

),

***SENSIBILITE=\_F (***

- 
- 
- 

***to see***

***[U4.50.02]***

- 
- 
- 

),

***SENS\_INIT =\_F (***

***/STATIONARY =  
“YES”, [DEFECT]***

***/  
EVOL\_THER = temp, [evol\_ther]***

*NUME\_INIT = nuini, [I]*

),

*INCREMENT =\_F (*

*LIST\_INST*

=

*litps,*

*[listr8]*

*NUME\_INIT*

= / 0,

/

*nuini,*

*[I]*

**NUME\_FIN**

=

**nufin,**

**[I]**

),

**PARAM\_THETA**

=

/

**theta,**

**[R]**

/

**0.57,**

**[DEFECT]**

**SOLVEUR**

=\_F (

**... to see [U4.50.01]...),**

**FILING**

**=\_F**

**(/LIST\_ARCH**

**= l\_arch**

**, [listis]**

**/**  
**PAS\_ARCH = ipas, [I]**

**/**  
**LIST\_INST**  
**= l\_inst**  
**, [listr8]**

**/**  
**INST = inst, [R]**

**PRECISION**

= /

**10. - 3, [DEFECT]**

/

**prec**

**[R]**

**CRITERION =/**

**“RELATIVE”,**

**[DEFECT]**

/

**“ABSOLUTE”,**

**CHAM\_EXCLU**

**= l\_cham**

**, [l\_Kn]**

),

**TITRATE**

**=**

**titrate,**

**[l\_Kn]**

)

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**3 Operands**

**3.1 Operand**

**MODEL**

**MODEL = Mo**

**Name of the model whose elements are the subject of thermal calculation.**

**3.2 Operand**

**CHAM\_MATER**

**CHAM\_MATER = chmat**

**Name of the affected material field on the model.**

**3.3 Operand**

**CARA\_ELEM**

**CARA\_ELEM = carac**

*The concept carac contains the characteristics of the elements of thermal hull, if they exist in the model.*

### **3.4 Word**

*key*

**EXCIT**

**EXCIT**

=

*Operand allowing to define several loadings. For each occurrence of the key word factor, one defines a load possibly multiplied by a function of time.*

#### **3.4.1 Operand**

**CHARGE**

**CHARGE = tank**

*Concept of the type charges produces by AFFE\_CHAR\_THER or AFFE\_CHAR\_THER\_F [U4.44.02].*

*Important remark:*

*For each occurrence of the key word factor EXCIT the various concepts tank used must be built on the same model Mo.*

#### **3.4.2 Operand**

**FONC\_MULT**

**FONC\_MULT = fonc**

*Multiplicative coefficient function of the time (concept of the function type) applied to the load.*

*Important remark:*

*The concomitant use of FONC\_MULT with a load containing of thermal loadings depending on the temperature is prohibited; i.e. for loadings of the type ECHANGE\_\*.*

### **3.5 Word**

*key*

**TEMP\_INIT**

## **TEMP\_INIT**

=

*Allows to define the initial field from which evolutionary calculation is carried out.*

**Note:**

*If key word TEMP\_INIT misses, one carries out only stationary calculation with the moment defined under the key word INCREMENT.*

*The initial field is stored in the structure of data evol\_ther result under sequence number 0.*

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### **3.5.1 Operand**

**STATIONARY**

**/**

**STATIONARY**

**=**

**“YES”**

*The initial value of the field of temperature is then the result of a stationary calculation precondition.*

### **3.5.2 Operand**



**VALE**

/

**VALE**

=

**tinit**

*The initial value of temperature is taken constant on all the structure.*

### **3.5.3 Operand**

**CHAM\_NO**

/

**CHAM\_NO**

=

**tinit**

*The initial value is defined by a cham\_no\_TEMP\_R (result of the operators AFFE\_CHAM\_NO [U4.44.11] or RECU\_CHAMP [U4.71.01]).*

### **3.5.4 Operand**

**EVOL\_THER**

/

**EVOL\_THER = temp**

*The initial value is extracted from a structure of data of the evol\_ther type.*

### **3.5.5 Operand**

**NUME\_INIT**

**NUME\_INIT = nuini\_evol**

*Sequence number of the field to be extracted from this structure of data.*

**Note:**

*Attention, it acts of the sequence number in the structure of data read in recovery by preceding key word EVOL\_THER. If this structure of data were calculated with a list of moments different from that used under the key word factor INCREMENT of the current resolution, it is imperative to inform NUME\_INIT under INCREMENT,*

*the same value of sequence number corresponding to physical moments different. If the two lists of moments are identical, one can to exempt to inform the same NUME\_INIT twice, under ETAT\_INIT and under INCREMENT.*

### **3.6 Word**

*key*

***SENSITIVITY***

*SENSITIVITY = sensitive parameter list*

*Activate the calculation of derived from the field of temperature compared to a significant parameter problem.*

*The document [U4.50.01] specifies the operation of the key word.*

### **3.7 Word**

*key*

***SENS\_INIT***

***SENS\_INIT***

*=*

*Allows to define the initial field from which the evolutionary calculation of derived from temperature is carried out, for a transitory calculation.*

*Note:*

*If key word SENS\_INIT misses, initialization is made by a field with the nodes no one.*

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#### **3.7.1 Operand STATIONARY**

/  
**STATIONARY**  
=  
**“YES”**

*The initial value is that of a preliminary stationary calculation. That is not possible that if it even mode of initialization is retained for the calculation of the temperature.*

#### **3.7.2 Operand EVOL\_THER**

/  
**EVOL\_THER = temp**

*The initial value is extracted from a structure of data of the evol\_ther type.*

#### **3.7.3 Operand NUME\_INIT**

**NUME\_INIT = nuini\_evol**

*Sequence number of the field to be extracted from this structure of indicated data.*

#### **3.8 Word key INCREMENT**

**INCREMENT =**

*Allows to define the moments of calculation which determine the intervals of time taken to integrate the differential equation.*

**Note:**

*If the key word INCREMENT misses, one creates a list of moments reduced to the only reality 0 and one carry out a stationary calculation.*

**3.8.1 Operand**

**LIST\_INST**

**LIST\_INST = litps**

*List moments, produced by DEFI\_LIST\_REEL [U4.34.01].*

**3.8.2 Operand**

**NUME\_INIT**

**NUME\_INIT =/0**

**/  
nuini**

*Index of the moment of starting calculation in the list litps.*

**3.8.3 Operand**

**NUME\_FIN**

**NUME\_FIN = nufin**

*Index of the moment of final calculation in the list litps.*

*The moments of calculation are those defined in the concept litps taken between the nuini and it nufin which is numbers of moment. Thus the first step of time is defined between the moment correspondent with nuini and that corresponding to nuini + 1. Stationary calculation, when it is asked, is made at the moment corresponding to nuini.*

*If NUME\_INIT misses and if temp is present under TEMP\_INIT, then  
nuini = nuini\_evol.*

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**3.9 Operand**

**PARM\_THETA**

**PARM\_THETA**

**=**

*The argument theta is the parameter of the theta-method applied to the evolutionary problem. It must to lie between 0 (explicit method) and 1 (completely implicit method). In the absence, word key, the value used is theta=0.57, a little higher than theta=0.5 corresponding to the diagram of Crank-Nicholson. The incidence of the choice of theta on the stability of the method is detailed in [R5.02.02].*

**3.10 Word**

**key**

**SOLVEUR**

**SOLVEUR =**

*This key word factor is optional: it makes it possible to define the method of resolution of the systems linear.*

*This operand is common to the whole of the total orders [U4.50.01].*

**3.11 Word**

**key**

## **FILING**

## **FILING**

=

*This key word is optional: by defect, the whole of the computed fields for all the calculated steps is filed in the concept result resulting from the order. It is used to store certain numbers of order in a structure of data result and/or to exclude from storage certain fields.*

### **Note:**

*In the event of stop of calculation for lack of time CPU, steps of time previously calculated are safeguarded in the base.*

### **3.11.1 Operand LIST\_ARCH**

*Concept of the type lists of entirety created by order DEFI\_LIST\_ENTI [U4.34.02] describing the list sequence numbers having to be stored in the structure of data result.*

### **3.11.2 Operand PAS\_ARCH**

*Whole value giving the value of step of filing: one will store the multiple sequence numbers of value ipas as well as the last actually calculated sequence number.*

### **3.11.3 Operand CHAM\_EXCLU**

*List texts indicating the fields excluded from filing. The list of the possible fields is described in the documents on the concepts result [U5.01].*

## **3.12 Operand**

### **TITRATE**

**TITRATE**

=

*titrate*

*Titrate that one wants to give to the result temp stored in the structure of data of the type evol\_ther [U4.03.01].*

## **4 Modeling**

*The problems of linear thermics can be dealt with with models using the finite elements 3D, 2D, AXIS or HULL described in the documents [U3.22.01], [U3.23.01], [U3.23.02] and [U3.24.01].*

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**5 Example**

**5.1 Calculation**

**transient**

**lr8 = DEFI\_LIST\_REEL (BEGINNING**

**=**

**0.E0**

**,**

**INTERVAL**

**=(**

**\_F (JUSQU\_A**

**= 2.E-4, a NUMBER**

**= 2 ),**

***\_F (JUSQU\_A***  
***= 1.E-3, a NUMBER***  
***= 10***  
***),***

***\_F (JUSQU\_A***  
***= 1.E-2, a NUMBER***  
***= 9 ),***

***\_F (JUSQU\_A***  
***= 1.E-1, a NUMBER***  
***= 9 ),***

***\_F (JUSQU\_A***  
***= 1.E+0, a NUMBER***  
***= 9 ),***



***\_F (JUSQU\_A***  
***= 2.0***  
***, A NUMBER***  
***= 10***  
***),)***

***)***  
  
***temple = THER\_LINEAIRE***  
***(***  
***MODEL***  
***=***  
***moth,***

***CHAM\_MATER***  
***= chmat,***

***EXCIT***  
***=***  
***\_F (LOAD***  
***=***  
***chth),***  
***TEMP\_INIT***  
***=***  
***\_F (***  
***STATIONARY = "yes"),***  
***INCREMENT***  
***=***

*\_F (*  
*LIST\_INST*  
*= lr8,*

*NUME\_FIN*  
*=*  
*30)*

*)*  
*temple = THER\_LINEAIRE*  
*(*  
*reuse =*  
*temple,*  
*MODEL*  
*=*  
*moth,*

*CHAM\_MATER*  
*= chmat,*

***EXCIT***  
=  
***\_F (LOAD***  
=  
***chth),***  
***TEMP\_INIT***  
=  
***\_F (***  
***EVOL\_THER***  
***= temple***

***NUME\_INIT***  
=  
***30),***  
***INCREMENT***  
=  
***\_F (***  
***LIST\_INST***  
***= lr8),***

)

*The first call to order THER\_LINEAIRE makes it possible to carry out a stationary calculation at the moment 0. and to connect an evolutionary calculation until the moment 0.1s (31 moments of calculation are 30 calculations of evolution).*

*The second call makes it possible to enrich the concept temple precedent, evolutionary calculation is continued to leave*

*31ième moment of calculation.*

## **5.2**

### ***Sensitivity to an imposed temperature***

*your*

*= DEFI\_PARA\_SENSI (VALE = 70  
)*

*Tb*

*= DEFI\_PARA\_SENSI (VALE = 30  
)*

*Ca*

*= AFFE\_CHAR\_THER\_F*

*(MODEL*

*= moth,*

*TEMP\_IMPO*

*=(*

*\_F (*

*GROUP\_MA = "bord\_sup",*

*TEMP*

*=*

*your),*

*\_F (GROUP\_MA = "bord\_inf",*

*TEMP*

*=  
Tb))*

*)  
temple = THER\_LINEAIRE*

*(  
MODEL  
=  
moth,*

*CHAM\_MATER*

*= chmat,  
EXCIT  
=\_F (LOAD  
=*

*chth*),  
*SENSIBILITE*=  
(  
*your*  
,  
*Tb*  
)

*This calculation will produce the structure of data temple, evol\_ther type, containing the field of temperature under the name TEMP. It will produce also two other structures of the evol\_ther type. first will contain, under the name of field TEMP, the field of derived from the temperature by report/ratio with the parameter your. The second will contain the derivative compared to the parameter Tb. The name of these structures is created automatically by the code and remains unknown to the user. The access to their contents (impression, test, post\_releve...) is done by calling upon the corresponding order with name of the principal structure, temp, and the name of the significant parameter concerned, your or Tb.*

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## **6 Remark**

*Order CALC\_ELEM [U4.81.01] makes it possible to calculate the heat flows, at the points of integration*

*or with the nodes, the field with the nodes of temperature thus obtained by THER\_LINEAIRE.*

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*Organization (S):* EDF-R & D /AMA

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***Document: U4.54.02***

***Operator THER\_NON\_LINE***

***1 Goal***

***To calculate the thermal response with nonlinearities of behaviors and boundary conditions.***

***The equation of heat is solved in evolutionary mode (except if no list of moment is provided, only***



*the stationary regime is then calculated). Nonthe linearities come is behavior (characteristics of material depend on the temperature), that is to say boundary conditions (radiation in infinite medium, nonlinear flow). A formulation in enthalpy was selected in order to to more easily take into account the phase shifts of material.*

*Evolutionary calculation can be initialized, at the first moment in three different ways (key word TEMP\_INIT):*

- by a constant temperature,*
- by a field of temperature, definite, or extracted as a preliminary from a preceding calculation,*
- by a stationary calculation.*

*This operator also allows to solve the problems of drying (nonlinear) while solving the equation of the heat where the water C concentration is comparable at a temperature, for resolution. Thermal conductivity is in this case the coefficient of diffusion, nonlinear out of C and function, possibly, of a temperature calculated as a preliminary.*

*To model the hydration of the concrete, the operator also allows to add a term function source variable of hydration to the equation of heat. This term is then given by an equation of evolution where the temperature intervenes.*

*The concept produced by operator THER\_NON\_LINE is of evol\_ther type as for an analysis linear by THER\_LINEAIRE [U4.54.01].*

*When a calculation of sensitivity of the result compared to a parameter is required, there is production of as many structures of data of the evol\_ther type of necessary parameters.*

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## 2 Syntax

*temper*  
*[evol\_ther]*  
=  
*THER\_NON\_LINE*

*(reuse = temper,*

*MODEL*  
=  
*Mo,*

*[model]*

*CHAM\_MATER*  
=  
*chmat,*  
*[cham\_mater]*

*EXCIT =\_F (*

**CHARGE**

=

**tank,**  
**[load]**

**FONC\_MULT**

=

**fonc,**  
**[function]**

),

**TEMP\_INIT =\_F (**

**/STATIONARY = “YES”,**

**[DEFECT]**

**/**

**VALE =**

**tinit,**

**[R]**

**/**

**CHAM\_NO =**

**tinit,**

**[cham\_no\_TEMP\_R]**

/  
**EVOL\_THER**  
=  
*temp,*  
*[evol\_ther]*

**NUME\_INIT**  
= *nuini\_evol,*  
*[I]*

),

**SENSITIVITY =\_F (**

.  
. .  
. .

*to see*  
*[U4.50.02]*

.  
. .  
. .

),

***INCREMENT =\_F (***

***LIST\_INST***

=

***litps,***  
***[listr8]***

***NUME\_INIT***

= / 0,

/

***nuini,***  
***[I]***

***NUME\_FIN***

=

***nufin,***  
***[I]***

),

**COMP\_THER\_NL =\_F (**

**RELATION**

**=**

**/**

**“THER\_NL”,**

**[DEFECT]**

**/**

**“THER\_HYDR”, [txm]**

**/**

**“SECH\_GRANGER”,**

**[txm]**

**/**

**“SECH\_MENSI”,**

**[txm]**

**/**

**“SECH\_BAZANT”,**

**[txm]**

**/**

**“SECH\_NAPPE”,**

**[txm]**

**/ALL = “YES”,**

**[txm]**

/

/

**GROUP\_MA = l\_grmail,**  
**[l\_gr\_ma]**

/

**NET**

=

**l\_maille,**  
**[l\_ma]**

),

**EVOL\_THER\_SECH = resuther,**  
**[evol\_ther]**  
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**NEWTON =\_F (**

**REAC\_ITER**  
**= /0,**  
**[DEFECT]**

**/it,**

**[I]**

**RESI\_LINE\_RELA= /1.E-3, [DEFECT]**  
**/reslin, [R]**



***ITER\_LINE\_MAXI= /0,  
[DEFECT]***

***/iterl,***

***[R]***

***),***

***CONVERGENCE=\_F (***

***RESI\_GLOB\_RELA= /1.E-6, [DEFECT]***

*/testr,*

**[R]**

***RESI\_GLOB\_MAXI= /testl, [R]***

***ITER\_GLOB\_MAXI=  
/10, [DEFECT]***

*/iterl,*

**[R]**

),

***PARM\_THETA***

=

/

***theta,***

***[R]***

/

***0.57,***

***[DEFECT]***

***SOLVEUR =\_F ([U4.50.01])***

***FILING***

***=\_F***

***(/LIST\_ARCH***

***= l\_arch***

***, [listis]***

/  
**PAS\_ARCH = ipas, [I]**

/  
**LIST\_INST**  
**= l\_inst**  
**, [listr8]**

/  
**INST = inst, [R]**

**PRECISION**  
**= /**  
**10. - 3, [DEFECT]**  
**/**  
**prec**  
**[R]**

**CRITERION** =/  
“**RELATIVE**”,  
[**DEFECT**]  
/  
“**ABSOLUTE**”,

**CHAM\_EXCLU**  
= *l\_cham*  
, [*l\_Kn*]

),

**OPTION**  
=  
/“**FLUX\_ELGA\_TEMP**”,

[*l\_Kn*]

/“*FLUX\_ELNO\_TEMP*”,

*TITRATE*

= *title*,

[*l\_Kn*]

);

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*3 Operands*

*3.1 Operand*

*MODEL*

*MODEL = Mo*

*Name of the model whose elements are the subject of thermal calculation.*

*3.2 Operand*

*CHAM\_MATER*

***CHAM\_MATER = chmat***

***Name of the affected material field on the model.***

### **3.3**

***Key word EXCIT***

***EXCIT***

***=***

***Key word factor allowing to define several loadings. For each occurrence of the key word factor, one defines a load possibly multiplied by a function of time.***

