_i ($i=1,r$) of r texts taken among: "TEMP", "TEMP_MIL", "TEMP_SUP", "TEMP_INF"

If key word DDL is omitted, by default the linear relation will relate to degrees of freedom "TEMP".

The argument of COEF_MULT must be a list a_i ($i=1,r$) of coefficients (of real type for AFFE_CHAR_THER and AFFE_CHAR_THER_F).

The argument of COEF_IMPO is a coefficient β for AFFE_CHAR_THER, a function of space for AFFE_CHAR_THER_F.

The following kinematical condition is applied: $\sum_{i=1}^{r} \alpha_i T_i = \beta$

Note:

*Components "TEMP_MIL", "TEMP_SUP" and "TEMP_INF" can intervene only in combinations only **assigned** to nodes which belong to shell elements (modelization "COQUE").*

*In the case of a linear relation between the degrees of freedom of the same node, one will repeat behind the key word NOEUD the name of the node as many times as there are degrees of freedom in the relation. **Example:** to impose $T_{\sup} = T_{\inf}$ on the node $N1$, one will write:*

```
LIAISON_DDL = _F  ( NOEUD=          (N1, N1),
                    DDL=               ("TEMP_SUP", "TEMP_INF"),
                    COEF_MULT=         (1. , - 1.),
                    COEF_IMPO=0       .,
                  )
```

It is important to note that to an occurrence of the key word factor LIAISON_DDL corresponds one and only one linear relation.
*If one wants to impose the same relation between 2 nodes groups GRN01 and GRN02 (even temperature node with node for example) **one cannot write:***

```
LIAISON_DDL = _F    ( GROUP_NO=       (GRN01, GRN02),
                      DDL=            ("TEMP",  "TEMP"),
                    COEF_MULT=        (1. , - 1.),
                    COEF_IMPO=0      .,                          )
```

This writing has meaning only if GRN01 and GRN02 contain each one one node. It will be necessary in the case to clarify each linear relation above, node by node.

Key word LIAISON_GROUP on the other hand makes it possible to condense the writing of the linear relations between 2 nodes groups in opposite.

4.11 Key word LIAISON_GROUP

4.11.1 Drank

Factor key word usable to define linear relations between couples of nodes, these couples of nodes being obtained while putting in opposite two lists of meshes or nodes.

According to the name of the operator called N, the values are provided directly (AFFE_CHAR_THER) or via a concept function (AFFE_CHAR_THER_F).

4.11.2 Syntax

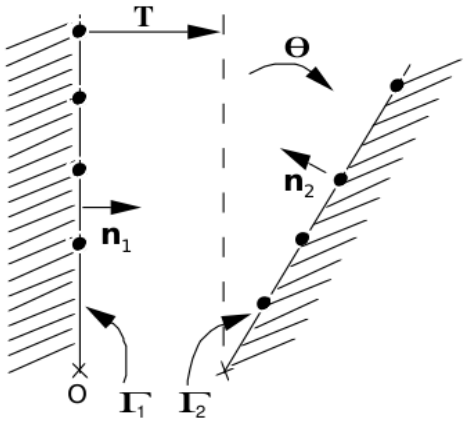
- for AFFE_CHAR_THER

```
   LIAISON_GROUP=_F  ( ♦/♦/MAILLE_1=lma1                        ,
[l_maille]
                                /GROUP_MA_1       =lgma1    ,
[l_gr_maille]

                              ♦/MAILLE_2=lma2                ,    [l_maille]
                                /GROUP_MA_2       =lgma2    ,
[l_gr_maille]

                            /  ♦  /  NOEUD_1=lno1        ,    [l_noeud]
                                  /GROUP_NO_1      =lgno1    ,    [l_gr_noeud]

                                  ♦  /  NOEUD_2=lno2        ,    [l_noeud]
                                     /GROUP_NO_2      =lgno2    ,    [l_gr_noeud]

                          ◊/SANS_NOEUD=lno                  ,    [l_noeud]
                            /SANS_GROUP_NO              =lgno ,    [l_gr_noeud]

                           ◊  DDL_1=        |     "TEMP",            [DEFAULT]
                                            |     "TEMP_MIL",
                                            |     "TEMP_INF",
                                            |     "TEMP_SUP",

                           ◊  DDL_2=        |     "TEMP",            [DEFAULT]
                                            |     "TEMP_MIL",
                                            |     "TEMP_INF",
                                            |     "TEMP_SUP",

                           ♦  COEF_MULT_1=       a1i,           [l_R]
                           ♦  COEF_MULT_2=       a2i,           [l_R]
                           ♦  COEF_IMPO=b            ,          [R]

                          ◊  |  CENTER=lr            ,             [l_R]
                             |     ANGL_NAUT=lr      ,             [l_R]
                             |  TRAN=lr              ,             [l_R]

                                        ◊SOMMET=' OUI',

                        )
```