#### ***3.3.1 Operand***

***CHARGE***

***CHARGE = tank***

***Concept of the type charges produces by AFFE\_CHAR\_THER or AFFE\_CHAR\_THER\_F [U4.44.02].***

***Important remark:***

***For each occurrence of the key word factor EXCIT the various concepts tank used must be built on the same model Mo.***

#### ***3.3.2 Operand***

***FONC\_MULT***

***FONC\_MULT = fonc***

***Multiplicative coefficient function of the time (concept of the function type) applied to charge.***

***Important remark:***

***The concomitant use of FONC\_MULT with a load containing of thermal loadings depending on the temperature is prohibited; i.e. for loadings of the type ECHANGE\_, RADIATION or FLUNL.***

### **3.4 Word**

**key**

**TEMP\_INIT**

**TEMP\_INIT = litps**

***Allows to define the initial field from which evolutionary calculation is carried out. The initial field is affected of the sequence number 0 and the initial moment takes as value the first reality of the list from moment litps.***

**Note:**

***If key word TEMP\_INIT misses, one carries out only stationary calculation at the moment defined under the key word INCREMENT.***

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**3.4.1 Operand**

**STATIONARY**

**/**

**STATIONARY**

**=**

**“YES”**

***The initial value is then the result of a preliminary stationary calculation. This calculation takes in account the boundary conditions defined under the key word CHARGES.***



### **3.4.2 Operand**

**VALE**

/

**VALE**

=

**tinit**

*The initial value of temperature is taken constant on all the structure.*

### **3.4.3 Operand**

**CHAM\_NO**

/

**CHAM\_NO**

=

**tinit**

*The initial value is defined by a cham\_no\_TEMP\_R (result of the operators AFFE\_CHAM\_NO [U4.44.11] or RECU\_CHAMP [U4.71.01]).*

### **3.4.4 Operand**

**EVOL\_THER**

/

**EVOL\_THER = temp**

*The initial value is extracted from a structure of data of the evol\_ther type.*

### **3.4.5 Operand**

**NUME\_INIT**

**NUME\_INIT = nuini\_evol**

*Sequence number of the field to be extracted from this structure of data.*

*The initial field is stored in the structure of data temper result under sequence number 0.*

**Note:**

*Attention, it acts of the sequence number in the structure of data read in recovery by*

*preceding key word EVOL\_THER. If this structure of data were calculated with a list of moments different from that used under the key word factor INCREMENT of the current resolution, it is imperative to inform NUME\_INIT under INCREMENT, the same value of sequence number corresponding to physical moments different. If the two lists of moments are identical, one can to exempt to inform the same NUME\_INIT twice, under ETAT\_INIT and under INCREMENT.*

### **3.5 Word**

*key*

**SENSITIVITY**

*SENSITIVITY = sensitive parameter list*

*Activate the calculation of derived from the field of temperature compared to a significant parameter problem.*

*The document [U4.50.01] specifies the operation of the key word.*

### **3.6 Word**

*key*

**INCREMENT**

*INCREMENT =*

*Allows to define the moments of calculation which determine the intervals of time taken to integrate the differential equation.*

*Note:*

*If the key word INCREMENT misses, one creates a list of moments reduced to the only reality 0. and a stationary calculation is carried out.*

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**Operator THER\_NON\_LINE**

**Date:**

**23/06/05**

**Author (S):**

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### **3.6.1 Operand**

**LIST\_INST**

**LIST\_INST = litps**

**List moments produced by DEF1\_LIST\_REEL [U4.34.01].**

### **3.6.2 Operand**

**NUME\_INIT**

**NUME\_INIT =/0**

**/**

**nuini**

**Index of the moment of starting calculation in the list litps.**

**If NUME\_INIT misses and if evol\_ther is present under TEMP\_INIT, then  
nuini = nuini\_evol.**

### **3.6.3 Operand**

**NUME\_FIN**

**NUME\_FIN = nufin**

**Index of the moment of final calculation in the list litps.**

**The moments of calculation are those defined in the concept litps taken between the nuini and it  
nufin number of moment. Thus the first step of time is defined between the moment  
correspondent with nuini and that corresponding to nuini + 1. Calculation, stationary,  
when it is asked, is made at the moment corresponding to nuini.**

## **3.7 Word**

*key*

**COMP\_THER\_NL**

**COMP\_THER\_NL**

=

*The resolution of drying was added in Code\_Aster because of analogy of the equations of the thermics and of drying. That supposes to assimilate the variable of calculation of drying, water concentration, with a variable of the type “TEMP” during the resolution.*

*By defect, the resolution carried out will be nonlinear thermics. This key word factor allows thus to distinguish the resolution of drying from thermics. Moreover, the equation of drying is characterized by a coefficient of diffusion which can be expressed in various forms. This key word factor also makes it possible to choose one of the equations of the drying, defined by the expression of sound*

*coefficient of diffusion, available in Aster. To carry out a nonlinear calculation of thermics, this key word becomes optional, and the concept of behavior is transparent for the user.*

*Note:*

*If key word COMP\_THER\_NL misses, a nonlinear calculation of thermics is carried out “standard”.*

### **3.7.1 Operand**

#### **RELATION**

**RELATION: /**

**“THER\_NL”**

**[DEFECT]**

**/**

**“THER\_HYDR”**

**/**

**“SECH\_GRANGER”**

**/**

**“SECH\_MENSI”**

**/**

**“SECH\_BAZANT”**

**/**

**“SECH\_NAPPE”**

*The syntax and the treatment of this key word are similar to the use of the key words COMP\_INCR and COMP\_ELAS of operator STAT\_NON\_LINE.*

/  
"THER\_NL"

*Standard nonlinear thermal resolution.*

*Supported modelings:*

- *continuous mediums 3D: 3D*
- *continuous mediums 2D: 2D, AXIS*

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/  
"THER\_HYDR"

*Resolution of the equation of heat with an additional source term: Q &*

*Q is the heat of hydration, presumedly constant. The variable of hydration is solution of the nonlinear law of evolution, solved simultaneously with the problem of thermics:*

*&*

*E*

*= () -*

**With  
E  
RT**

*One will refer to the documentation of operator **DEFI\_MATERIAU** for the significance of various parameters.*

*Supported modelings:*

- continuous mediums 3D: 3D*
- continuous mediums 2D: 2D, AXIS*

*/  
“SECH\_GRANGER”*

**C**  
*Resolution of the drying characterized by the equation*

$$- [ \text{Div} ( D C, T) C ]$$

*= 0*  
**T**  
*It is the equation of nonlinear heat where the variable of drying C holds the role of temperature. The choice of the relation of behavior makes it possible to define the coefficient of diffusion*

*( D C, T) according to various usual forms of the literature. The formulation of Granger of the coefficient of diffusion is given by the expression:*

$$T$$

$$Q 1$$

$$I$$

$$D C T = A$$

$$BC$$

$$S$$

$$(, )$$

$$\exp ($$

$$)$$

$$\exp-$$

$$-$$

**T**

**R**  
**0**  
**T T0**

*One will refer to the documentation of operator **DEFI\_MATERIAU** for the significance of various parameters. In the case of the use of this law **SECH\_GRANGER**, it is necessary to ensure itself of coherence enters the material used and the law of behavior: i.e. that key word **SECH\_GRANGER** indeed was indicated in **DEFI\_MATERIAU** for the material used.*

*Supported modelings:*

- *continuous mediums 3D: 3D*
- *continuous mediums 2D: 2D, AXIS*

*As the resolution of drying is carried out by an operator of thermics, them supported modelings are thermal modelings, but which do not have whereas one conceptual value of a geometrical nature.*

/

**“SECH\_MENSI”**

*Resolution of the drying characterized by the law of **MENSI**.  
In the case of the use of this law **SECH\_MENSI**, it is necessary to be ensured of coherence enters the material used and the law of behavior: i.e. that the key word **SECH\_MENSI** indeed was indicated in **DEFI\_MATERIAU** for material used.  
Supported modelings: analogue with **SECH\_GRANGER**.*

/

**“SECH\_BAZANT”**

*Resolution of the drying characterized by the law of **BAZANT**.  
In the case of the use of this law **SECH\_BAZANT**, it is necessary to be ensured of coherence enters the material used and the law of behavior: i.e. that the key word **SECH\_BAZANT** indeed was indicated in **DEFI\_MATERIAU** for material used.  
Supported modelings: analogue with **SECH\_GRANGER**.*

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/

**“SECH\_NAPPE”**

*Resolution of drying with a coefficient of diffusion defined by a tablecloth Aster. In the case of the use of this law SECH\_NAPPE, it is necessary to be ensured of coherence enters the material used and the law of behavior: i.e. that the key word SECH\_NAPPE indeed was indicated in DEFI\_MATERIAU for material used. Supported modelings: analogue with SECH\_GRANGER.*

**3.7.2 Operands**  
**ALL/GROUP\_MA/MESH**

**/ALL = “YES”**

/

**GROUP\_MA =**  
*l\_grmail*

/

**NET =**  
*l\_maille*

*Specify the meshes to which the relation of behavior is applied. In way analogue with mechanics, one can use several different laws of drying, applied with groups of complementary meshes. On the other hand, thermal cannot be it mixed with drying. Behavior “THER\_NL” is necessarily applied to all grid, option ALL: “YES”, default option, which is in fact, in the case general, transparent for the user.*



### **3.8 Operand**

**EVOL\_THER\_SECH**

**EVOL\_THER\_SECH=**  
**resuther**

*This operand is specific to the resolution of drying. Drying is solved after a calculation preliminary thermics in the case general, (calculation not coupled but chained thermal/drying), it thermal field intervening like auxiliary variable, allowing to calculate the coefficient of diffusion of certain laws. It is an input datum of the calculation of the drying, which must be one structure of data of the evol\_ther type. This key word is obligatory only for the laws "SECH\_GRANGER" and "SECH\_NAPPE", whose coefficient of diffusion depends on the temperature.*

*The structure of data of here well informed thermal evolution will have been obtained by an execution*

*the preceding one of an operator of thermics, linear or not.*

### **3.9 Word**

**key**

**NEWTON**

**NEWTON =**

*Specify the characteristics of the method of resolution of the nonlinear problem (method of NEWTON-RAPHSON).*

#### **3.9.1 Operand**

**REAC\_ITER**

**REAC\_ITER**  
**=/0 [DEFECT]**

**/**  
**it**

*The matrix used for the total iterations of the method is the tangent matrix which is revalued at the beginning of each increment of time and all the it iterations of*

**NEWTON** for an increment of time given (precisely to the iterations of number it, 2it, 3it...). Thus with the first iteration of **NEWTON**, one does not reassemble the matrix tangent that if it is worth 1: if not one keeps the matrix used in the phase of prediction. By convention if it is worth 0 the matrix is not revalued during all the step time.

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**3.9.2 Operand**

**RESI\_LINE\_RELA/ITER\_LINE\_MAXI**

**RESI\_LINE\_RELA =/1.E-3**

**[DEFECT]**

**/**

**reslin**

***ITER\_LINE\_MAXI***

***=***

***/0 [DEFECT]***

***/***

***itlin***

***In fact the parameters of linear research make it possible to ensure the best convergence of the method of NEWTON (cf [R5.03.01] for more details). One gives the maximum iteration count itelin to carry out (the default value 0 indicates that one does not make linear research) and the precision reslin to reach to realize convergence of linear research.***

***Note:***

***It is not necessary to specify a precision very nor an iteration count raised, practice showing that 2 or 3 iterations of linear research are sufficient. One can thus be satisfied to ask for 3 iterations with precision by defect.***

***3.10 Word***

***key***

***CONVERGENCE***

***CONVERGENCE:***

***Allows to define the values associated with the criteria with convergence:***

***If none of the two operands following is present, then all occurs like if:***

***RESI\_GLOB\_RELA = 1.E-6.***

***3.10.1 Operand RESI\_GLOB\_RELA***

***RESI\_GLOB\_RELA =/1.e-6***

*/testr*

*The algorithm continues the external iterations as long as the relative residue is higher than testr.*

*1/2*

*1/2*

*(2  
F N)*

*(S 2  
I  
I)  
testr*

*>  
I = 1, ..., Nb ddl*

*i = 1, ..., Nb ddl*

*where  $F_i$  indicates the residue and  $I$  the thermal loading, index  $N$  indicates the  $n$ th one iteration.*

### ***3.10.2 Operand RESI\_GLOB\_MAXI***

***RESI\_GLOB\_MAXI =/  
1.e-3***

***/testl***

***The algorithm continues the external iterations as long as the absolute residue is higher than testl.***

***N***

***max***

***I***

***F > testl***

***I = 1, ..., Nb ddl***

***where Fi indicates the residue, index N indicates the nth iteration.***

### ***3.10.3 Operand ITER\_GLOB\_MAXI***

***ITER\_GLOB\_MAXI = /10***

***/iterl***

***The algorithm continues the iterations as long as their number is lower than iterl.***

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### **3.11 Operand**

**PARM\_THETA**

**PARM\_THETA = theta**

*The argument theta is the parameter of the théta-method applied to the evolutionary problem. It must to lie between 0 (explicit method) and 1 (completely implicit method). In the absence, word key, the value used is theta=0.57, a little higher than theta=0.5 corresponds to the diagram of Crank-Nicholson. The incidence of the choice of theta on the stability of the method is detailed in [R5.02.02].*

### **3.12 Word**

**key**

**SOLVEUR**

**SOLVEUR =**

*This key word factor is optional: it makes it possible to choose another solvor of resolution of system.*

*This operand is common to the whole of the total orders [U4.50.01].*

### **3.13 Word**

**key**

**FILING**

**FILING**

**=**

*This key word is optional: by defect, the whole of the computed fields for all the calculated steps is filed in the concept result resulting from the order. It is used for tocker certain numbers of order in a structure of data result and/or to exclude from storage certain fields.*

**Note:**

*In the event of stop of calculation for lack of time CPU, steps of time previously calculated are safeguarded in the base.*

### **3.13.1 Operand LIST\_ARCH**

*Concept of the type lists of entirety created by order DEFI\_LIST\_ENTI [U4.34.02] describing the list sequence numbers having to be stored in the structure of data result.*

### **3.13.2 Operand PAS\_ARCH**

*Whole value giving the value of step of filing: one will store the multiple sequence numbers of value ipas as well as the last actually calculated sequence number.*

### **3.13.3 Operand CHAM\_EXCLU**

*List texts indicating the fields excluded from filing. The list of the possible fields is described in the documents on the concepts result [U5.01].*

### **3.14 Operand OPTION**

**OPTION = "FLUX\_ELGA\_TEMP"**

*This option carries out the calculation of the heat flow at the points of integration from temperature.*

**OPTION = "FLUX\_ELNO\_TEMP"**

*This option carries out the calculation of the heat flow to the nodes starting from the temperature.*

*Calculation*

*precondition of "FLUX\_ELGA\_TEMP" is not obligatory.*

### **3.15 Operand TITRATE**

**TITRATE**

**=**

*titrate*

*Titrate that one wants to give to the result stored in temper, structure of data of the type evol\_ther [U4.03.01].*

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#### **4 Modeling**

*The problems of nonlinear thermics can be dealt with with models using the elements stop 3D, 2D or AXIS described in the documents [U3.22.01], [U3.23.01] and [U3.23.02] and [U3.24.01].*

#### **5 Example**

*One defined below the principal orders used to carry out a calculation of thermics non-linear transient. The example indicates how to continue calculation by enriching the concept result and how to specify the “initial” field.*

***lr8 = DEFI\_LIST\_REEL (BEGINNING = 0.D0,***

***INTERVAL***

***=\_F (***

***JUSQU\_A=5.e-3, NOMBRE= 10),***



**INTERVAL**  
**=\_F (**  
**JUSQU\_A=5.e-2, NOMBRE= 9),**

**INTERVAL**  
**=\_F (**  
**JUSQU\_A=4.e-0, NOMBRE= 79),**

**INTERVAL**  
**=\_F (**  
**JUSQU\_A=6.e-0, NOMBRE= 20),**

)

**conduc =**  
**DEFI\_FONCTION (**  
**NOM\_PARA**  
**=**  
**“TEMP”,**  
**VALE =\_F (**

**0.0**

,

210.0,

660.0 , 210.0,

660.01,

95.0,

1200.00,

95.0

)

**PROL\_DROIT**

=

**“LINEAR”**,

**PROL\_GAUCHE**

=

**“LINEAR”**,

)

**enthal =**

**DEFI\_FONCTION**

(

**NOM\_PARA**

=

**“TEMP”**,

**VALE =\_F (**

0.0

,  
0.0,

660.0

,  
**1.980E9,**

660.01,  
**3.060E9,**  
1200.00,  
**4.451E9**

)  
**PROL\_DROIT**  
=  
**“LINEAR”,**  
**PROL\_GAUCHE**  
=  
**“LINEAR”,**

)

**aluminum = DEFI\_MATERIAU**  
**(THER\_NL =\_F (LAMBDA**  
**= conduc,**  
**BETA =**  
**enthal**

)

)

...

**temple**

=

**THER\_NON\_LINE (MODELE=moth, CHAM\_MATER=chmat,**  
**TEMP\_INIT**  
**=\_F (VALE**

```
=  
20.0  
,  
INCREMENT  
=_F (LIST_INST  
=  
lr8),  
EXCIT  
=_F (LOAD  
=  
chth  
,  
CONVERGENCE  
=_F (RESI_GLOB_RELA  
=1.E-6,  
  
ITER_GLOB_MAXI  
=10  
,  
  
)  
  
...  
temple = THER_NON_LINE  
(reuse = temple,  
MODELE=moth  
,  
CHAM_MATER=chmat,  
TEMP_INIT  
=_F (EVOL_THER  
=  
temple,  
NUME_INIT  
=  
20),  
INCREMENT  
=_F (LIST_INST  
=  
lr8),
```

**EXCIT**  
**=\_F (LOAD**  
**=**  
**chth**  
**),**  
**CONVERGENCE**  
**=\_F (RESI\_GLOB\_REL**  
**=**  
**1.E-6,**  
**ITER\_GLOB\_MAXI=**  
**10 )**

**)**  
**...**  
**END ();**  
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***Operator THER\_NON\_LINE\_MO***

### ***1 Goal***

***To calculate the nonlinear stationary thermal response with mobile loading.***

***This operator allows to solve the equation of stationary heat in a mobile reference frame related to a loading and moving in a given direction and at a speed [R5.02.04].***

***Nonthe linearities of the problem come as well from the characteristics of material which depend temperature, that boundary conditions of the radiation type.***

***The problems of this type can be dealt with with models using of the finite elements of structure plans, axisymmetric and three-dimensional.***

***The concept produced by this operator is of evol\_ther type as for an analysis by THER\_LINEAIRE [U4.54.01] or THER\_NON\_LINE [U4.54.02], but it contain one number of order since a stationary calculation is carried out.***

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## *2 Syntax*

*temper [evol\_ther] = THER\_NON\_LINE\_MO*

*(*  
*MODEL*  
*=*  
*Mo,*  
*[model]*

*CHAM\_MATER =*  
*chmat,*  
*[cham\_mater]*

*EXCIT =\_F (*

*CHARGE*  
*=*



*tank,*  
*[char\_ther]*

),

*TEMP\_INIT =\_F (*

*EVOL\_THER*

=

*temp,*  
*[evol\_ther]*

*NUME\_INIT*

*=/nuini\_evol, [I]*

/

*0,*  
*[DEFECT]*

),

**CONVERGENCE =\_F (**

**CRIT\_TEMP\_RELA =/1.E-3,  
[DEFECT]**

**/**

**testr,  
[R]**

**CRIT\_ENTH\_RELA =/1.E-2,  
[DEFECT]**

**/**

**testl,  
[R]**

**ITER\_GLOB\_MAXI =/10,  
[DEFECT]**

**/**

**iterl,  
[R]**

),

***SOLVEUR =\_F (see document [U4.50.01])***

),

***TITRATE***

=

***titrate,***

***[l\_Kn]***

);

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***3 Operands***

### **3.1 Operand**

#### **MODEL**

**MODEL = Mo**

*Name of the model whose elements are the subject of thermal calculation.*

### **3.2 Operand**

#### **CHAM\_MATER**

**CHAM\_MATER = chmat**

*Name of the affected material field on the model.*

### **3.3 Word**

*key*

#### **EXCIT**

**EXCIT**

=

*Key word factor allowing to define several loadings. For each occurrence of the key word factor, one defines a time-constant load.*

#### **3.3.1 Operand**

##### **CHARGE**

**CHARGE = tank**

*Concept of the type charges produces by **AF FE\_CHAR\_THER** or **AF FE\_CHAR\_THER\_F** [U4.44.02].*

*Important remarks:*

*For each event of the key word factor **EXCIT** the various concepts tank used must be built on the same model **Mo**.*

*In addition, operator **AF FE\_CHAR\_THER** or **AF FE\_CHAR\_THER\_F** must obligatorily to inform under the key word factor **CONVECTION** a concept of the **cham\_no\_DEPL\_R** type defining the rate of travel of the field and product by **AF FE\_CHAM\_NO**.*

*It is necessary to take care to define boundary conditions coherent with the run of the part (or of the loading, according to the selected reference frame) and the assumption of stationnarity:*

*If the solid is animated of a uniform translatory movement at constant speed, it is equivalent to consider the field of temperature calculated:*

- like a photograph at a given moment,*
- or like a temporal succession of the chart of temperature in a section of fixed, orthogonal X-coordinate with the direction of run.*

*Mobile loading*

*$v = \text{tape speed}$*

*C.L temperature*

*Adiabatic C.L*

*imposed*

*time*

*$T = 0$*

*$T = \text{infinite}$*

*Thus, downstream under space (early in time), the boundary condition on the edge of part must impose the temperature of the part before does not arrive the mobile loading.*

*Upstream in space (or late in time), a heat flux no one (adiabaticity)*

*the assumption of stationnarity guarantees.*

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*3.4 Word*

*key*

*TEMP\_INIT*

*TEMP\_INIT = litps*

*Allows to define the initial field from which calculation in pointer under condition of stationnarity is carried out.*

### **3.4.1 Operand** **EVOL\_THER**

**EVOL\_THER = temp**

*Name of the structure of data of the evol\_ther type whose the field is extracted from temperature from which the solution with the problem is calculated.*

### **3.4.2 Operand** **NUME\_INIT**

**NUME\_INIT =/nuini\_evol**

**/**

**0**

**[DEFECT]**

*Sequence number of the field to be extracted from this structure of data.*

#### **Note:**

*For this type of calculation, there is no initial condition to define (it is defined with one boundary condition on an edge of the field defined by the model). But, one can nevertheless to carry out stationary calculation starting from a field of temperature already calculated as solution of the problem for part of the load only. That can be useful if the application of the totality of the loading makes convergence difficult. One can then connect several resolutions with a loading which evolves/moves gradually and to take as reiterated first of a calculation running the solution of calculation precedent. Concretely, one uses key word TEMP\_INIT then to define the field of temperature with which one wants to initialize current calculation.*

### **3.5 Word**

**key**

**CONVERGENCE**

**CONVERGENCE =**

*Allows to define the values associated with the criteria with convergence:*

### **3.5.1 Operand**

**CRIT\_TEMP\_RELA**

**CRIT\_TEMP\_RELA =/1.e-3**

**/**

**testr**

*The algorithm continues the iterations as long as the relative variation of reiterated is higher than testr.*

*where*

*indicate the value of the temperature to node I for the nth iteration.*

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**Code\_Aster** ®

**Version**

**7.4**

**Titrate:**

**Operator THER\_NON\_LINE\_MO**

**Date:**

**20/01/05**

**Author (S):**

**C. Key DURAND**

**:**

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### **3.5.2 Operand**

**CRIT\_ENTH\_RELA**

**CRIT\_ENTH\_REL** =/1.e-2

/  
**testl**

*The algorithm continues the iterations as long as the relative variation of reiterated is higher than testl.*

*where*  
*indicate the value of the enthalpy to the nth iteration at the ième point of Gauss.*

**3.5.3 Operand**  
**ITER\_GLOB\_MAXI**

**ITER\_GLOB\_MAXI** =/10  
/  
**iterl**

*The algorithm continues the external iterations as long as the iteration count external is lower than iterl.*

**3.6 Word**  
**key**  
**SOLVEUR**

**SOLVEUR** =

*This key word factor is optional: it makes it possible to choose another solver of resolution of system.*

*This operand is common to the whole of the total orders [U4.50.01].*

**3.7 Operand**  
**TITRATE**

**TITRATE** = *title*

*Titrate that one wants to give to the result stored in temp structure of data of the evol\_ther type [U4.03.01].*

**4 Modeling**



*The problems of nonlinear thermics in pointer and under condition of stationnarity can to be treated with models using the finite elements 3D or plane 2D described in the documents [U3.23.01] and [U3.24.01].*

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*Titrate:*

*Operator THER\_NON\_LINE\_MO*

*Date:*

*20/01/05*

*Author (S):*

*C. Key DURAND*

*:*

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*5 Examples*

*One presents below the principal orders used to carry out a calculation of thermics non-linear in pointer and under condition of stationnarity.*

*conduc =*

*DEFI\_FONCTION (*

*NOM\_PARA*

*=*

*“TEMP”,*

*VALE*

*=*

*(*

*20.0,*

*95.0,*

*500.0, 325.0,*

*1000.0, 700.0*

),  
**PROL\_DROIT =**  
**“CONSTANT”,**  
**PROL\_GAUCHE=**  
**“CONSTANT”,**

)  
  
**enthal =**  
**DEFI\_FONCTION**  
**(**  
**NOM\_PARA**  
**=**  
**“TEMP”,**  
**VALE**  
**=**  
**(**

**0.0, 0.0,**  
  
**500.0, 1.40E9,**  
  
**510.0, 3.50E9,**  
**1200.0, 4.70E9**

),  
**PROL\_DROIT =**  
**“LINEAR”,**  
**PROL\_GAUCHE=**  
**“LINEAR”,**

)

**chechmate**

=

**DEFI\_MATERIAU****(THER\_NL=****\_F (****LAMBDA =****conduc,****BETA**

=

**enthal****),)**

...

**chavi****= AFFE\_CHAM\_NO****(GRID = email,****SIZE = "DEPL\_R",****AFFE = \_F (ALL = "YES",****NOM\_CMP = ("DX", "DY"),****VALE\_R = (1.0, 0.0))****tank = AFFE\_CHAR\_THER****(****MODEL =****model,****FLUX\_REP = \_F (GROUP\_MA = penny,****FLUN = 5.E6),****CONVECTION = \_F (SPEED =****chavi)****)****temple**

=

**THER\_NON\_LINE\_MO****(****MODEL**

=

**model,****CHAM\_MATER =****chmat,****EXCIT****= \_F (LOAD =****tank**

),

)

...

**END ()**

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***Titrate:***

***Operator FACT\_LDLT***

***Date:***

**31/01/06**

***Author (S):***

***J. Key PELLET***

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***Organization (S): EDF-R & D /AMA***

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***Document: U4.55.01***

***Operator FACT\_LDLT***

### ***1 Goal***

***To factorize a matrix assembled in a product of two triangular matrices. This factorization then allows to quickly solve the linear systems thanks to order RESO\_LDLT.***

***This order is usable only for the matrices of which method of resolution (selected in order NUME\_DDL) is “LDLT”, “MULT\_FRONT” or “MUMPS”.***

***Product (or modifies) a structure of data of the type matr\_asse.***

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***Titrate:***

***Operator FACT\_LDLT***

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***31/01/06***

***Author (S):***

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### ***2 Syntax***

***chechmate***

***[matr\_asse\_\*] = FACT\_LDLT***

(  
***reuse = chechmate,***

***MATR\_ASSE =***

***chechmate***

,

/

***[matr\_asse\_DEPL\_R]***

/

***[matr\_asse\_DEPL\_C]***

/

***[matr\_asse\_TEMP\_R]***

/

***[matr\_asse\_TEMP\_C]***

/

***[matr\_asse\_PRES\_R]***

/

***[matr\_asse\_PRES\_C]***

***!# If method LDLT or MULT\_FRONT:***

***STOP\_SINGULIER =/“YES”  
, [DEFECT]***

***/“NOT”***

,

***NPREC =  
/nprec,***

***[I]***

/

8

,

***[DEFECT]***

***# If method LDLT:***

**PRE\_COND**  
=/"WITHOUT"  
, [DEFECT]  
/  
"DIAG"  
,

/  
**BLOC\_DEBUT =**  
*data base,*

[I]

/  
**DDL\_DEBUT = dd,**

[I]



/  
***BLOC\_FIN = bf,***

***[I]***

/  
***DDL\_FIN =  
df,***

***[I]***

***/# If method MUMPS:***

***TYPE\_RESOL  
=  
/  
"CAR"  
,  
[DEFECT]***

***/“NONSYM”,***

***/“SYMDEF”,***

***/“SYMGEM”,***

***PCENT\_PIVOT =***

***/***  
***20***

***,***  
***[DEFECT]***

***/***  
***pcpiv***  
***[R]***

**TITRATE =**  
*titrate,*

**[I\_K80]**

**INFORMATION =**  
*/ 1*  
,

**[DEFECT]**

*/*  
*2*  
,

)

*if MATR\_ASSE:*  
*[matr\_asse\_DEPL\_R]*  
*then [\*]*  
*->*  
*DEPL\_R*  
*[matr\_asse\_DEPL\_C]*  
*DEPL\_C*  
*[matr\_asse\_TEMP\_R]*  
*TEMP\_R*  
*[matr\_asse\_TEMP\_C]*  
*TEMP\_C*  
*[matr\_asse\_PRES\_R]*  
*PRES\_R*  
*[matr\_asse\_PRES\_C]*  
*PRES\_C*

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Version

8.2

Titrate:

Operator *FACT\_LDLT*

Date:

31/01/06

Author (S):

**J. Key PELLET**

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### **3 Operands**

*The choice of the method of resolution is made as a preliminary in order *NUME\_DDL* (key word *METHOD*).*

*Three methods are possible: “LDLT”, “MULT\_FRONT” and “MUMPS”.*

.

*for method “LDLT”, if the user uses a réentrant concept:*

*subdued = *FACT\_LDLT* (reuse = subdued, *MATR\_ASSE* = subdued)*

*it “crushes” its initial matrix. It will not be able to thus make combination of matrices any more or of product stamps *X* vector,*

.

*for methods “MULT\_FRONT” and “MUMPS”, the factorized matrix is stored elsewhere.*

*For these method, it is thus strongly recommended to use a réentrant concept; that avoid duplicating the initial matrix.*

.

*for method “MUMPS”, the factorized matrix is stored only in memory. When the “job” finishes, factorized is lost. It is thus necessary Re-to factorize the matrices with each *CONTINUATION*.*

#### **3.1 Operand**

***MATR\_ASSE***

***MATR\_ASSE = chechmate***

***Name of the matrix assembled to factorize. This matrix can be real or complex, symmetrical***

*or not.*

### **3.2 Operands**

***STOP\_SINGULIER, NPREC, TYPE\_RESOL and PCENT\_PIVOT***

*These key words are described in [U4.50.01].*

### **3.3 Operand**

***TITRATE***

***TITRATE = title***

*Titrate that one wants to give to the result [U4.02.01].*

### **3.4 Operand**

***INFORMATION***

***INFORMATION =***

***1: no impression***

### **3.5 Operand**

***PRE\_COND***

*The effect of this key word is “to standardize” the matrix before its factorization. The author of this document in forever considering the interest!*

***PRE\_COND =***

***Type of prepacking.***

***“WITHOUT”:***

***no prepacking (defect).***

***“DIAG”:***

***prepacking by the diagonal. Lines having a diagonal term no one, are not treated.***

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**3.6**

***Partial factorization (method LDLT)***

***For method “LDLT”, the operator allows to factorize only partially the matrix. This possibility is “historical”. It makes it possible to factorize the matrix in several “times” (several work). Today, the interest of this functionality is not imagined well.***

***/BLOC\_DEBUT = data base***

***- ième***

***data base: partial factorization since the data base block included.***

***/DDL\_DEBUT = dd***

***- ième***

***dd: partial factorization since the dd equation included (in established internal classification by operator NUME\_DDL [U4.61.11]).***

***/BLOC\_FIN = bf***

***- ième***

***bf: partial factorization until the bf block included.***

***/DDL\_FIN = df***

*- ième*

*df: partial factorization until the df equation included (in internal classification established by operator NUME\_DDL [U4.61.11]).*

*The operator carries out the following checks:*

*.  
if the name of the produced concept corresponds to a new concept, factorization is out-place: it is checked that factorization begins well with the first degree of freedom.*

*.  
if the argument df is negative or higher than the order of the matrix, then this one will be factorized until the end. If not, one carries out a partial factorization (of the 1st equation) until  
- ième  
df  
equation included.*

*BLOC\_DEBUT and DDL\_DEBUT*

*.  
in the absence of key words BLOC\_DEBUT and DDL\_DEBUT, the matrix will be factorized to leave of its first line.*

*.  
if argument data base of key word BLOC\_DEBUT is negative or null, the matrix will be factorized with  
to leave the first block. If not, one carries out a partial factorization starting from the data base-ième  
block  
included.*

*.  
if the argument dd of key word DDL\_DEBUT is negative or null, the matrix will be factorized to leave first equation. If not, one carries out a partial factorization from dd-ième  
equation included.*

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*Titrate:*

*Operator FACT\_LDLT*



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**1**  
**bf**  
**data base**  
**end**  
**data base**  
**bf**  
**dd**  
**df**  
**1**  
**df**  
**dd**  
**End**

#### **4 Example**

##### **4.1** **Method LDLT except place**

**naked = NUME\_DDL (MATR\_RIGI = kel,**  
**METHOD = "LDLT")**  
**K = ASSE\_MATRICE (MATR\_ELEM = kel,**  
**NUME\_DDL = naked)**  
**k2 = FACT\_LDLT (MATR\_ASSE = K)**  
**U = RESO\_LDLT (MATR\_FACT = k2,**  
**CHAM\_NO = F)**

##### **4.2** **Method LDLT in place**

**naked = NUME\_DDL (MATR\_RIGI = kel,**  
**METHOD = "LDLT")**  
**K = ASSE\_MATRICE (MATR\_ELEM = kel,**  
**NUME\_DDL = naked)**

***K = FACT\_LDLT (reuse = K, MATR\_ASSE = K)***  
***U = RESO\_LDLT (MATR\_FACT = K,***  
***CHAM\_NO = F)***

### ***4.3 Method***

#### ***multi-frontal***

***naked = NUME\_DDL (MATR\_RIGI = kel,***  
***METHOD = "MULT\_FRONT")***  
***K = ASSE\_MATRICE (MATR\_ELEM = kel,***  
***NUME\_DDL = naked)***  
***K = FACT\_LDLT (reuse = K, MATR\_ASSE = K)***  
***U = RESO\_LDLT (MATR\_FACT = K,***  
***CHAM\_NO = F)***

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***Organization (S): EDF-R & D /AMA***

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***Document: U4.55.02***

***Operator RESO\_LDLT***

***1 Goal***

***To solve a system of linear equations by a “direct” method.***

***The operator allows real or complex resolutions. The matrix must have been beforehand factorized by order FACT\_LDLT [U4.55.01].***

***In spite of its name, this order corresponds to the three established methods of “direct” resolution in Aster: the resolution LDLT, the method multifrontale and method MUMPS. The effective choice of method is done through order NUME\_DDL [U4.61.11].***

***The resolution by combined gradient is done by order RESO\_GRAD [U4.55.04].***

***Product a structure of data of the cham\_no\_\* type.***

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***Operator RESO\_LDLT***

***Date:***

***31/01/06***

**Author (S):**

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**2 Syntax**

**U**

**[cham\_no\_\*]**

=

**RESO\_LDLT**

(

**reuse = U,**

**MATR\_FACT**

=

**With,**

/

**[matr\_asse\_DEPL\_R]**

/

**[matr\_asse\_DEPL\_C]**

/

**[matr\_asse\_TEMP\_R]**

/

**[matr\_asse\_TEMP\_C]**

/

**[matr\_asse\_PRES\_R]**

/

**[matr\_asse\_PRES\_C]**

**CHAM\_NO**

=

**B,**

/

**[cham\_no\_DEPL\_R]**

/

**[cham\_no\_DEPL\_C]**

/

**[cham\_no\_TEMP\_R]**

/

**[cham\_no\_TEMP\_C]**

/

**[cham\_no\_PRES\_R]**

/

**[cham\_no\_PRES\_C]**

**CHAM\_CINE**

= vcine

**,/[cham\_no\_DEPL\_R]**

/

**[cham\_no\_TEMP\_R]**

/

**[cham\_no\_PRES\_C]**

# if solvor MUMPS:

*RESI\_RELA*  
= /1.e-6  
, [DEFECT]  
/  
*eps*  
, [R]