- for AFFE_CHAR_THER_F

```
   LIAISON_GROUP=_F  ( ♦/♦/MAILLE_1=lma1                        ,
[l_maille]
                                /GROUP_MA_1       =lgma1    ,
[l_gr_maille]

                              ♦/MAILLE_2=lma2               ,    [l_maille]
                                /GROUP_MA_2       =lgma2    ,
[l_gr_maille]

                            /♦     /   NOEUD_1=lno1        ,    [l_noeud]
                                   /GROUP_NO_1      =lgno1   ,    [l_gr_noeud]

                              ♦    /   NOEUD_2=lno2        ,    [l_noeud]
                                   /GROUP_NO_2      =lgno2   ,    [l_gr_noeud]

                          ◊/SANS_NOEUD=lno                  ,    [l_noeud]
                            /SANS_GROUP_NO              =lgno ,    [l_gr_noeud]

                           ◊   DDL_1=        |     "TEMP",           [DEFAULT]
                                             |     "TEMP_MIL",
                                             |     "TEMP_INF",
                                             |     "TEMP_SUP",

                           ◊   DDL_2=        |     "TEMP",           [DEFAULT]
                                             |     "TEMP_MIL",
                                             |     "TEMP_INF",
                                             |     "TEMP_SUP",

                          ♦    COEF_MULT_1=     a1i   ,          [l_R]
                          ♦    COEF_MULT_2=     a2i   ,          [l_R]
                          ♦COEF_IMPO=              bf,             [function]

                          ◊  |   CENTER=lr           ,             [l_R]
                             |      ANGL_NAUT=lr     ,             [l_R]
                             |   TRAN=lr             ,             [l_R]

                                                ◊SOMMET=' OUI'
                        )
```

4.11.3 Operands



Appears 4.11.3-a: Geometrical transformation of a border in another

"general" Kinematical condition: $\sum_{i=1}^{NDDL1} \alpha_{1i} T_i|_{\Gamma_1} + \sum_{i=1}^{NDDL2} \alpha_{2i} T_i|_{\Gamma_2} = \beta$

/♦/MAILLE_1 =
/GROUP_MA_1 =

These operands define Γ_1 via meshes which compose it.

♦/MAILLE_2 =
/GROUP_MA_2 =

These operands define Γ_2 via meshes which compose it.

/ ♦ /NOEUD_1 =
/GROUP_NO_1 =

These operands define Γ_1 via the nodes which compose it.

♦ /NOEUD_2 =
/GROUP_NO_2 =

These operands define Γ_2 via the nodes which compose it.

◊ /SANS_GROUP_NO =:
/SANS_NOEUD =

These operands make it possible to remove list of the couples of nodes as screw - with - screw all the couples of which at least one of the nodes belongs to nodes list described by these operands.

That makes it possible to avoid the accumulation of linear relations on the same node during various iterations on the key word factor LIAISON_GROUP what leads most of the time to a matrix singular.

♦COEF_MULT_1 (resp. COEF_MULT_2)

List of realities dimensioned exactly with the number of degrees of freedom declared in DDL_1 (resp. DDL_2) corresponding to the multiplying coefficients of the linear relation.

♦COEF_IMPO : coefficient of blocking of the linear relation:

β : reality for AFFE_CHAR_THER
β_f : function for AFFE_CHAR_THER_F

◊CENTER : coordinates of the center of rotation
◊ANGL_NAUT : nautical angles in degrees defining rotation (see AFFE_CARA_ELEM [U4.42.01] key word ORIENTATION)
◊TRAN : components of vector translation

the These operands make it possible to define a virtual transformation (rotation and/or translation) approximate Γ_1 in Γ_2 order to ensuring the bijectivity of the function opposite.

◊ DDL_1 (resp. DDL_2):

List texts taken among:
"TEMP", "TEMP_MIL", "TEMP_INF", "TEMP_SUP"

"TEMP_MIL", "TEMP_INF" and "TEMP_SUP" can be used only for shell elements thermal (modelization: "COQUE").

By default, the degree of freedom considered for all the nodes of the linear relations is "TEMP".

◊SOMMET = "OUI'

When meshes of edge are quadratic, the use of SOMMET: "OUI' forces the algorithm of pairing to associate the nodes tops with other nodes tops. In the case of fine meshes, that makes it possible in certain cases to avoid the problems of conflicts of screw - with-screw.

4.11.4 Use of LIAISON_GROUP

- LIAISON_GROUP generates linear relations only between 2 nodes (one on Γ_1, one on Γ_2)

  to generate linear relations on more than 2 nodes, to use key word LIAISON_DDL.

- determination of the couples of nodes in opposite:

  initially, one draws up the two lists of nodes to be put in opposite (IE to be paired), for each occurrence of factor key word the LIAISON_GROUP:

  - for key words GROUP_NO_1 and GROUP_NO_2, they are the nodes setting up the nodes groups,
  - for key words GROUP_MA_1 and GROUP_MA_2, they are the nodes of meshes setting up the mesh groups.

  The redundancies being eliminated, the two lists of nodes obtained must have the same length.

  The determination of the couples of nodes in opposite is done in several stages:

  - for each node $N1$ of the first list, one seeks the node image $N2=f(N1)$ of the second list. If F is not injective (a node $N2$ is the image of two distinct nodes $N1$ and $N1'$), the following error message is transmitted:

    <F> <AFFE_CHAR_THER> <PACOAP> CONFLICT BETWEEN THE FACE-TO-FACE NODES

    LE NOEUD N2 Is facing the nodes N1 AND N1'

  - for each node $N2$ of the second list, one seeks the node image $N1=g(N2)$ of the first list. If G is not injective (a node $N1$ is the image of two distinct nodes $N2$ and $N2'$), the following error message is transmitted:

    <F> <AFFE_CHAR_MECA> <PACOAP> CONFLICT IN WITH RESPECT TO
    the NODES
    LE NOEUD N1 Is facing the nodes N2 AND N2'

  - one checks that $g=f^{-1}$, i.e. the couples obtained by the stages a) and b) are the same ones (one wants to have a bijection f between the two lists of nodes). If F is not surjective, the following error message is transmitted:

    <F> <AFFE_CHAR_MECA> <PACOAP> CONFLICT BETWEEN THE FACE-TO-FACE NODES GENERATE
    SUCCESSIVELY FROM LISTS LIST1 AND LIST2
    LE NOEUD OF the FIRST LISTE N1 IS NOT the IMAGE Of AUCUN NOEUD PAR CORRESPONDENCE INVERSE

  For a given N node, one calls nodes list node $f(N)$ image the node of the other which carries out the minimum of distance with N. To facilitate pairing, in particular in the case of particular geometries (where the borders Γ_1 and Γ_2 could "almost" result one from the other by the composition of a translation and a rotation), one gives the opportunity before you calculate of making a virtual geometrical transformation of the first nodes group (translation and rotation (cf [Figure 4.11.3-a]) the distances (key words TRAN, CENTER and ANGL_NAUT).

  For each occurrence of factor key word the LIAISON_GROUP, one thus builds the list of the new couples in opposite. When all the occurrences were swept, one removes list the couples in double.