*TITRATE*  
= *titr*  
,  
[l\_K80]

*INFORMATION*  
=  
/1, [DEFECT]

/  
2

)  
  
*if CHAM\_NO:*

*[cham\_no\_DEPL\_R] then [\*]*

*->*

*DEPL\_R*

*[cham\_no\_DEPL\_C]*

*DEPL\_C*

*[cham\_no\_TEMP\_R]*

*TEMP\_R*

*[cham\_no\_TEMP\_C]*

*TEMP\_C*

*[cham\_no\_PRES\_R]*

*PRES\_R*

*[cham\_no\_PRES\_C]*

*PRES\_C*

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### 3 General information

*This order makes it possible to solve the linear systems  $AX = B$  where  $A$  is a matrix “factorized beforehand” by order `FACT_LDLT` [U4.51.01].*

*The resolution is possible for boundary conditions of `DIRICHLET` (boundary conditions kinematics) dualized or eliminated [U2.01.02]. In this last case, if the loading  $X = X0$  on the “edge” 0 was translated by a kinematic load (operator `AFFE_CHAR_CINE` [U4.44.03] taking into account in the assembled matrix (operator `ASSE_MATRICE` [U4.61.22], the “value” of it loading ( $X0$ ), calculated by operator `CALC_CHAR_CINE` [U4.61.03] must be provided by the word key `CHAM_CINE`.*

### 4 Operands

#### 4.1 Operand

**`MATR_FACT`**

**`MATR_FACT = A,`**

*Name of the factorized matrix, concept produced by operator `FACT_LDLT`. This matrix can be real or complex, symmetrical or not.*

#### 4.2 Operand

**`CHAM_NO`**

**`CHAM_NO = B`**

,

*Name of the vector second member (in general obtained by order `ASSE_VECTEUR`).*

#### 4.3 Operand

**`CHAM_CINE`**

**`CHAM_CINE = vcine,`**

*Name of the vector representing the “value” of the boundary conditions of the translated type “`DIRICHLET`”*

*in the form of kinematic loading (i.e. by use of one of the orders `AFFE_CHAR_CINE` or `AFFE_CHAR_CINE_F`).*

*This `cham_no` comes from the execution of operator `CALC_CHAR_CINE` on the list of the `char_cine`*

*(loadings kinematics) associated assembled matrix A [U2.01.02].*

#### **4.4 Operand**

**RESI\_RELA**

**RESI\_RELA = 1.e-6 (defect)/eps**

*This key word is described in [U4.50.01]*

#### **4.5 Operand**

**TITRATE**

**TITRATE =**

*titr,*

*Titrate that one wants to give to the produced result [U4.03.01].*

#### **4.6 Operand**

**INFORMATION**

**INFORMATION =**

*1: no impression.*

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**5 Examples**

.

***Constitution of the assembled matrices:***

***One calculated before the elementary terms Kel, Fel.***

***naked = NUME\_DDL (MATR\_RIGI = Kel)***

***Kass***

***=***

***ASSE\_MATRICE***

***(MATR\_ELEM = Kel,  
NUME\_DDL = naked,)***

***Fass***

***=***

***ASSE\_VECTEUR***

***(MATR\_ELEM = Fel,  
NUME\_DDL = naked,)***

.

***Factorization in place:***

***Kass***

***= FACT\_LDLT***

***(reuse = Kass,***

***MATR\_ASSE = Kass,***

***)***

.

***Out-place resolution:***

***Uass***

***= RESO\_LDLT***

(*MATR\_FACT = Kass, CHAM\_NO = Fass,*)

.  
*Resolution in place:*

*Fass*

=

*RESO\_LDLT*

(*reuse=Fass,*

*MATR\_FACT=Kass, CHAM\_NO=Fass,*)

.  
*for the use of the loads kinematics (with elimination of the imposed degrees of freedom), to see the example given in order AFFE\_CHAR\_CINE [U4.44.03].*

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*Operator FACT\_GRAD*

*Date:*

*31/01/05*

*Author (S):*

**X. DESROCHES** *Key*

*:*

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*Organization (S): EDF-R & D /AMA*

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***Document: U4.55.03***

***Operator FACT\_GRAD***

### ***1 Goal***

***To build a matrix of prepacking for a resolution by combined gradient. This matrix makes it possible to accelerate the convergence of the algorithm of the gradient combined (operator RESO\_GRAD [U4.55.04]). This operator applies only to real and symmetrical matrices.***

***Product a structure of data of the matr\_asse\_\* type.***

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***Operator FACT\_GRAD***

***Date:***

***31/01/05***

***Author (S):***

**X. DESROCHES Key**

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**2 Syntax**

***matfac [matr\_asse\_\*] = FACT\_GRAD***

***(MATR\_ASSE***

***= chechmate***

**,**

**/**

***[matr\_asse\_DEPL\_R]***

**/**

***[matr\_asse\_TEMP\_R]***

**/**

***[matr\_asse\_PRES\_R]***

***PRE\_COND***

***= "LDLT\_INC"***

**,**

***[DEFECT]***

***NIVE\_REMPLISSAGE***

**=**

**/**

**0,**

***[DEFECT]***

**/**

***N,***  
***[I]***

***INFORMATION***

***=***  
***/***  
***1,***  
***[DEFECT]***

***/ 2,***

***);***

***if MATR\_ASSE: [matr\_asse\_DEPL\_R]***  
***then [\*]***  
***- > DEPL\_R***  
***[matr\_asse\_TEMP\_R]***  
***[\*]***  
***- > TEMP\_R***  
***[matr\_asse\_PRES\_R]***

[\*]

- > *PRES\_R*

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7.4

Titrate:

Operator *FACT\_GRAD*

Date:

31/01/05

Author (S):

**X. DESROCHES** Key

:

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### **3 Operands**

#### **3.1 Operand**

***MATR\_ASSE***

***MATR\_ASSE***

=

***Name of the real and symmetrical matrix which one wants préconditionner.***

#### **3.2 Operand**

***PRE\_COND***

***PRE\_COND*** =

***Method of prepacking:***

***“LDLT\_INC”:***

***the matrix of prepacking is obtained by a decomposition LDLT incomplete of the assembled matrix.***

***This decomposition is more or less complete, according to the level of filling. The matrix matfac result is of type matr\_asse.***

#### **3.3 Operand**

***NIVE\_REMPLISSAGE***

***NIVE\_REMPLISSAGE***

= / 0

*/N*

*The matrix of prepacking (P) used to accelerate the convergence of the gradient combined by factorizing in a more or less complete way the initial matrix (A) is obtained.*

*If niv = 0 (defect)*

*P has same storage that A. factorization is incomplete because one does not use for calculations that the terms which one can store in P.*

*P thus represents an approximation (poor) of  $AI$ ; its storage is weak.*

*If niv = 1*

*One stores in P in addition to the terms which had their place in initial storage, them “downward” of first generation of the initial terms. Indeed during factorization, one null term in A can become nonnull in P. One obtains thus the filling of level 1.*

*If niv = 2,...*

*The same process is taken again: the matrix P filled on the level niv-1 creates the terms of stamp P on the level niv.*

*The larger niv is, the closer the matrix P is to  $AI$  and thus more the combined gradient converge quickly (in iteration count).*

*On the other hand, more niv is the great more storage of P becomes bulky (in memory and on disc) and more the iterations are expensive in CPU.*

*The first tests showed (roughly) that the size of P was worth:*

*.  
3,5\* size (A) for niv = 1*

*.  
7,5\* size (A) for niv = 2*

*Our experiment of this key word is still limited and we advise to use the value by defect (niv = 0).*

*If niv = 0 does not allow the gradient combined to converge, one will test successively them*

*values niv = 1, 2, 3.*

*Instruction manual*

*U4.5- booklet: Methods of resolution*

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*Code\_Aster* ®

*Version*

*7.4*

*Titrate:*

*Operator FACT\_GRAD*

*Date:*

*31/01/05*

*Author (S):*

*X. DESROCHES Key*

*:*

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*3.4 Operand*

*INFORMATION*

*INFORMATION*

*=*

*1: no impression,*

*2: this option is reserved for the developers. Intermediate impressions on the file message.*

*4 Example*

*of use*

*naked*

*= NUME\_DDL (MATR\_RIGI= mel, METHODE= "GCPC");*

*subdued = ASSE\_MATRICE (MATR\_ELEM= mel, naked NUME\_DDL=*  
*);*

*kmatas = FACT\_GRAD*

*(MATR\_ASSE= subdued);*

*Instruction manual*

*U4.5- booklet: Methods of resolution*

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---

**Code\_Aster** ®

**Version**

**7.4**

**Titrate:**

**Operator RESO\_GRAD**

**Date:**

**15/02/05**

**Author (S):**

**X. DESROCHES Key**

**:**

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**Organization (S): EDF-R & D /AMA**

**Instruction manual**

**U4.5- booklet: Methods of resolution**

**Document: U4.55.04**

**Operator RESO\_GRAD**

## ***1 Goal***

***To solve a linear system by the method of the pre-conditionné combined gradient. prepacking is obtained before by operator FACT\_GRAD [U4.55.03] and is necessary to obtain a satisfactory convergence in a minimum of iterations.***

*Operator sometimes réentrant (if one takes again a solution already obtained by RESO\_GRAD).*

*Product a structure of data of the cham\_no\_\* type.*

*Instruction manual*

*U4.5- booklet: Methods of resolution*

*HT-66/05/004/A*

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***Code\_Aster*** ®

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*7.4*

*Titrate:*

*Operator RESO\_GRAD*

*Date:*

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*Author (S):*

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*:*

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## ***2 Syntax***

$S [cham\_no\_*] = RESO\_GRAD$

*(reuse*

*= S,*

*MATR\_ASSE*

=

*With,*

/

*[matr\_asse\_DEPL\_R]*

/

*[matr\_asse\_TEMP\_R]*

/

*[matr\_asse\_PRES\_R]*

*CHAM\_NO*

=

*B,*

/

*[cham\_no\_DEPL\_R]*

/

*[cham\_no\_TEMP\_R]*

/

*[cham\_no\_PRES\_R]*

*CHAM\_CINE*

=

*vcine,*

/

*[cham\_no\_DEPL\_R]*

/

*[cham\_no\_TEMP\_R]*

/

*[cham\_no\_PRES\_R]*

*MATR\_FACT*

=

*precond,*

/

*[matr\_asse\_DEPL\_R]*

/

*[matr\_asse\_TEMP\_R]*

/

*[matr\_asse\_PRES\_R]*

*RECOVERY*

=

/“YES”

,

/

“NOT”

,

*[DEFECT]*

*RESI\_RELA*

=

/

*1.E-6*

,

*[DEFECT]*

/

*resi*

,

*[R]*

*NMAX\_ITER*

=

/

*niter*

,

*[I]*

/

*0*

,

*[DEFECT]*

*INFORMATION*

=

*/ 1 ,*

*/ 2 ,*

)

*If CHAM\_NO:*

*[cham\_no\_DEPL\_R]*

*then (\*)*

*DEPL\_R*



*[cham\_no\_TEMP\_R]*

*TEMP\_R*

*[cham\_no\_PRES\_R]*

*PRES\_R*

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***Code\_Aster*** ®

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*Date:*

*15/02/05*

*Author (S):*

***X. DESROCHES*** *Key*

*:*

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***3 Operands***

***3.1 Operand***

***MATR\_ASSE***

***MATR\_ASSE***

***= A***

*Name of the matrix assembled of the system to solve.*

### **3.2 Operand**

**CHAM\_NO**

**CHAM\_NO**

=

**B**

*Name of the cham\_no second member of the system.*

### **3.3 Operand**

**CHAM\_CINE**

**CHAM\_CINE**

= *vcine*

*Name of the vector representing the “value” of the conditions limit of degree type of freedom imposed translated in the form of kinematic loading (i.e. by the use of the order AFFE\_CHAR\_CINE (\_F). This cham\_no comes from the execution of operator CALC\_CHAR\_CINE on the list of the CHAR\_CINE (kinematic loading) associated assembled matrix A. Cf [U4.61.03].*

### **3.4 Operand**

**MATR\_FACT**

**MATR\_FACT**

= *precond*

*Stamp prepacking, obtained by operator FACT\_GRAD [U4.55.03]. prepacking is necessary to obtain a good convergence in a minimum iterations.*

### **3.5 Operand**

**RECOVERY**

**RECOVERY**

=

*Indicate if one is or not in resumption of a preceding calculation which would not have converged sufficient:*

*calculation is initialized by:*

**$X(0) = 0$**   
**null vector so TAKEN again = "NOT"**

**$X(0) = S$**   
**the cham\_no solution "so TAKEN again = "YES"; in this case, it is necessary to indicate reuse = S.**

**The default value is "NOT".**

### **3.6 Operand**

**RESI\_RELA**

**RESI\_RELA**  
**=**

**Criterion of convergence of the algorithm; it is a relative criterion on the residue:**

**$rm$  resi**

**B**

**$rm$  is the residue with the iteration  $m$**

**B**

**is the second member and the euclidian norm.**

**The default value is 1.E-6.**

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### **3.7 Operand**

***NMAX\_ITER***

***NMAX\_ITER***

***= niter***

***Maximum iteration count of the algorithm.***

***If NITER = the 0 then number maximum of iterations is calculated as follows:***

***niter = nequ/2 where nequ is the number of equations of the system.***

***The default value is 0.***

***3.8 Operand***

***INFORMATION***

***INFORMATION***

***=***

***Parameter of impression:***

***1 = nothing,***

***2 =***

***one prints the n° iteration to which one reached the criterion of convergence and the standard of the residue with a message of convergence.***

***Instruction manual***

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***Titrate:***

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***Date:***

***15/02/05***

***Author (S):***

***X. DESROCHES Key***

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### *Algorithm of the gradient combined by LDLT*

*Are:*

*A: the matrix of the system to be reversed,*

*C: the matrix of prepacking, where  $D = \text{diag}(A)$ ,*

*b: the vector second member of the system.*

#### *4.1 Initialization*

*()*

*X O = null vector*

*so BEGUN AGAIN: "NOT"*

*cham\_no produced*

*so BEGUN AGAIN: "YES"*

*(O)*

*(O)*

*R*

*= Ax*

*- B*

*0 = 0.*

4.2

#### *Body of the algorithm*

*rm*

*For m = 0 with niter and as long as*

*resi to make*

*B*

*~ (m)*

*(m)*

*that is to say to solve Cr*

**= R**

**where C**

**LDLT**

**=**

**incomplete,**

**~ (m)**

**(m)**

**that is to say to solve Dr.**

**=r**

**where D = diag (A)**

**(m) ~ (m)**

**m = (R, R)**

**(0)**

**~(0)**

**if m = 0 p**

**= R**

**(m)**

**(m)**

**m**

**(m -**

**~**

**) 1**

**if m > 0 p**

**= R**

**+**

**p**

**M-1**

**(m)**

**(m)**

**(R, p)**

**( )**

**m =**

**(**

**m)**

**(m)**

***(p, A.p)***

***(m+) 1***

***(m)***

***(m)***

***(m)***

***X***

***= X***

***-***

***p***

***reiterated m + 1***

***(m+) 1***

***(m)***

***(m)***

***(m)***

***R***

***= R***

***-***

***Ap***

***residue m + 1***

***End for m***

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***5 Example***

*of use*

*naked*

= *NUME\_DDL* (*MATR\_RIGI*= *mel*, *METHODE*= "GCPC", *RENUM*= "WITHOUT",)

*subdued* = *ASSE\_MATRICE* (*MATR\_ELEM*= *mel*, *naked NUME\_DDL*=

)

*vecas* = *ASSE\_VECTEUR* (*VECT\_ELEM*= *vel*, *naked NUME\_DDL*=

)

*kmatas*

= *FACT\_GRAD*

(*MATR\_ASSE*=

*subdued*

)

*EPD*

= *RESO\_GRAD*

(*CHAM\_NO* = *vecas*, *MATR\_ASSE*=

*subdued*,

*MATR\_FACT*=

*kmatas*,

*NMAX\_ITER*=

*1000*

,  
*RESI\_RELA*=

*1e-07*



)

## **6 Bibliography**

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[2]

**J.P. GREGOIRE: Establishment and optimization of the algorithm of the combined gradient [R6.01.02].**

**Instruction manual**

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**Code\_Aster ®**

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**7.4**

**Titrate:**

**Operator CALC\_MATR\_ELEM**

**Date:**

**09/02/05**

**Author (S):**

**J. Key PELLET**

**:**

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**Organization (S): EDF-R & D /AMA**

***Instruction manual***

***U4.6- booklet: Elementary matrices/Vectors and assembly***

***Document: U4.61.01***

***Operator CALC\_MATR\_ELEM***

***1 Goal***

***To calculate gatherable elementary matrices by order ASSE\_MATRICE.***

***The possible options of calculations are:***

***“AMOR\_ACOU”, “MASS\_MECA”, “RIGI\_FLUI\_STRU”, “RIGI\_ROTA”, “AMOR\_MECA”,  
“MASS\_MECA\_DIAG”, “RIGI\_GEOM”, “RIGI\_THER”, “IMPE\_MECA”, “MASS\_THER”,  
“RIGI\_MECA”,  
“MASS\_ACOU”, “ONDE\_FLUI”, “RIGI\_MECA\_HYST”, “MASS\_FLUI\_STRU”, “RIGI\_ACOU”,  
“RIGI\_MECA\_LAGR”, “MASS\_ID\_MDEP\_R”, “MASS\_ID\_MDNS\_R”, “MASS\_ID\_MTEM\_R”,  
“MASS\_ID\_MTNS\_R”***

***Product a structure of data of the matr\_elem\_\* type.***

***Instruction manual***

***U4.6- booklet: Elementary matrices/Vectors and assembly***

***HT-66/05/004/A***

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***Code\_Aster ®***

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***Titrate:***  
***Operator CALC\_MATR\_ELEM***

***Date:***  
***09/02/05***  
***Author (S):***  
***J. Key PELLET***  
***:***  
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***2 Syntax***