Note:

In the couples of nodes in opposite, the order of the nodes is important. So for the first occurrence of LIAISON_GROUP, a node N belonged to the first nodes group and a node M with the second nodes group, and that for the second occurrence of LIAISON_GROUP, it is the reverse, one will obtain at the conclusion of pairing the couples (N,M) and (M,N). They will not be eliminated during detection of the redundancies; on the other hand, the matrix obtained will be singular. Thus, one advises to keep same logic during the description of edges as screw - with - screw.

4.12 Key word LIAISON_MAIL

4.12.1 Drank

Factor key word making it possible “to thermically restick” two edges of a structure. These edges can be with a grid differently (incompatible meshes) but must result one from the other by rotation and/or translation.

4.12.2 Syntax

- in AFFE_CHAR_THER only

```
LIAISON_MAIL =_F  ( ♦  |   GROUP_MA_MAIT =lgma_mait          ,
                       |   MAILLE_MAIT   =lma_mait        ,

                    ♦  |   GROUP_MA_ESCL =lgma_escl          ,
                       |   MAILLE_ESCL   =lma_escl        ,
                       |   GROUP_NO_ESCL =lgno_escl          ,
                       |   NOEUD_ESCL    =lno_escl        ,

                    ◊  |   ♦TRAN     =       (tx, ty, [tz]),         [l_R]
                       |   ♦CENTER    =      (xc, yc, [zc]),         [l_R]
                           ♦ANGL_NAUT    =   (alpha, [beta, gamma]),
[l_R]
                   )
```

face 1 is called face “Master”; face 2 is called face “slave”.

4.12.3 Operands

4.12.3.1 GROUP_MA_ESCL / MAILLE_ESCL / GROUP_NO_ESCL / NOEUD_ESCL

These key words make it possible to define all the nodes of slave face. One takes all the nodes specified by key keys GROUP_NO_ESCL and NOEUD_ESCL more possibly the nodes carried by meshes specified by key keys GROUP_MA_ESCL and MAILLE_ESCL.

4.12.3.2 GROUP_MA_MAIT / MAILLE_MAIT

These key words make it possible to define the group of meshes where they with respect to the nodes of slave face will be sought.

One should not give meshes surface (in 3D) composing the face Master, but meshes the voluminal adjacent ones with the face Master. Meshes specified are candidates for the search of opposite. One can give too much of it.

4.12.3.3 CENTER / ANGL_NAUT / TRAN

These operands make it possible to define the geometrical transformation (rotation and/or translation) making it possible to pass from slave face to the face Master. The command carries out initially rotation then the translation.

Caution: the transformation is in the meaning slave-Master.

This boundary condition applies to the plane modelizations ("PLANE" or "AXIS") or voluminal ("3D").

4.13 Key word ECHANGE_PAROI

4.13.1 Drank

Factor key word usable to apply conditions of heat exchange between 2 walls. These walls can be defined of two ways:

- each one separately, by one or more meshes, or one or more mesh groups (case of walls with a grid);
- from a crack X-FEM list, two walls corresponding then to the two lips of each crack. In this case it is also possible to impose the continuity of the field of températire through the lips of each crack.

4.13.2 Syntax

- for AFFE_CHAR_THER

```
ECHANGE_PAROI=_F  (
                    # if the wall is with a grid
                   ♦/GROUP_MA_1      =lgma        ,       [l_gr_maille]
                      /MAILLE_1  =lma         ,       [l_maille]
                   ♦/GROUP_MA_2      =lgma        ,       [l_gr_maille]
                      /MAILLE_2  =lma         ,       [l_maille]
                   ♦COEF_H        =h           ,          [R]
                   ◊TRAN      =lr                ,          [l_R]

                    # if the wall is defined with cracks X-FEM
                   ♦FISSURE       =lfiss             ,
[l_fiss_xfem]
                   ♦/COEF_H       =h           ,          [R]
                      /TEMP_CONTINUE    =      ' OUI'
                  )
```

- for AFFE_CHAR_THER_F

```
ECHANGE_PAROI=_F  (
                    # if the wall is with a grid
                   ♦/GROUP_MA_1      =lgma        ,       [l_gr_maille]
                      /MAILLE_1  =lma         ,       [l_maille]
                   ♦/GROUP_MA_2      =lgma        ,       [l_gr_maille]
                      /MAILLE_2  =lma         ,       [l_maille]
                   ♦COEF_H        =h           ,          [function]
                   ◊TRAN      =lr                ,          [l_R]

                    # if the wall is defined with cracks X-FEM
                   ♦FISSURE       =lfiss             ,
[l_fiss_xfem]
                   ♦/COEF_H       =h           ,          [function]
```

```
                                    /TEMP_CONTINUE    =      ' OUI'
                                )
```

4.13.3 Operands

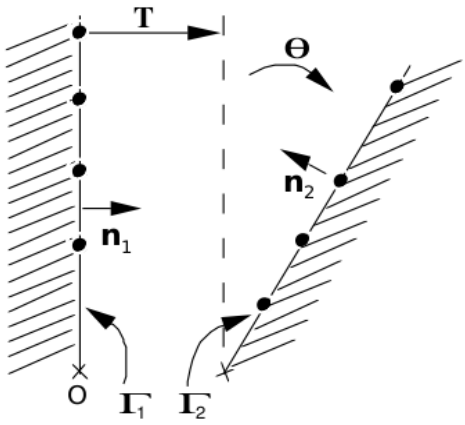
4.13.3.1 Case of walls with a grid

♦COEF_H

Coefficient of heat exchange between the 2 walls.
Reality for the operator AFFE_CHAR_THER, function for operator AFFE_CHAR_THER_F.

♦/GROUP_MA_1
/MAILLE_1

♦/GROUP_MA_2
/MAILLE_2



Appears 4.13.3-a

These operands make it possible to define the 2 lists of meshes representing for the subscripted list "_1" the wall Γ_1 for the subscripted list "_2" the wall Γ_2.

The walls are in correspondence and must comprise the same number of meshes and of nodes.

The limiting condition applied between these 2 walls is:

on Γ_1 : $k\frac{\partial T_1}{\partial n_1}=h\left(T_2-T_1\right)$ n_1 norm external with Γ_1

on Γ_2 : $k\frac{\partial T_2}{\partial n_2}=h\left(T_1-T_2\right)$ n_2 norm external with Γ_2

where $T_1|_{\Gamma_1}=T \qquad T_2|_{\Gamma_1}=T\circ f$
$T_1|_{\Gamma_2}=T\circ f^{-1} \qquad T_2|_{\Gamma_2}=T$

f representing the bijection which puts in opposite a node of Γ_1 and a node of Γ_2.

Component

◊TRAN of vector translation.
This operand makes it possible to define a virtual transformation (translation) approximate of Γ_1 in Γ_2 order to ensuring the bijectivity of the function as screw - - screw. TRAN characterizes a translation:

in 2D one thus has : TRAN = (tx, ty)
in 3D one a: TRAN = (tx, ty, tz)

4.13.3.2 Case of one or more cracks X-FEM

♦FISSURE

Lists cracks X-FEM.
For each crack given in this list, the two walls in opposite are defined like the upper lip and the lower lip of crack. There is thus as much couple of walls in opposite than of cracks present in this list.

♦/COEF_H

Coefficient of heat exchange enters the lips of crack. Reality for the operator AFFE_CHAR_THER , function for operator AFFE_CHAR_THER_F .
If this key word is present, the condition of exchange imposed between the lips of each crack given under the key word CRACK is the same one as in the case of a wall with a grid (see § preceding), while taking identitié for the bijection f since the upper lips and lower of each crack are geometrically confused.

/TEMP_CONTINUE

This key word can be indicated only with the value "OUI'.
If this key word is present, one imposes the continuity of the field of temperature through the lips of each crack given under the key word FISSURES, by cancelling the degrees of freedom of enrichment ("Heaviside" and "ace-tip").