***mel***

***[matr\_elem\_\*] = CALC\_MATR\_ELEM***

***(***  
***/OPTION = "RIGI\_MECA",***

***/MODEL***

***=***

***Mo,***  
***[model]***

***CHAM\_MATER***

***=***

***chmat,***

**[cham\_mater]**

**CARA\_ELEM**

= *caract*

, [*cara\_elem*]

**MODE\_FOURIER**

=/nh

, [**I**]

/

0

,

[**DEFECT**]

/

**CHARGE**

=

*l\_char*

,

[*l\_char\_meca*]

**INST**

=

/

**tps**

, **[R]**

/

**0.0**

, **[DEFECT]**

/

**OPTION =**

**“RIGI\_MECA\_LAGR”,**

**MODEL**

=

**Mo**

,

**[model]**

**CHAM\_MATER**

=

**chmat,**

**[cham\_mater]**

**CHARGE**

=  
*l\_char*  
,  
*[l\_char\_meca]*

*INST =*  
*/tps*  
,  
*[R]*  
*/*  
*0.0*  
,  
*[DEFECT]*

*THETA*  
*= ch\_theta*  
,  
*[theta\_geom]*

*PROPAGATION =,*  
*[R]*

*/*  
*OPTION =/"MASS\_MECA",*

/  
“*MASS\_MECA\_DIAG*”  
,

***MODEL***

=

***Mo***

,

***[model]***

***CHAM\_MATER***

=

***chmat,***

***[cham\_mater]***

***CHARGE***

=

***tank***

,

***[char\_meca]***

**INST =**  
**/tps**  
**,**  
**[R]**  
**/**  
**0.0**  
**,**  
**[DEFECT]**

**CARA\_ELEM**  
**=**  
**caract**  
**,**  
**[cara\_elem]**

**/**  
**OPTION =/"MASS\_ID\_MDEP\_R",**

**/**  
**"MASS\_ID\_MDNS\_R"**  
**,**



/  
**“MASS\_ID\_MTEM\_R”**  
,

/  
**“MASS\_ID\_MTNS\_R”**  
,

**MODEL =**  
**Mo,**  
**[model]**

/  
**OPTION = “RIGI\_GEOM”,**

**MODEL**  
**=**  
**Mo**  
**,**  
**[model]**

**CARA\_ELEM**

=

**carac,**

**[cara\_elem]**

**SIEF\_ELGA = sig, [cham\_elem\_SIEF\_R]**

**MODE\_FOURIER**

**=/nh**

**, [I]**

**/**

**0**

**,**

**[DEFECT]**

**/**

**OPTION = "RIGI\_ROTA",**

**MODEL = Mo, [model]**

**CHAM\_MATER**

=

*chmat,*  
*[cham\_mater]*

***CHARGE***

=

*l\_char, [l\_char\_meca]*

***INST =***

*/tps*

,

***[R]***

/

*0.0*

,

***[DEFECT]***

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Operator *CALC\_MATR\_ELEM*

Date:

09/02/05

Author (S):

**J. Key PELLET**

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/

*OPTION = "AMOR\_MECA",*

*MODEL = Mo, [model]*

/

*CARA\_ELEM = carac,*  
*[cara\_elem]*

/

*RIGI\_MECA = rigiel,*  
*[matr\_elem\_DEPL\_R]*

*MASS\_MECA = massel,*  
*[matr\_elem\_DEPL\_R]*

*CHAM\_MATER*  
=  
*chmat,*  
*[cham\_mater]*

*CHARGE*  
=  
*tank,*  
*[char\_meca]*

*INST*  
=  
/  
*tps*  
*, [R]*

/  
0.0  
, [DEFECT]

/  
OPTION = "RIGI\_MECA\_HYST",

MODEL = Mo,

CHAM\_MATER  
=  
chmat,  
[cham\_mater]

CHARGE  
=  
l\_char, [l\_char\_meca]

INST  
=  
/

*tps*

,

*[R]*

/

*0.0*

,

*[DEFECT]*

*RIGI\_MECA = rigiel,*

*[matr\_elem\_DEPL\_R]*

/

*OPTION= "RIGI\_THER",*

*/ MODEL =*

*Mo,*

*[model]*

*CHAM\_MATER*

=

*chmat,*

*[cham\_mater]*

*CARA\_ELEM*  
=  
*carac*,  
*[cara\_elem]*

*MODE\_FOURIER*  
=*nh*  
, *[I]*  
/  
*0*  
,  
*[DEFECT]*

/  
*CHARGE= lchar*,  
*[l\_char\_ther]*

/  
*OPTION= "MASS\_THER"*,



*MODELE* = *Mo*,  
[*model*]

*CHAM\_MATER* =  
*chmat*  
,  
[*cham\_mater*]

*CARA\_ELEM*  
=  
*carac*  
,  
[*cara\_elem*]

/  
*OPTION* =  
"RIGI\_ACOU",

*MODEL* =  
*Mo*,  
[*model*]

*CHAM\_MATER*

=

*chmat,*

*[cham\_mater]*

*CHARGE*

=

*lchar,*

*[l\_char\_acou]*

/

*OPTION =/"MASS\_ACOU",*

/

*"AMOR\_ACOU"*

,

*MODEL =*

*Mo,*

*[model]*

*CHAM\_MATER=*

*chmat*

,

*[cham\_mater]*

/  
*OPTION* =  
“*RIGI\_FLUI\_STRU*”,

*MODEL* =  
*Mo*,  
[*model*]

*CARA\_ELEM*  
=  
*carac*  
,  
[*cara\_elem*]

*CHAM\_MATER*=  
*chmat*  
,  
[*cham\_mater*]

*CHARGE*  
=  
*l\_char*, [*l\_char\_meca*]

*INST* =/tps

,

[R]

/

0.0

,

[DEFECT]

*OPTION* =

“MASS\_FLUI\_STRU”,

*MODEL* =

Mo,

[model]

*CARA\_ELEM*

=

carac

,

[cara\_elem]

*CHAM\_MATER=*

*chmat*

,  
*[cham\_mater]*

*CHARGE*

=

*tank,*

*[char\_meca]*

*INST =/tps*

,  
*[R]*

/

*0.0*

,  
*[DEFECT]*

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*Operator CALC\_MATR\_ELEM*

*Date:*

*09/02/05*

*Author (S):*

***J. Key PELLET***

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*/OPTION =*  
*/"IMPE\_MECA",*  
*/*  
*"ONDE\_FLUI"*  
*,*

*MODEL*  
*= Mo,*  
*[model]*

*CHARGE*  
*=*  
*lchar*  
*,*  
*[l\_char\_meca]*

*CHAM\_MATER=*  
*chmat*  
*,*  
*[cham\_mater]*

)

**If OPTION “AMOR\_ACOU”**

**then [\*]**

**PRES\_C**

**“AMOR\_MECA”**

**DEPL\_R**

**“IMPE\_MECA”**

**DEPL\_R**

**“MASS\_ACOU”**

**PRES\_C**

**“MASS\_FLUI\_STRU”**

**DEPL\_R**

**“MASS\_MECA”**

**DEPL\_R**

**“MASS\_MECA\_DIAG”**

**DEPL\_R**

**“MASS\_THER”**

**TEMP\_R**

**“ONDE\_FLUI”**

**DEPL\_R**

**“RIGI\_ACOU”**

**PRES\_C**

**“RIGI\_FLUI\_STRU”**

**DEPL\_R**

**“RIGI\_GEOM”**

**DEPL\_R**

**“RIGI\_MECA”**

**DEPL\_R**

**“RIGI\_MECA\_HYST”**

**DEPL\_C**

**“RIGI\_MECA\_LAGR”**

**DEPL\_R**

**“RIGI\_ROTA”**

**DEPL\_R**

**“RIGI\_THER”**

**TEMP\_R**

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**Operator CALC\_MATR\_ELEM**

**Date:**

**09/02/05**

**Author (S):**

**J. Key PELLETT**

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**3 Operands**

**3.1 Operand**

**OPTION**

**OPTION =**

**The table which follows gives the list of the matrices calculated by an option as well as the type of element which the option applies.**

**This type of element is given either by the name of the phenomenon having made it possible to define the model, maybe by the name of the operator having produced the concept charges.**

**Option Phenomenon**

**or**

**Stamp**

**operator**



### **MECHANICAL “AMOR\_MECA”**

*Damping of the elements calculated by combination linear of rigidity and the mass [U2.06.03] or by direct assignment for the discrete elements.*

### **MECHANICAL “IMPE\_MECA”**

*Acoustic impedance of the surface elements belonging to modelings “3D\_FLUIDE” or “2D\_FLUIDE” of the model Mo [U4.53.11].*

### **'MECHANICAL MASS\_FLUI\_STRU'\***

*Mass elements of the model Mo with taking into account fluids external and intern with the structure and coefficient of containment.*

### **MECHANICAL “MASS\_MECA”**

*Mass elements of the model Mo.*

### **MECHANICAL “MASS\_MECA\_DIAG”**

*Mass (diagonal) elements of the model Mo.*

### **“MASS\_ID\_MDEP\_R”**

### **MECHANICS**

*Stamp “identity”. This matrix can be used to calculate them*

### **“MASS\_ID\_MDNS\_R”**

*eigenvalues and clean modes of another matrix*

*(for example rigidity to test the movements of*

### **“MASS\_ID\_MTEM\_R”**

*solid body).*

### **“MASS\_ID\_MTNS\_R”**

*There are 4 different options adapted to the 4 possibilities:*

*symmetrical mechanics + matrix - > MDEP\_R*

*not-symmetrical mechanics + matrix - > MDNS\_R*

*symmetrical thermics + matrix - > MTEM\_R*

*not-symmetrical thermics + matrix - > MTNS\_R*

### **MECHANICAL “ONDE\_FLUI”**

*Acoustic impedance of the surface elements of model Mo pertaining to modelings “3D\_FLUIDE” and “2D\_FLUIDE”.*

*This impedance corresponds to the influence of a wave incidental harmonic of pressure [U4.53.11].*

### **'MECHANICAL RIGI\_FLUI\_STRU'\***

*Rigidity of the elements of the model Mo with taking into account fluids external and intern with the structure and coefficient of containment.*

### **MECHANICAL “RIGI\_GEOM”**

*Geometrical rigidity of the elements of the model Mo.*

**MECHANICAL “RIGI\_MECA”**

*Rigidity of the elements of the model Mo.*

**AFFE\_CHAR\_MECA**

*Stamp associated with the multipliers with LAGRANGE with lchar.*

**MECHANICAL “RIGI\_MECA\_HYST”**

*Hysteretic rigidity (complex) calculated by multiplication by a complex number simple rigidity [U2.06.03].*

**AFFE\_CHAR\_MECA**

*Stamp associated with the multipliers with LAGRANGE with lchar.*

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*7.4*

*Titrate:*

*Operator CALC\_MATR\_ELEM*

*Date:*

*09/02/05*

*Author (S):*

*J. Key PELLET*

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**MECHANICAL “RIGI\_MECA\_LAGR”**

*Rigidity of the elements of the model Mo “deformed” by one field [U4.82.03].*

**AFFE\_CHAR\_MECA**

*Stamp associated with the multipliers with LAGRANGE with lchar.*

**MECHANICAL “RIGI\_ROTA”**

*Rigidity of rotation of the elements of the model Mo*

**THERMAL “MASS\_THER”**

*Mass elements of the model Mo.*

### **THERMAL “RIGI\_THER”**

*Rigidity of the elements of the model Mo.*

### **AFFE\_CHAR\_THER**

*Rigidity coming from the conditions of exchange of lchar.*

### **AFFE\_CHAR\_THER**

*Stamp associated with the multipliers with LAGRANGE with lchar.*

### **ACOUSTIC “AMOR\_ACOU”**

*Damping of the elements of the model Mo.*

### **ACOUSTIC “MASS\_ACOU”**

*Mass elements of the model Mo.*

### **ACOUSTIC “RIGI\_ACOU”**

*Rigidity of the elements of the model Mo.*

### **AFFE\_CHAR\_ACOU**

*Stamp associated with the multipliers with LAGRANGE with lchar.*

*The marked options \* relate to the resorption of software FLUSTRU:*

*These two options: “RIGI\_FLUI\_STRU” and “MASS\_FLUI\_STRU” make it possible to calculate them*

*matrices of mass and rigidity (and thus a modal base) for a structure of beam (SEG2) bathed by an external fluid. The relation of behavior of material must be ELAS\_FLU.*

## **3.2 Operands**

### **MODEL/CHAM\_MATER/CARA\_ELEM**

#### **MODEL =**

*This operand is used to indicate the elements for which calculations must be carried out elementary: it is pointed out that the finite elements for the majority are defined in the model.*

*There are two exceptions:*

*1) Elements of dualisation of the conditions of DIRICHLET, i.e. elements allowing to impose conditions on the degrees of freedom of displacement in mechanics, degrees of freedom of temperature in thermics and degrees of freedom of pressure in accoustics.*

*2) Nodal loading elements.*

*These elements are defined in the concepts of the char\_meca type, char\_ther or char\_acou.*

*One must thus provide the argument l\_char for the calculation of the elementary matrices of rigidity: RIGI\_MECA, RIGI\_THER, RIGI\_ACOU, RIGI\_MECA\_HYST and RIGI\_MECA\_LAGR.*

**CHAM\_MATER =**

*Name of the material field where the characteristics of materials of the elements are defined.*

*This argument is almost always necessary.*

*In practice, one can do some:*

*.  
for the discrete elements whose elementary matrices are defined in the concept  
cara\_lem. See AFFE\_CARA\_ELEM [U4.42.01],*

*.  
for the calculation of rigidities due to the dualisation of the boundary conditions.*

**CARA\_ELEM = carac**

*The elementary characteristics carac are necessary if there exists in the model of  
elements of beam, hull or of the discrete elements or if a reference mark of anisotropy were defined  
on*

*solid elements (MASSIVE key word of order AFFE\_CARA\_ELEM).*

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**3.3 Operand**

**CHARGE and INST**

**CHARGE = tank**

*This operand has several distinct functions:*

- 1) *to specify the elements for which elementary calculations of rigidity are made (conditions of DIRICHLET),*
- 2) *for the options of mechanics, to specify a possible field of temperature when it material is a function of the temperature (cf key word INST). In this case, to make attention so that there are not several different temperatures in the argument lchar, the temperature used is then the first found in the list of the loads (Cf AFFE\_CHAR\_MECA\_..., key word TEMP\_CALCULEE [U4.44.01 § 3.3]),*
- 3) *for the option “IMPE\_MECA”: to give the value of the acoustic impedance of the meshes of edge,*
- 4) *for the option “ONDE\_FLUI”: to give the value of the pressure of the incidental wave,*
- 5) *for the option “RIGI\_ROTA”: to give the value of the rotation imposed on the model.*

*Example:*

*If one wants to distinguish two different concepts matr\_elem for same option RIGI\_MECA:*

- *for the elements of the model,*
- *for the elements of DIRICHLET.*

*and that the material is a function of the temperature, one can write:*

```

chtemp
=
AFFE_CHAR_MECA

(TEMP_CALCULEE = temper1)
chabloc =
AFFE_CHAR_MECA

(DDL_IMPO = .....)
melmo
=

```

***CALC\_MATR\_ELEM***

***(MODEL = Mo,***

***OPTION***

***=***

***“RIGI\_MECA”***

***,***

***CHAM\_MATER***

***=***

***.....,***

***CHARGE***

***=***

***chtemp***

***,***

***INST***

***=1.,***

***)***

***melbloc =***

***CALC\_MATR\_ELEM***

***(OPTION = “RIGI\_MECA”,***

***CHARGE***

***=***

***chabloc,***

***)***

***INST = tps***

***The argument tps is used only into thermomechanical.***

***Lorsqu " there exists a temperature in one of the concepts charges, one uses the field then of temperature possibly interpolated at the moment tps. This field of temperature can vary characteristics of the material field if the material is a function of the temperature; if not this argument is useless.***

### ***3.4 Operand***

***MODE\_FOURIER***

***MODE\_FOURIER = nh***

***Positive or null entirety indicating the harmonic of FOURIER on whom one calculates the matrices elementary.***

***By defect: nh = 0***

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### ***3.5 Operand***

***SIEF\_ELGA (option "RIGI\_GEOM")***

***SIEF\_ELGA = sig***

***The stress field sig given for the calculation of option “RIGI\_GEOM” must have in theory summer calculated with option “SIEF\_ELGA\_DEPL” (stress field at the points of GAUSS of elements) (cf orders CALC\_CHAM\_ELEM [U4.81.03] or CALC\_ELEM [U4.81.01]). The theory of fambement linear indeed supposes a theory of small displacements rubber bands.***

### ***3.6 Operands***

***RIGI\_MECA and MASSE\_MECA (options “AMOR\_MECA” and “RIGI\_MECA\_HYST”)***

***RIGI\_MECA***

***=***

***Elementary matrices of rigidity (option: “RIGI\_MECA”) necessary to the calculation of the matrices of damping (“AMOR\_MECA”) or of hysteretic rigidity (“RIGI\_MECA\_HYST”) to see “Note of use of damping and hysteretic rigidity ” [U2.06.03].***

***MASS\_MECA =***

***Elementary matrices of mass (option: “MASS\_MECA” or “MASS\_MECA\_DIAG”) necessary with the calculation of the matrices of damping (“AMOR\_MECA”).***

***Note:***

***For option “RIGI\_MECA\_HYST”, the result of calculation will contain in addition to rigidity hysteretic of the elements of the model, the “rigidity” of the elements of Lagrange of the loads provided.***

### ***3.7 Operands***

***THETA and PROPAGATION (option “RIGI\_MECA\_LAGR”)***

***THETA = ch\_theta***

***These key words relate to only the Lagrangian propagation [U4.82.03].***

## ***4***

***Examples of calculations with CALC\_MATR\_ELEM***

### ***4.1***



## ***Stamp geometrical rigidity for the buckling of EULER***

```
rigigeom = CALC_MATR_ELEM (  
OPTION = "RIGI_GEOM", MODELS = Mo,  
CARA_ELEM  
=  
carac  
,  
SIEF_ELGA  
=  
chsig  
)
```

### ***4.2***

#### ***Stamp of "mass" in accoustics***

```
massacou = CALC_MATR_ELEM (  
OPTION = "MASS_ACOU", MODELS = Mo,  
CHAM_MATER  
=  
chmat  
,  
CHARGE  
=  
tank  
)
```