4.13.4 Use of ECHANGE_PAROI

In the case of a wall with a grid:

The user gives two lists of meshes from which the couples from paired nodes will result. These lists are initially sorted by type of mesh: the paired nodes will come from meshes from identical type. For each mesh of the first list, one determines the mesh nearest in the second list by calculating all the distances from the nodes taken two to two (one traverses all the possible permutations). The distance minimum obtained defines at the same time the mesh in opposite and the couples of nodes paired for two the meshes concerned ones. As in LIAISON_GROUP [§4.11], it is possible to carry out a virtual geometrical transformation before you calculate (rotation and/or translation) the distances.

In the case of one or several cracks X-FEM:

One defines as many couples of walls in opposite than there are cracks in the list indicated for the key word FISSURES.

•If key word COEF_H is present, all the cracks contained in this list will see affected the same coefficient of heat exchange (real or function). To assign a value of the clean coefficient of heat exchange to each crack, it is necessary to use the character répétable factor key word ECHANGE_PAROI.
•If key word TEMP_CONTINUE is present, one imposes the continuity of the field of temperature through all cracks contained in this list.

4.13.5 Meshes and modelizations supporting this loading:

In the case of walls with a grid:

The lists of meshes given by the user must be made up of meshes of edge, of meshes of coupling then are automatically generated. The table below provides a summary of meshes of edges as of the modelizations for which this kind of loading is supported.

Net edge	Modelization	Nets coupling generated

SEG2, SEG3	PLANE, PLAN_DIAG AXIS, AXIS_DIAG	SEG22, SEG33
TRIA3, TRIA6, QUAD4, QUAD8, QUAD9	3D, 3D_DIAG	TRIA33, TRIA66, QUAD44, QUAD88, QUAD99

In the case of one or several cracks X-FEM:

The cracks must be created with operator DEFI_FISS_XFEM beforehand [U4.82.08], and the model (well informed for the key word MODELS) with operator MODI_MODELE_XFEM [U4.41.11], which is possible only if in the following cases:

- modelization 3D for meshes support HEXA8, PENTA6, PYRA5, TETRA4
- modelizations PLANE and AXI for meshes support QUAD4 and TRIA3

4.14 Key word LIAISON_UNIF

4.14.1 Drank

Factor key word making it possible to impose the same value (unknown) on the temperatures of a set of nodes.

These nodes are defined by the mesh groups, meshes, the nodes groups or nodes list to which they belong.

4.14.2 Syntax

- for AFFE_CHAR_THER and AFFE_CHAR_THER_F

```
LIAISON_UNIF =_F  (
                      ♦/MAILLE=lma                  ,
[l_maille]
                         /GROUP_MA     =lgma ,              [l_gr_maille]
                          /NOEUD           =lno  ,              [l_noeud]
                          /GROUP_NO        =lgno ,              [l_gr_noeud]

                       ♦   DDL = |   "TEMP" ,                 [DEFAULT]
                                 |   ' TEMP_MIL',
                                 |   ' TEMP_INF',
                                 |   ' TEMP_SUP',
                    )
```

4.14.3 Operands

♦/MAILLE
/GROUP_MA
/NOEUD
/GROUP_NO

These operands make it possible nodes list to define one n N_i from which one eliminated the redundancies (for MESH and GROUP_MA, it acts of connectivities of meshes).

♦DDL

This operand makes it possible to define a list of degrees of freedom $T_i(i=1,r)$ of r texts taken among: "TEMP", "TEMP_MIL", "TEMP_INF", "TEMP_SUP".

$r\times(n-1)$ The "kinematical" conditions resultants are:

$T_i(N_1)=T_i(N_k)$ for $k\in(2,...,n)$, $i\in(1,...,r)$

Note:

Components "TEMP_MIL", "TEMP_SUP", "TEMP_INF" can intervene only for nodes of shell elements.

4.15 Key word LIAISON_CHAMNO

4.15.1 Drank

Factor key word usable to define a linear relation between all the temperatures present in a concept CHAM_NO.

4.15.2 Syntax

```
LIAISON_CHAMNO = _F  ( ♦  CHAM_NO   =chamno   ,              [cham_no]
                       ♦  COEF_IMPO =   B,                  [R]
                       ◊NUMÉRIQUE_LAGR  =     "NORMAL",
[DEFAULT]
                                          /   "APRES",
                     )
```

4.15.3 Operands

CHAM_NO =

Name of the chamno which is used to define the linear relation. The temperatures connected are all those present in the chamno. The coefficients to be applied to the temperatures are the values of these temperatures in the chamno.

Example:

Let us suppose that one has a bearing chamno on 3 nodes of names $N01$, $N02$ and $N03$.

Let us suppose that the values of the temperatures in these 3 nodes in the chamno are respectively 2. , 5.4 and 9.1. The linear relation that one will impose is:
$2.T(NO1)+5.4T(NO2)+9.1T(NO3)=\beta$

COEF_IMPO =

It is the value of the real coefficient β to the second member of the linear relation.

NUME_LAGR =

If "NORMAL", the 2 Lagrange multipliers associated with the relation will be such as the first will be located before all the terms implied in the relation and the second after, in the assembled matrix.

If "APRES", the 2 Lagrange multipliers associated with the relation will be located after all the terms implied in the relation, in the assembled matrix.

This choice has the advantage of having an assembled matrix whose obstruction is weaker but has the disadvantage to be able to reveal a singularity in the matrix.

4.16 Key word CONVECTION

4.16.1 Drank

Key word usable to take into account the term of transport of heat by convection whose statement is $\rho C_p . V\ grad\ T$, appearing in the form of particulate derivative $\rho C_p \frac{dT}{dt} : \rho C_p \frac{dT}{dt} = \rho C_p \frac{\partial T}{\partial t} + \rho C_p V\ grad\ T$.

In the case of a liquid medium, V indicates the velocity imposed of the fluid particle on the current point.

In the case of a mobile solid medium, V indicates the velocity of solid. In all the cases, it is supposed that the velocity field is known a priori. The case of a mobile solid is rather frequent in practice. It relates to in particular the applications of welding or surface treatment which bring into play a heat source moving in a given direction and at a velocity.

The thermal problem is then studied in a reference frame related to the source (cf THER_NON_LINE_MO [U4.54.03]).

4.16.2 Syntax

```
CONVECTION = _F   ( ♦VITESSE     =v                    [cham_no_sdaster])
```

4.16.3 Operand

For AFFE_CHAR_THER and AFFE_CHAR_THER_F,

VELOCITY =

Name of the velocity field at time when computation is carried out.

This field is a concept cham_no of the cham_no_depl_r type. It must have been defined on all the model for which one carries out computation.

4.17 Key word SOUR_NL

4.17.1 Drank

Factor key word usable to apply **volumic sources depending on the temperature** (2D or 3D) to **a field** defined by one or more meshes or on the mesh groups of the voluminal **type**.

This loading is available only in command AFFE_CHAR_THER_F. The values are provided via a tabulated function of the temperature of type function. The heat source, argument of key word SOUR, is a function of the temperature, other than any other parameter. Moreover, it is necessarily of a tabulated function and not about a formula.

4.17.2 Syntax

```
SOUR_NL=_F     (
               ♦/TOUT          =          ' OUI',
                  /  |   NET    =lma       ,          [l_maille]
                     |   GROUP_MA =lgma      ,          [l_gr_maille]

               ♦SOUR           =sf            ,             [function]
             )
```

4.17.3 Operands

This loading applies to the types of meshes and the following modelizations:

Net	Modelization
HEX A8, HEXA20, HEXA27 PYRA5, PYRA13, PENTA6, PENTA15 TETRA4, TETRA10	3D
TRIA3, TRIA6, QUAD4, QUAD8, PLANE	QUAD9, AXIS
HEX A8, PYRA5, PENTA6, TETRA4	3D_DIAG
TRIA3, QUAD4	PLAN_DIAG, AXIS_DIAG

/♦SOUR = S,

Value of the source depending on the temperature and presumedly constant on the element.