### ***4.3***

#### ***Stamp rigidity of the elements of LAGRANGE in mechanics***

```
rigibloc = CALC_MATR_ELEM (  
OPTION = "RIGI_MECA", LOAD = ch_bloc)
```

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## ***Operator CALC\_VECT\_ELEM***

***Date:***

***19/01/05***

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***J. Key PELLETT***

***:***

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***Organization (S): EDF-R & D /AMA***

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***Document: U4.61.02***

## ***Operator CALC\_VECT\_ELEM***

***1 Goal***

***To calculate a whole of gatherable elementary vectors by ASSE\_VECTEUR.***

*The possible options of calculation are:*

*“CHAR\_MECA”, “CHAR\_THER”, “CHAR\_ACOU”, “FORC\_NODA”, “CHAR\_MECA\_LAGR”.*

*Product a structure of data of the vect\_elem\_\* type.*

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*2 Syntax*

*vel*

*[vect\_elem\_\*]*

*=*

*CALC\_VECT\_ELEM*

*(/OPTION = “CHAR\_MECA”,*

/  
**CHAM\_MATER = chmat, [cham\_mater]**

**CARA\_ELEM**  
**= carac**  
**, [cara\_elem]**

**CHARGE = lchar,**  
**[l\_char\_meca]**

**INST =/tps**  
**, [R]**  
**/**  
**0.0**  
**, [DEFECT]**

**MODE\_FOURIER**

**=/nh,**

**[I]**

**/**

**0,**

**[DEFECT]**

**#**

**case**

**of one**

**model**

**container**

**#**

**substructures**

**statics**

**:**

**/**

**MODEL**

**=**

**Mo,**

**[model]**

**SOUS\_STRUC = \_F (**

*CAS\_CHARGE = nocas, [K8]*

*/ALL = "YES",*

*/*  
*NET = lmail, [l\_maille]*  
*)*

*/*  
*OPTION = "CHAR\_THER",*

**CARA\_ELEM**

=

*carac,*

*[cara\_elem]*

**CHARGE**

=

*lchar*

,

*[l\_char\_ther]*

/

**OPTION = "CHAR\_ACOU",**

**CHAM\_MATER = *chmat,***

*[cham\_mater]*

**CHARGE**

=

*lchar*

,

*[l\_char\_acou]*

/  
**OPTION =**  
**“FORC\_NODA”,**

**SIEF\_ELGA**  
**=**  
**chsig**  
**,**  
**[cham\_elem\_SIEF\_R]**

**CARA\_ELEM**  
**=**  
**carac**  
**,**  
**[cara\_elem]**

**MODEL = Mo**  
**,**  
**[model]**



/  
***OPTION = "CHAR\_MECA\_LAGR",***

***CHAM\_MATER = chmat,***

***[cham\_mater]***

***THETA = CH, [theta\_geom]***

***PROPAGATION =/0. ,***

***[DEFECT]***

/  
,  
[R]

*CHARGE = lchar,*

*[l\_char\_meca]*

)

*If*

*OPTION*

*“CHAR\_THER”*

*then [\*]*

*TEMP\_R*

*“CHAR\_MECA”*

*DEPL\_R*

*“CHAR\_ACOU”*

*PRES\_R*

*“FORC\_NODA”*

*DEPL\_R*

*“CHAR\_MECA\_LAGR”*

*DEPL\_R*

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### **3 General information**

***This order is used to calculate a whole of elementary vectors (correspondent with an option chosen). The concept created of vect\_elem\_\* type could be then assembled by the operator ASSE\_VECTEUR [U4.42.03] to give a second member of the cham\_no\_\* type.***

***The options available are:***

***“CHAR\_MECA”***

***to obtain the second member of a mechanical problem,***

***“CHAR\_THER”***

***to obtain the second member of a thermal problem,***

***“CHAR\_ACOU”***

***to obtain the second member of an acoustic problem,***

***“CHAR\_MECA\_LAGR”***

***to obtain the second member during an analysis of propagation***

***Lagrangian of crack [U4.82.03] (valid in 2D only),***

***and “FORC\_NODA” for the calculation of the nodal forces equivalent to a stress field.***

***This last option is calculated by the formula:***

***. () D***

***: tensor of constraints***

***: function test***

### **4 Operands**

#### **4.1 Operand**

**CHARGE**

**CHARGE = lchar**

***The list of the loads lchar must be coherent with the selected option:***

.  
“*mechanical*” loads for option “*CHAR\_MECA*”,

.  
“*thermal*” loads for option “*CHAR\_THER*”,

.  
“*acoustic*” loads for option “*CHAR\_ACOU*”.

*This argument is obligatory (except for option “FORC\_NODA”).*

*It gives access all the data concerning the “loading” of the system. It is necessary that all the loads of the list are based on the same model.*

***Notice concerning the mechanical loading of thermal origin:***

*In mechanics, a field of temperature can intervene in two ways in one loading:*

.  
*by caused dilation,*

.  
*by the variation of the material characteristics according to T.*

*By convention, if a thermal evolution is present in one of the loads of lchar, these two effects are taken into account.*

*If one wants to dissociate them, it is necessary (according to the sought effect):*

.  
*to give material characteristics **independent** of T,*

.  
*or to give a null dilation coefficient.*

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#### **4.2 Operand**

**INST**

*INST = tps*

*The parameter tps is used only into thermomechanical, when there is a temperature in one concepts charges. One then uses the field of temperature at the moment tps like mechanical loading (dilation). In this case, the parameter chmat is necessary (for dilation coefficient and the temperature of reference cf AFFE\_MATERIAU).*

#### **4.3 Operand**

**CHAM\_MATER**

*CHAM\_MATER*

*Name of the material field where the material characteristics of the elements are defined. This argument is necessary into thermomechanical for the loadings gravity, rotation, dilation and in accoustics.*

#### **4.4 Operand**

**CARA\_ELEM**

*CARA\_ELEM = carac*

*This concept of the cara\_elem type is necessary if there exists in the model of the elements of structure (beam, plate, hull or of the discrete elements).*

#### **4.5 Operand**

**MODE\_FOURIER**

*MODE\_FOURIER = nh*

*Positive or null entirety indicating the harmonic of FOURIER on whom one calculates the vector elementary for an axisymmetric model 2D. By defect, nh = 0.*

*nh intervenes only for one loading where there is thermal dilation.*

#### **4.6 Operand**

##### **SIEF\_ELGA**

*SIEF\_ELGA = chsig*

*Name of a stress field at the points of GAUSS, allowing the calculation of the nodal forces. The model used is that which made it possible to calculate chsig.*

##### **Note:**

*For data-processing reasons, if the stress field chsig were calculated on one **subset** of the meshes of the model, it is necessary to give the name of this model by the key word **MODEL = Mo**.*

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#### ***4.7 Operands necessary to calculations with under-structuring statics***

*MODEL = Mo*

*This key word is obligatory to find the substructures affected by the loading: Mo is the name of the model which carries the substructures.*

*SOUS\_STRUC*

*This key word factor makes it possible to specify which are the loadings to be used for substructures. In its absence, the loadings on under structures are null.*

*These loadings are added to the loadings “finite elements” which can be applied to remain model.*

*CAS\_CHARGE = nocas*

*nocas is the name of the loading case to be used. See operator *MACR\_ELEM\_STAT* [U4.62.01].*

*/ALL = “YES”*

*This key word makes it possible to affect the loading nocas to all under structures of model.*

/

*NET*

=

*l\_mail*

*This key word factor makes it possible to assign the loading nocas only to some substructures.*

#### **4.8**

#### ***Operands for the calculation of Lagrangian propagation of crack***

*THETA = CH,*

*PROPAGATION*

=

,

*These two key words relate to only the Lagrangian propagation [U4.82.03].*

#### ***5 Examples***

.

***Mechanical loading at the moment T = 12. of a structure affected by a thermal evolution:***

*vel = CALC\_VECT\_ELEM  
(OPTION = "CHAR\_MECA",*

*CHAM\_MATER = chmat, LOAD = (ch\_force, ch\_tempe), INST = 12. ,)*

.

***Calculation of the nodal forces (postprocessing) for a model 3D:***

*vel = CALC\_VECT\_ELEM  
(OPTION = "FORC\_NODA",  
SIEF\_ELGA*

=

*chsig,*

)

.

***Calculation of the second member for a problem of linear thermics stationary:***



*vel = CALC\_VECT\_ELEM*  
*(OPTION = "CHAR\_THER",*  
*CHARGE = ch\_ther)*

.

*Calculation of the mechanical loading of a structure containing of the static substructures:*

*vel = CALC\_VECT\_ELEM*  
*(OPTION = "CHAR\_MECA",*  
*CHARGE*

=

*ch\_meca*

,

*MODEL = Mo, SOUS\_STRUC= \_F (CAS\_CHARGE = "ch\_f1", TOUT= "YES"))*

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*Titrate:*

*Operator CALC\_CHAR\_CINE*

*Date:*

*31/01/06*

*Author (S):*

*J. Key PELLET*

*:*

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*Organization (S): EDF-R & D /AMA*

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***Document: U4.61.03***

***Operator CALC\_CHAR\_CINE***

***1 Goal***

***To calculate the field with the nodes corresponding to the degrees of freedom imposed by AFFE\_CHAR\_CINE.***

***This field with the nodes thus calculated will have to be used at the time of the resolution of the linear system with operators RESO\_LDLT [U4.51.02] or RESO\_GRAD [U4.51.04].***

***This operator is useful only for calculations “step by step” where one solves the linear systems by orders RESO\_LDLT or RESO\_GRAD.***

***Product a structure of data of the cham\_no type.***

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***Version***

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**Titrator:**

**Operator** *CALC\_CHAR\_CINE*

**Date:**

*31/01/06*

**Author (S):**

**J. Key** *PELLET*

**:**  
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### **2 Syntax**

*u0 [cham\_no\_\*]*

=

*CALC\_CHAR\_CINE*

(  
*NUME\_DDL*

=

*naked*

,  
*[nume\_ddl]*

*CHAR\_CINE = chci,/[l\_char\_cine\_meca]*

/

*[l\_char\_cine\_ther]*

/

*[l\_char\_cine\_acou]*

***INST =/T, [R]***

***/***

***0.0***

***,***

***[DEFECT]***

***INFORMATION =/1, [DEFECT]***

***/2,***

***)***

***If CHAR\_CINE: [l\_char\_cine\_meca]***

***then [\*]***

***DEPL\_R***

**[l\_char\_cine\_ther]**

**[\*]**

**TEMP\_R**

**[l\_char\_cine\_acou]**

**[\*]**

**PRES\_C**

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**3 Operands**

**3.1 Operand**

**NUME\_DDL**

**NUME\_DDL = naked**

**Name of classification associated with the matrix which will be used for the resolution.**

**3.2 Operand**

**CHAR\_CINE**

**CHAR\_CINE = l\_chci**

**List names of the loads kinematics to be evaluated.**

***The calculated cham\_no will contain:***

***value 0 on the degrees of freedom which are not imposed,***

***the specified value by the loads kinematics on the degrees of freedom which are imposed.***

***Caution:***

***If a degree of freedom is imposed several times (if it appears in several loads kinematics of the list l\_chci), the specified value on this degree of freedom will be the sum of specified values, which is undoubtedly not what the user wishes!  
This dangerous behavior is unfortunately supplied with no alarm.***

***If the kinematic load is of function type, the specified value in a degree of freedom is that obtained by evaluation of the function to the co-ordinates of the node carrying the degree of freedom  
and at the moment T [§3.3].***

### ***3.3 Operand***

***INST***

***INST = T***

***Moment being used to evaluate possible functions of time [§3.2].***

### ***3.4 Operand***

***INFORMATION***

***INFORMATION = impr***

***Parameter of impression:***

***1: (defect) not of impression,***

***2: impression of the cham\_no\_\* result.***

### ***4 Examples***

*An example of sequence of orders using CALC\_CHAR\_CINE is given in documentation of order AFFE\_CHAR\_CINE [U4.44.03].*

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*8.2*

*Titrate:*

*Operator NUME\_DDL*

*Date:*

*31/01/06*

*Author (S):*

*J. Key PELLET*

*:*

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*Organization (S): EDF-R & D /AMA*

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*Operator NUME\_DDL*

## ***1 Goal***

***To number the unknown factors of a system of linear equations. This operator “also prepares” assembly of the matrix associated with this system with equations.***

***It is in this operator that the method of resolution of the linear systems is selected: LDLT, gradient combined or multi-frontal.***

***Product a structure of data of the nume\_ddl type.***

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## ***2 Syntax***

***naked [nume\_ddl] = NUME\_DDL***

***(***

***/***

**MODEL**

=

**Mo**

,

**[model]**

**CHARGE**

=

**lchar,**

/

**[l\_char\_meca]**

/

**[l\_char\_ther]**

/

**[l\_char\_acou]**

/

**MATR\_RIGI**

=

**lme1**

,

/

**[l\_matr\_elem\_TEMP\_R]**

/

**[l\_matr\_elem\_DEPL\_R]**

/

**[l\_matr\_elem\_DEPL\_C]**

/

**[l\_matr\_elem\_PRES\_C]**

/

**METHOD**

=

**“MULT\_FRONT”**

,

**[DEFECT]**

**RENUM**

=

/

**“MONGREL”,**

,

**[DEFECT]**

/

**“MANDELEVIUM”**

,

/

**“MDA”**

,

/

**METHOD**

=

**“LDLT”**

,

**RENUM**

=

/

**“RCMK”**

,

**[DEFECT]**

/

**“WITHOUT”**

,

/

**METHOD**

=

**“MUMPS”**

,

/

**METHOD**

=

**“GCPC”**

,

**RENUM**

=

/

**“RCMK”**

,

**[DEFECT]**

/

**“WITHOUT”**

,

**INFORMATION**

=

/

1

,

**[DEFECT]**

/ 2 ,

)

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### ***3 General information***

***This order makes it possible to number the equations (and the unknown factors) of the linear systems with***

***to solve. One also prepares the work of assembly of the matrices, by drawing up the tables of pointers corresponding to the storage chosen for these matrices.***

***The choice of the method is made by the key word METHOD (method “MULT\_FRONT” by defect).***

### ***4 Operands***

#### ***4.1 Operand***

***MODEL/LOAD***

***/MODEL = Mo, LOAD = lchar***

***The code will number the degrees of freedom of the elements of the model Mo as well as the degrees of***

***freedom of dualisation of the conditions kinematics dualized possibly present in loads of the list lchar.***

#### ***4.2 Operand***

***MATR\_RIGI***

*/MATR\_RIGI = lmel*

*List matr\_elem\_\* allowing to establish the classification of the unknown factors of the problem.*

*The goal of this operator is to number all the degrees of freedom of the problem. These degrees of freedom are those carried by the elementary matrices calculated by the operator CALC\_MATR\_ELEM (lmel).*

*Because of dualisation of the conditions “kinematics”, the degrees of freedom of Lagrange are carried by the matr\_elem calculated by option “RIGI\_MECA” (or “RIGI\_THER”,...) on the loads where the conditions kinematics are defined.*

*It is thus important to give in lmel, the list of all the matr\_elem of “rigidity” and of not to forget the loads in operator CALC\_MATR\_ELEM [U4.61.01].*

### **4.3 Operand METHOD**

*This operand is used to choose the method of resolution which one will apply to the future linear systems who will be built on the nume\_ddl produced by this order.*

*/“MULT\_FRONT”  
method “multi\_frontale” without swivelling  
/“MUMPS” method “multi\_frontale” with swivelling  
/“LDLT”  
factorization of the type LU without swivelling  
/“GCPC”  
combined gradient*

*The choice of the method of resolution has an important influence on the mode of storage of assembled matrices (future) matr\_asse\_\**

*/  
“LDLT”  
storage “line of sky” per blocks  
/“MULT\_FRONT”,  
“MUMPS”  
or “GCPC” storage “Morse”*

*The storage Morse (which preserves only the nonnull terms of the matrix) is much more economic than line storage of sky.*

*On the other hand for a large system, this storage imposes a size important memory because the*

## **matrix**

*is stored in only one vector, whereas line storage of sky is cut out in several blocks of size fixed by key word TAILLE\_BLOC of the order BEGINNING.*

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## **4.4 Operand**

### **RENUM**

*This operand is used to renumber (if it is wished) the unknown factors of the problem.*

**“MANDELEVIUM”**

*(Degree Minimum): it is the method of renumerotation associated with the resolution*

*MULT\_FRONT. It minimizes the filling of the matrix during its factorization*

*(i.e.: appearance of nonnull terms).*

**“MDA”**

*(Degree Minimum Approximate): it is an approximate method of the preceding method. With*

*priori, classification obtained is a little less optimal than by “MANDELEVIUM” (for what*

*relate to the filling), but it is less expensive to establish.*

**“MONGREL”** *another method of classification for the multi-frontal method. It is based on one technique of “encased dissection”.*



**“WITHOUT”**

*one keeps the initial order of the nodes given in the file of grid*

**“RCMK”** *“Reverse CUTHIL MAC KEE” this algorithm of renumerotation is often effective for to reduce the place necessary to storage “line of sky” of the assembled matrix. It is thus also effective in time CPU during the triangulation of such a matrix, by the operator FACT\_LDLT [U4.55.01].*

#### **4.5 Operand INFORMATION**

*INFORMATION*

=

/  
1  
*on the file MESSAGE.*

- *numbers total degrees of freedom, numbers nodes,*
- *a number of degrees of freedom of LAGRANGE,*
- *maximum height of a column (and average height),*
- *a number of stored terms (for storage “MORSE”),*
- *a number of blocks (for line storage of sky),*
- *information concerning the renumerotation.*

#### **5 Examples**

**# for a resolution “LDLT” with renumerotation “RCMK”:**

***naked = NUME\_DDL (MATR\_RIGI = mel, METHOD = “LDLT”,***

***)***

***K = ASSE\_MATRICE (MATR\_ELEM = mel, NUME\_DDL = naked***

***,***

)

***K = FACT\_LDLT (MATR\_ASSE = K,  
reuse = K,***

)

***U = RESO\_LDLT (MATR\_ASSE = K,  
CHAM\_NO = F,***

)

***# for a resolution "MULTI\_FRONTALE":***

***naked***

***=***

***NUME\_DDL***

***(MATR\_RIGI***

***=***

***mel,***

***)***

***K = ASSE\_MATRICE (MATR\_ELEM = mel, NUME\_DDL = naked***

***,***

)

***K = FACT\_LDLT (MATR\_ASSE = K,***

*reuse = K,*

)

*U = RESO\_LDLT (MATR\_ASSE = K,  
CHAM\_NO = F,*

)

*# for a resolution "GRADIENT COMBINES":*

*naked = NUME\_DDL (MATR\_RIGI = mel, METHOD = "GCPC",*

)

*K = ASSE\_MATRICE (MATR\_ELEM = mel, NUME\_DDL = naked*

,

)

*K2*

=

*FACT\_GRAD*

*(MATR\_ASSE*

=

*K,*

)

*U = RESO\_GRAD (MATR\_ASSE = K,  
MATR\_FACT = K2, CHAM\_NO = F,*

)

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*Date:*

31/01/05

*Author (S):*

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*Organization (S): EDF-R & D /AMA*

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***Document: U4.61.21***

***Macro order MACRO\_MATR\_ASSE***

***1 Goal***

*To calculate one or more assembled matrices (rigidity, mass, damping,...).*

*This order is recommended to create `matr_asse` them necessary to dynamic calculations. It avoids tiresome calls to the “basic” orders: `CALC_MATR_ELEM [U4.41.01]`, `NUME_DDL [U4.61.01]`, `ASSE_MATRICE [U4.61.22]`.*

*Product one or more structure of data of the `matr_asse_*` type more, possibly, one structure of data of the `nume_ddl` type.*

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*2 Syntax*

*`MACRO_MATR_ASSE` (*

*`MODEL`*

*=*

*`Mo`*

*,*

*[`model`]*

*`CHAM_MATER` = `chmater`,*

*[`cham_mater`]*

*`CARA_ELEM`*

*=*

*`carac`*

*,*

**[cara\_elem]**

**CHARGE**

=

**l\_char**

,

/

**[l\_char\_meca]**

/

**[l\_char\_ther]**

/

**[l\_char\_acou]**

**INST =/tps**

,

**[R]**

/

**0.**

,

**[DEFECT]**

**NUME\_DDL**

=

**naked**

,

**[nume\_ddl]**

**SOLVEUR = \_F**

**(... to see [U4.50.01])**

**MATR\_ASSE**

=

**(\_F (**

**STAMP =**

**subdued**

,

**[matr\_asse\_\*]**

**OPTION**

=

#

**phenomenon**

**mechanics**

:

/

**“RIGI\_MECA”**

,

**MODE\_FOURIER**

**=/nh**

**, [1]**

/

**0**

,

**[DEFECT]**

/

**“RIGI\_GEOM”**

,

**SIEF\_ELGA**

=

**sig**

**, [cham\_elem\_SIEF\_R]**



**MODE\_FOURIER**

**=/nh**

**, [I]**

**/**

**0**

**,**

**[DEFECT]**

**/**

**“RIGI\_ROTA”**

**,**

**/**

**“IMPE\_MECA”**

**,**

**/**

**“ONDE\_FLUI”**

**,**

**/**

**“RIGI\_MECA\_HYST”**

**,**

**/**

**“RIGI\_FLUI\_STRU”**

**,**

**/**

**“AMOR\_MECA”**

**,**

**/**

**“MASS\_FLUI\_STRU”**

**,**

**/**

**“RIGI\_MECA\_LAGR”**

**,**

**PROPAGATION**

**=**

,  
[R]

*THETA = ch\_theta, [theta\_geom]*

/  
"MASS\_MECA"

,  
/  
"MASS\_MECA\_DIAG"

,  
/  
"MASS\_ID\_MDEP\_R"

,  
/  
"MASS\_ID\_MDNS\_R"

,  
#  
*phenomenon*  
*thermics*

:  
/  
"RIGI\_THER"

,

*MODE\_FOURIER*

*=/nh*

, [I]

/

0

,  
[DEFECT]

/  
"MASS\_THER"  
,  
/  
"RIGI\_THER\_CONV"  
,  
/  
"RIGI\_THER\_CONV\_D"  
,  
/  
"MASS\_ID\_MTEM\_R"  
,  
/  
"MASS\_ID\_MTNS\_R"  
,

#  
*phenomenon*  
*accoustics*

:  
/  
"RIGI\_ACOU"  
,  
/  
"MASS\_ACOU"  
,  
/  
"AMOR\_ACOU"

,),  
*TITRATE*  
=  
*titr*  
,  
[l\_Kn]

)  
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**3 Operands**

**3.1**

**Concepts created by the macro-order**

**This macro-order creates several typified concepts:**

**.**

**a *matr\_asse\_\** with each event of the key word factor *MATR\_ASSE* (key word *STAMPS*),**

**.**

**possibly a *nume\_ddl* (key word *NUME\_DDL*) if this one does not exist as a preliminary.**

**That is to say for example the sequence:**

**...**

**# *naked* is not a still existing concept.**

**MACRO\_MATR\_ASSE (MODEL = Mo...,**

**NUME\_DDL**

**=**

**Co (“*naked*”),**

**MATR\_ASSE**

**=**

**(**

**\_F (**

**MATRICE=**

**Co (“*K*”),**

**OPTION=' RIGI\_MECA'))**

**MACRO\_MATR\_ASSE** (*MODEL = Mo...*,  
**NUME\_DDL**  
 =  
*naked*,  
**MATR\_ASSE**  
 =  
 (  
 \_F (*MATRICE=co* (“M”), *OPTION=' MASS\_MECA'*),  
 \_F (*MATRICE=co* (“A”), *OPTION=' AMOR\_MECA'*),),)

*the 1st call to MACRO\_MATR\_ASSE creates*

*1 MATR\_ASSE: K*

*1*

*NUME\_DDL: naked*

*the 2nd call to MACRO\_MATR\_ASSE creates*

*2 MATR\_ASSE: M and A*

### **Note:**

*At the time of the 2nd call, the concept nume\_ddl is provided (there exists, there was created by the 1st call).*

*In this case, it is supposed to be appropriate for the 2 matr\_asse to create; it is thus important that it nume\_ddl is initially calculated for an option of the type “RIGIDITY” to contain the nodes of Lagrange of the loads of blockings (cf CALC\_MATR\_ELEM [U4.61.01]).*

*In the preceding example, the 3 matr\_asse K, M and A is based on same classification unknown factors (naked). It is a condition necessary for the algorithms of search for clean modes.*

### **3.2 Operands**

#### **MODEL/CHAM\_MATER/CARA\_ELEM**

*MODEL = Mo*

*This operand is used to indicate the elements for which calculations must be carried out elementary: it is pointed out that the finite elements for the majority are defined in the model.*

*There are some exceptions:*

*1) Elements of dualisation of the conditions of DIRICHLET, i.e. elements allowing to impose conditions on the degrees of freedom of displacement in mechanics, degrees of freedom of temperature in thermics and degrees of freedom of pressure in accoustics.*

*2) Nodal heat exchange, loading elements between walls,...*

*These elements are defined in the concepts of the `char_meca` type, `char_ther` or `char_acou`.*

*One must thus provide the argument `l_char` for the calculation of the assembled matrices of rigidity:*

*`RIGI_MECA`,*

*`RIGI_THER`,*

*`RIGI_ACOU`,*

*`RIGI_MECA_HYST`,*

*`RIGI_THER_CONV` (`_D`) and*

*`RIGI_MECA_LAGR`.*

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*31/01/05*

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*`CHAM_MATER` = `chmater`*

*Name of the material field where the characteristics of materials of the elements are defined.*

*This argument is almost always necessary.*

*In practice, one can do some:*

*.*

*for the discrete elements whose elementary matrices are defined in the concept `cara_elem`. See `AFFE_CARA_ELEM` [U4.42.01],*

*.*

*for the calculation of rigidities due to the dualisation of the boundary conditions.*

**CARA\_ELEM** = *carac*

*The elementary characteristics carac are necessary if there exists in the model of elements of structure (discrete beam, hull or elements) or of the elements of continuous medium nonisotropic.*

### **3.3 Operands**

#### **CHARGE and INST**

**CHARGE** = *lchar*

*This operand has several distinct functions:*

- 1) to specify the elements for which elementary calculations of rigidity are made (conditions of DIRICHLET),*
- 2) for the options of thermomechanical, to specify a possible field of temperature when the material is a function of the temperature (cf key word INST). In this case, to pay attention so that there are not several different temperatures in the argument lchar, the temperature used is then the first found in the list of the loads (cf AFFE\_CHAR\_MECA\_..., operand TEMP\_CALCULEE [U4.44.01 §3.3]),*
- 3) for options "RIGI\_THER\_CONV (\_D)": to give the value the speed of convection,*
- 4) for  
the option  
"IMPE\_MECA": to give the value of the acoustic impedance of the meshes of edge,*
- 5) for  
the option  
"ONDE\_FLUI": to give the value of the pressure of the incidental wave,*
- 6) for  
the option  
"RIGI\_ROTA": to give the value of the rotation imposed on the model.*

**INST** =  
*tps*

*The argument tps is used only into thermomechanical.*

*Lorqu' there exists a temperature in one of the concepts l\_char, one uses the field then of temperature possibly interpolated at the moment tps. This field of temperature can vary characteristics of the material field if the material is a function of the temperature; if not this argument is useless.*

### **3.4 Operand**

#### **NUME\_DDL and key word SOLVEUR**

***NUME\_DDL = naked***

***The user the macro one must always give a name of concept behind key word NUME\_DDL. If the concept does not exist, it is created and SOLVEUR then is used (see hereafter).***

***If the concept exists, it is used to number the matrices. In this case SOLVEUR is ignored.***

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***31/01/05***

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***SOLVEUR =***

***\_F (...)***

***This key word makes it possible to choose the method of resolution of system linear which one will apply***

***with the assembled matrices which one creates in this order. That can seem astonishing of to choose as of the construction of the matrices, the way in which possibly one will make use of it!***

***Reason***

***in is that the resolution of the linear systems is a “capital” operation, potentially expensive in time and memory capacity (or disc). According to the adopted method, the mode of storage and the method of classification of the unknown factors is given. Those thus must to be selected as of the construction of the matrices.***

***The description of the arguments of this key word is made in [U4.50.01].***

***3.5 Word***

***key***



## **MATR\_ASSE**

*This key word factor makes it possible to ask for the calculation of an assembled matrix (with each occurrence).*

*The name of the assembled matrix is given by the operand STAMPS and the “nature” of the matrix is defined by the operand OPTION.*

*Possible options: “RIGI\_MECA”, “MASS\_MECA”,... are described in [U4.61.01 §3.1].*

*The choice of the option determines the type of the matr\_asse\_\* result [U4.61.01 §2].*

### **3.6**

*Operands particular to certain options*

#### **3.6.1 Operand**

**MODE\_FOURIER**

**MODE\_FOURIER = nh**

*Positive or null entirety indicating the harmonic of FOURIER on whom one calculates the matrices.*

*By defect: nh = 0*

#### **3.6.2 Operand**

**SIEF\_ELGA** (option “RIGI\_GEOM”)

**SIEF\_ELGA = sig**

*The stress field sig given for the calculation of option “RIGI\_GEOM” must be calculated with option “SIEF\_ELGA\_DEPL” (stress field at the points of GAUSS of the elements) (cf orders CALC\_CHAM\_ELEM [U4.81.03] or CALC\_ELEM [U4.81.01]).*

#### **3.6.3 Operands**

**THETA** and **PROPAGATION** (option “RIGI\_MECA\_LAGR”)

*These operands are useful for the Lagrangian propagation of crack.*

### **3.7 Operand**

**TITRATE**

**TITRATE**

*Titrate that one wants to give to the result [U4.03.01].*

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**7.4**

**Titrate:**

**Macro order MACRO\_MATR\_ASSE**

**Date:**

**31/01/05**

**Author (S):**

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**4 Examples**

**4.1**

**Calculation of mechanical clean modes**

**MACRO\_MATR\_ASSE (MODEL = Mo,**

**CHARGE = ch\_blocage,**

**CHAM\_MATER**

**=**

**chmat**

**,**

**CARA\_ELEM**

**=**

**carac**

**,**

**NUME\_DDL**

**=**

**Co (“naked”),**

**MATR\_ASSE = (\_F (MATRIX = Co (“K”), OPTION = “RIGI\_MECA”),**

**\_F**

**(MATRIX**

**=**

*Co (“M”), OPTION = “MASS\_MECA”),),)*

*modes = MODE\_ITER\_SIMULT (MATR\_A = K  
, MATR\_B = M  
...)*

#### 4.2 *Calculation of modes of buckling of Euler*

*% chsief is the stress field related to the loading*

*MACRO\_MATR\_ASSE (MODEL = Mo,  
CHARGE = ch\_blocage,  
CHAM\_MATER  
=  
chmat  
,  
CARA\_ELEM  
=  
carac  
,  
NUME\_DDL  
=  
Co (“naked”),  
MATR\_ASSE = (\_F (MATRICE= Co (“K”), OPTION=' RIGI\_MECA'),  
\_F (MATRICE=co (“KG”), OPTION=' RIGI\_GEOM', SIEF\_ELGA=chsief),),)  
modflamb = MODE\_ITER\_SIMULT (MATR\_A = K  
, MATR\_B = KG...)*

#### 4.3 *Calculation of clean modes “numerical”*

*The eigenvalues and clean modes calculated here are those of the problem:  
 $M - *I = 0$  where  $M$  is an unspecified matrix and  $I$  the matrix “identity”.*

*This functionality is a functionality of “programmer” who can be useful to include/understand some  
numerical behaviors: bad conditioning of the matrix of rigidity,...*

*MACRO\_MATR\_ASSE (MODEL = Mo,  
CHARGE = ch\_blocage,  
CHAM\_MATER  
=  
chmat*

,  
**CARA\_ELEM**  
=  
**carac**  
,  
**NUME\_DDL**  
=  
**Co (“naked”),**  
  
**MATR\_ASSE = (\_F (MATRIX = Co (“K”), OPTION = “RIGI\_MECA”),**  
**\_F**  
**(MATRIX**  
**=**  
**Co (“I”), OPTION = 'MASS\_ID\_MDEP\_R),),)**  
  
**modflamb = MODE\_ITER\_SIMULT (MATR\_A = K**  
**, MATR\_B = I**  
**...)**

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**Version**  
**7.4**

**Titrate:**  
**Operator ASSE\_MATRICE**

**Date:**  
**27/01/05**  
**Author (S):**  
**J. Key PELLET**  
**:**  
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**Organization (S): EDF-R & D /AMA**

***Instruction manual***

***U4.6- booklet: Elementary matrices/Vectors and assembly***

***Document: U4.61.22***

***Operator ASSE\_MATRICE***

***1 Goal***

***To create a matrix by assembly of elementary matrices.***

***The produced matrix is “hollow”; it is stored in form “Morse” or “line of sky” according to method of resolution selected in operator NUME\_DDL [U4.61.11].***

***Product a structure of data of the matr\_asse\_\* type.***

***Instruction manual***

***U4.6- booklet: Elementary matrices/Vectors and assembly***

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***Code\_Aster ®***

***Version***

***7.4***

***Titrate:***

***Operator ASSE\_MATRICE***

**Date:**

**27/01/05**

**Author (S):**

**J. Key PELLET**

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## **2 Syntax**

**my [matr\_asse\_\*] = ASSE\_MATRICE**

**(  
MATR\_ELEM  
=  
mel,  
/  
[matr\_elem\_DEPL\_R]**

**/  
[matr\_elem\_DEPL\_C]**

**/  
[matr\_elem\_TEMP\_R]  
/  
[matr\_elem\_PRES\_C]**

**NUME\_DDL =  
naked  
,  
[nume\_ddl]**

**CHAR\_CINE  
=**

*cha,*  
*/*  
*[char\_cine\_meca]*  
*/*  
*[char\_cine\_ther]*  
*/*  
*[char\_cine\_acou]*

***INFORMATION***

*=*  
*/*  
*1*  
*,*  
*[DEFECT]*

*/ 2 ,*

*)*

*if*  
*MATR\_ELEM*  
*[matr\_elem\_DEPL\_R]*  
*then*  
*[\*]*

*DEPL\_R*  
*[matr\_elem\_DEPL\_C]*  
*DEPL\_C*  
*[matr\_elem\_TEMP\_R]*  
*TEMP\_R*  
*[matr\_elem\_PRES\_C]*

## ***PRES\_C***

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### ***3 Operands***

#### ***3.1 Operand***

***MATR\_ELEM***

***MATR\_ELEM = mel,***

***Name of the concept matr\_elem\_\* to be assembled.***

#### ***3.2***

***Classification and storage***

***NUME\_DDL = naked,***

***Specify the classification of the equations of the assembled system and the mode of storage of stamp.***

#### ***3.3 Operand***

***CHAR\_CINE***



**CHAR\_CINE = cha,**

*Name of the kinematic load to take into account in the matrix assembled for one treatment by elimination of the degrees of freedom forced (see order AFFE\_CHAR\_CINE [U4.44.03]).*

### **3.4 Operand INFORMATION**

#### **INFORMATION**

*The impression of information allows on the assembled matrix*

**1 :**

*no impression,*

**2 :**

*impression of the number of stored terms and the coefficient of conditioning of the degrees of freedom of the type "LAGR",*

#### **4 Example**

*subdued =  
ASSE\_MATRICE*

*(*

*NUME\_DDL*

*=*

*naked*

*,*

*MATR\_ELEM*

*=*

*mel,)*

**Note:**

*The elementary matrices of mel will be assembled according to classification naked.*

*It is necessary thus that this classification takes into account all the degrees of freedom of these elementary matrices (in particular degrees of freedom corresponding to the dualisation of boundary conditions). One will thus make:*

*mel = CALC\_MATR\_ELEM (OPTION = "RIGI\_MECA",*

**MODEL = Mo, LOAD = condlim,)**

**naked = NUME\_DDL (MATR\_RIGI = mel)**

**subdued = ASSE\_MATRICE (NUME\_DDL = naked, MATR\_ELEM = mel,)**

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*Operator ASSE\_VECTEUR*

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*Organization (S): EDF-R & D /AMA*

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***U4.61.23 document***

***Operator ASSE\_VECTEUR***

## ***1 Goal***

***To build a field with the nodes by assembly of elementary vectors.***

***This field will be able, for example, being used like second member for the resolution of a system linear.***

***Product a structure of data cham\_no\_\*.***

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## ***2 Syntax***

***vecas [cham\_no\_\*] = ASSE\_VECTEUR***

***(***  
***VECT\_ELEM = lvel,***  
***/[l\_vect\_elem\_DEPL\_R]***

***/[l\_vect\_elem\_TEMP\_R]***

***/[l\_vect\_elem\_PRES\_R]***

***/[l\_vect\_elem\_PRES\_C]***

***NUME\_DDL***

***= naked***

***,***  
***[nume\_ddl]***

***)***

***If VECT\_ELEM: [l\_vect\_elem\_DEPL\_R]***

***[\*]***

***DEPL\_R***

***[l\_vect\_elem\_TEMP\_R]***

***TEMP\_R***

***[l\_vect\_elem\_PRES\_R]***

***PRES\_R***

***[l\_vect\_elem\_PRES\_C]***

***PRES\_C***

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### ***3 Operands***

#### ***3.1 Operand***

***VECT\_ELEM***

***VECT\_ELEM = lvel***

***List concepts of the vect\_elem\_\* type to be assembled. The various elementary vectors are summoned in the same assembled vector (of cham\_no\_\* type). The assembly is licit only if the various concepts all vect\_elem\_\* correspond to the same size DEPL\_R, TEMP\_R, PRES\_R or PRES\_C.***

#### ***3.2 Operand***

***NUME\_DDL***

***NUME\_DDL = naked***

***Defines the classification of the degrees of freedom to use for the assembled vector.***

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***Code\_Aster*** ®  
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***Titrate:***  
***Operator MACR\_ELEM\_STAT***

**Date:**

**31/01/05**

**Author (S):**

**J. Key PELLET**

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**Organization (S): EDF-R & D /AMA**

**Instruction manual**

**U4.6- booklet: Elementary matrices/Vectors and assembly**

**Document: U4.62.01**

**Operator MACR\_ELEM\_STAT**

**1 Goal**

**To create macronutrients for calculations of static under-structuring.**

**Product a structure of data of the macr\_elem\_stat type.**

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**Titrate:**

**Operator** *MACR\_ELEM\_STAT*

**Date:**

**31/01/05**

**Author (S):**

**J. Key PELLET**

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**2 Syntax**

***S1 (macr\_elem\_stat)***

**= *MACR\_ELEM\_STAT* (**

***reuse = S1,***

***DEFINITION = \_F (***

***MODEL***

**=**

***Mo***

**,**

***[model]***

***CHAM\_MATER***

**=**

***chmat***

**,**

**[cham\_mater]**

**CARA\_ELEM**

=

**carac**

,

**[cara\_elem]**

**CHAR\_MACR\_ELEM**

= **lchar**

,

**[l\_char\_meca]**

**INST**

=

**/inst,**

**[R]**

**/ 0.0**

,

**[DEFECT]**

**NMAX\_CAS**

= **/ 10,**

**[DEFECT]**

***/nbcamx***

,  
***[I]***

***NMAX\_CHAR***

= / 10,  
***[DEFECT]***

***/nbchmx***

,  
***[I]***

)

***OUTSIDE = \_F (***

***/NODE***

= *l\_no*

,  
***[l\_noeud]***

**/GROUP\_NO**  
**= l\_gno**  
**,**  
**[l\_gr\_noeud]**

**),**

**RIGI\_MECA = \_F (),**

**MASS\_MECA = \_F (),**

**CAS\_CHARGE**  
**=**  
**(\_F (**

**NOM\_CAS**  
**=**  
**nocas**  
**,**  
**[k8]**

**SUIV =**  
**/"YES"**  
**,**  
**[DEFECT]**

***/“NOT”***

***CHARGE***

***=***

***lchar***

***,***

***[l\_char\_meca]***

***INST =/tps***

***,***

***[R]***

***/ 0.0***

***,***

***[DEFECT]***

***),),***

)

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**3 General information**

***This operator is an obligatory point of passage for the static under-structuring. He is useful:***

**.**

***to define a macronutrient (key words: DEFINITION and OUTSIDE),***

**.**

***to ask the condensation of the matrix of rigidity (or of mass),***

**.**

***to define (and condense) the associated loadings; the user can name on this occasion one or more loading case.***

***These 3 stages can be made in only one call to MACR\_ELEM\_STAT. But they can be made in several times thanks to the use of the key word “reuse” (enrichment of the macr\_elem\_stat). The stage of definition is obligatorily to realize in first. The condensation of the mass must to make after the condensation of rigidity.***

***The macr\_elem\_stat is a structure of data which contains:***

**.**



*its references: model, cara\_elem, cham\_mater, load,*

.

*its topological description: external nodes,*

.

*its condensed matrices (rigidity, mass,...),*

.

*a list of named condensed loadings.*

*The use of the whole of the operators of static under-structuring is described in a note of U2 booklet.*

## ***4 Operands***

### ***4.1 Word***

*key*

***DEFINITION***

***DEFINITION***

*This key word factor (not répétable) is used to define the macronutrient.*

#### ***4.1.1 Operand***

***MODEL***

***MODEL = Mo***

*Name of the model which one wants to condense. The matrices (and loadings) which one condenses are always calculated on the model as a whole. When one wants to condense several subsets of the same grid, it is thus necessary to create several models on different groups of meshes.*

#### ***4.1.2 Operand***

***CHAM\_MATER***

***CHAM\_MATER = chmat***

*Name of the material field associated with the model. This argument is useless if the model contains that discrete elements and static substructures.*

#### ***4.1.3 Operand***

***CARA\_ELEM***

***CARA\_ELEM = carac***

***Name of the elementary characteristics if the model comprises elements of beam, of plate or of hull.***

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***4.1.4 Operands***

***CHAR\_MACR\_ELEM/INST***

***CHAR\_MACR\_ELEM = lchar***

***This argument is used to define:***

***.***

***the thermal loading which modifies possibly the characteristics of material, when those depend on the temperature; one will specify if necessary the moment of the thermal evolution (key word INST),***

***.***

***the conditions kinematics applied to the nodes intern (cf key word OUTSIDE) of the macro element.***

***INST = inst***

***During a calculation for which the material characteristics depend on the temperature, one***

*specify the field of temperature here to be used. The field used is that corresponding to the moment inst of the thermal evolution referred in the list of the loads lchar (to defer to order CALC\_MATR\_ELEM (“RIGI\_MECA”)) [U4.61.01].*

*Remarks on the conditions kinematics:*

*Under the operators of static under-structuring, the conditions kinematics of type “Dirichlet” are always dualisées, ever eliminated.*

*In general one will apply the conditions kinematics to the external nodes to higher level of under-structuring. Thus they will not appear in the loads of lchar.*

*On the other hand, the conditions kinematics which it is necessary to give before condensation (lchar) are those which one will not be able to give any more afterwards:*

*• the conditions implying of the nodes intern (ddl imposed or relations linear) because these nodes will be eliminated,*

*• conditions defined starting from the edges of the finite elements (FACE\_IMPO) bus these finite elements will not exist any more after condensation.*

*Notice on the argument lchar:*

*The loads which appear in the list lchar, which is those allow to calculate the matrices of rigidity and mass:*

*• possible load of temperature modifying the material characteristics,*  
*• conditions kinematics (dualisation).*

*on the other hand, these loads intervene of nothing in the definition loadings (second members).*

*For example, dilations due to the field of temperature will not be taken in count in a loading case which if the load containing this field of temperature is explicitly given in the definition of this loading case (key words CAS\_CHARGE and LOAD). In the same way the conditions kinematics not null must be given again in the definition of the loading cases.*

#### **4.1.5 Operands**

**NMAX\_CAS/NMAX\_CHAR**

***NMAX\_CAS = nbcamx***

***One gives one here raising of the number of loading cases which the user will define on macronutrient (cf argument CAS\_CHARGE). This number is taken by defect with 10.***

***NMAX\_CHAR = nbchmx***

***One gives one here raising of the number of concepts of the type charges that one will affect to each loading case (cf argument CAS\_CHARGE). This number is taken by defect with 10.***

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***4.2 Word***

***key***

***OUTSIDE***

***OUTSIDE***

***=***

***This key word factor (not répétable) is used to define the whole of the “external” nodes where will be digests matrices and loadings (the other nodes will be known as “internal”). This key word in the first call to order MACR\_ELEM\_STAT (one must appear defines outside of a macronutrient in only once).***

***Each external node carries the same degrees of freedom as the node corresponding of the model***

*Mo. A macronutrient (and geometrically) entirely is topologically defined by the whole of its external nodes.*

#### *4.2.1 Remarks on the definition of the “outside” of a macro element*

*The outside of a macronutrient is the whole of the “external” nodes which define topology and geometry of the macronutrient,*

*each “external” node carries all the degrees of freedom which exist on this node in subjacent model. The macronutrients produced by Aster are usable only in resticking their external nodes and consequently all degrees of freedom which it carry. Other computer codes operate differently. For certain modelings (slip, articulation,...), one will be led not to restick certain nodes and to use, on the level of under-structuring superior, of the linear relations between the degrees of freedom of the nodes external several macronutrients,*

*at the time of the definition of the external nodes of a macronutrient, if a node appears several time, one counts it only only once,*

*for reasons of programming, it is necessary that there are at the same time external nodes and internal nodes: none the families can be empty.*

#### *4.2.2 Operands*

*NOEUD/GROUP\_NO*

*/  
NODE = l\_noeu*

*List names of nodes which one wishes “external”.*

*/  
GROUP\_NO = l\_grno*

*List names of the groups of nodes which one wishes “external”.*

#### *4.3 Words*

*keys*

*RIGI\_MECA/MASS\_MECA*

*RIGI\_MECA*

*This key word is used to specify that one wants to condense the matrix of rigidity. This matrix is calculated on all the elements of the model like on the elements of LAGRANGE of conditions kinematics contained in the argument of CHAR\_MACR\_ELEM.*

## **MASS\_MECA**

*This key word is used to specify that one wants to condense the matrix of mass. This matrix is calculated on all the elements of the model (condensation of GUYAN).*

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## **4.4 Word**

**key**

**CAS\_CHARGE**

## **CAS\_CHARGE**

*This key word factor makes it possible to define a whole of named loading cases (key word NOM\_CAS).*

*These loading cases could be applied to the model of higher level (CALC\_VECT\_ELEM [U4.61.02]).*

*In general, one will seek to apply the nodal loadings (FORCE\_NODALE) to the level superior of under-structuring.*

*On the other hand all the loadings defined on the finite elements must be applied above all*

*condensation: (GRAVITY, ROTATION, FORCE\_FACE, FORCE\_CONTOUR, FORCE\_INTERNE, FORCE\_COQUE, FORCE\_POUTRE, PRES\_REP,...) since these finite elements “will have disappeared” after condensation.*

*Let us note that for a macronutrient, there is no concept of contour, orientation, of face,...*

#### **4.4.1 Operand NOM\_CAS**

*NOM\_CAS = nocas*

*The loading condensed under the name nocas (between “quotes”) corresponds to loading defined by the arguments of LOAD and INST to which one adds systematically loadings of name nocas possibly present on under structures of lower level contained in the model Mo.*

#### **4.4.2 Operand SUIV**

*SUIV = “YES”/“NOT”*

*This key word said if the loading case “follows” the macronutrient in its transformations geometrical: translation, rotation, (cf operator DEFI\_MAILLAGE [U4.23.01]). By example, the loading due to a rotation (centrifugal force), a pressure (or one opposed dilation) is “following” because its direction is related to the position of substructure. On the other hand, gravity is a loading “not follower” (his direction is absolute).*

*Caution:*

*The loadings kinematics are always “following” because their catch in account is made in the matrix of rigidity (dualisation) and this matrix is “following” by nature.*

#### **4.4.3 Operands CHARGE/INST**

*CHARGE = lchar,*

***INST = tps,***

***The key words CHARGES and INST have the same significance as in the operator CALC\_VECT\_ELEM [U4.61.02].***

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**5**

***Examples of definition of a macro element***

**5.1**

***To define the outside of a macronutrient***

*sup1 =*  
*MACR\_ELEM\_STAT*  
(

*DEFINITION*

=

*\_F*

(

*MODEL*

=

*Mo,*

*CHAM\_MATER*

=

*chmat),*

*OUTSIDE = \_F (GROUP\_NO = EXT.),*

)  
*sup3* =  
*MACR\_ELEM\_STAT*  
(

*DEFINITION* = *\_F* (*MODEL* = *Mo*,  
*CHAM\_MATER*  
=  
*chmat*),

*OUTSIDE* = *\_F* (*NODE* = ("N3", "N4"), *GROUP\_NO* = ("L1", "L3"),)

## 5.2

### *To condense matrices of rigidity and mass*

*sup1* =  
*MACR\_ELEM\_STAT*  
(*reuse* = *sup1*,

*RIGI\_MECA* = *\_F* (), *MASSE\_MECA* = *\_F* (),

)

## 5.3

### *To define a loading on the macronutrient*

*sup1* =

*MACR\_ELEM\_STAT*

*(reuse = sup1,*

*CAS\_CHARGE = (NOM\_CAS = "ch1", LOAD = ch1,)*

)

***5.4 To define the macronutrient, its loadings, and to ask condensation of the matrices***

*sup2 =*

*MACR\_ELEM\_STAT*

(

*DEFINITION*

*= \_F*

*(MODEL = Mo, CHAM\_MATER = chmat),*

*OUTSIDE*

*=*

*\_F*

(

*GROUP\_NO*

*=*

*EXT.*

)

*RIGI\_MECA*

*=*

*\_F*

(

*MASSE\_MECA = \_F (*

*CAS\_CHARGE*

= *\_F*

(*NOM\_CAS* = "ch1", *LOAD* = ch1),

)

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*Titrate:*

*Operator DEPL\_INTERNE*

*Date:*

*03/02/05*

*Author (S):*

***J. Key PELLET***

*:*

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*Organization (S): EDF-R & D /AMA*

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***Document: U4.62.02***

***Operator DEPL\_INTERNE***

***1 Goal***

***To calculate the field of displacement inside a static substructure. The result of order is then a field of displacement on the grid associated with the macronutrient (i.e. grid of lower level). One can reiterate this operation until the grids moreover low level (those which contain the finite elements).***

***This stage can be regarded as a postprocessing on the macronutrient. It cannot be carried out that after the total resolution. The field thus calculated can then be used by the operator CALC\_CHAM\_ELEM (or other operators) to calculate the constraints,....***

***When a macronutrient gave rise to several substructures, fields of displacements in these substructures are restored on the grid subjacent with the macronutrient. It y thus has change of reference mark of the field of displacement if the substructure were turned. If the substructure were turned of +, the field of displacement is turned of. This field of displacement is then coherent with the grid and one can connect them postprocessings: calculation of the constraints,...***

***Product a structure of data of the cham\_no\_DEPL\_R type.***

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***Titrate:***

***Operator DEPL\_INTERNE***

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**03/02/05**  
**Author (S):**  
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## **2 Syntax**

***U (cham\_no\_DEPL\_R) = DEPL\_INTERNE***  
**(**

***DEPL\_GLOBAL***  
**=**  
***ug***  
**,**  
***[cham\_no\_DEPL\_R]***

***NET***  
**=**  
***email***  
**,**  
***[mesh]***

***NOM\_CAS =/nocas***  
**,**  
***[K8]***

/'',

**[DEFECT]**

)

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***7.4***

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***Operator DEPL\_INTERNE***

***Date:***

***03/02/05***

***Author (S):***

***J. Key PELLET***

***:***

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### **3 Operands**

#### **3.1 Operand**

**DEPL\_GLOBAL**

**DEPL\_GLOBAL = ug**

*ug is the name of the field of displacement obtained at the time of the resolution at the total level.*

#### **3.2 Operand**

**NET**

**NET = email**

*One gives here the name of the mesh which supports the substructure (cf operator*

**DEFI\_MALLAGE**

**[U4.23.01]).**

#### **3.3 Operand**

**NOM\_CAS**

**NOM\_CAS = nocas**

*nocas is the name of the loading case corresponding to ug. This data is essential if it exist a loading distributed on the substructure. It is with the user to make sure that the field ug corresponds well to the loading case nocas.*

*If nocas = '', the field of displacement were calculated without loading distributed on substructure.*

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#### **4 Example**

**.**

**Grid of level 1: my, macronutrient: S1**

**S1**

**O**

**.**

**Grid of level 2: 2 substructures: S1 and S2 (obtained by rotation of S1).**

**S2**

**S1**

**O**

**Ug displacement:**

**.**

**known on the external nodes of the substructures,**

**.**

**it is supposed radial (compared to O).**

**.**

**u2 = DEPL\_INTERNE (DEPL\_GLOBAL = ug, MESH = S2)**

**O**

**U2 displacement:**

**.**

**known on all the nodes of my,**

**.**

**there remains radial because the field was turned of - 45° to be coherent with the grid.**

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**Titrate:**

**Operator CALC\_CHAR\_SEISME**

**Date:**

**08/02/05**

**Author (S):**

**Y. PONS, Fe WAECKEL, L. VIVAN**

**Key: U4.63.01-G Page:**

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**Organization (S): EDF-R & D /AMA, SINETICS, CS IF**

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**Document: U4.63.01**

**Operator CALC\_CHAR\_SEISME**

## **1 Goal**

**To establish the seismic loading for a calculation of response moving relative compared to supports. For a better theoretical comprehension of this loading, one will refer to the document [R4.05.01].**

**The produced concept is directly usable during a direct transitory analysis with DYNA\_LINE\_TRAN [U4.53.02] or by modal synthesis with DYNA\_TRAN\_MODAL [U4.53.21]. In revenge for a nonlinear direct transitory analysis with DYNA\_NON\_LINE [U4.53.01], it is necessary to transform this concept charges some starting from operator AFFE\_CHAR\_MECA [U4.44.01].**

**Product an assembled vector, concept of the cham\_no\_depl\_R type.**

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## **2 Syntax**

**$S [cham\_no\_depl\_R] = CALC\_CHAR\_SEISME$**

**(MATR\_MASS = m**

*[matr\_asse\_DEPL\_R]*

*DIRECTION = (d1, d2, d3, r1, r2, r3)*

*[l\_R]*

*/MONO\_APPUI = "YES"*

*/*  
*MODE\_STAT = mode [mode\_stat]*

*/NODE*  
*=*  
*noeu*  
*[l\_noeud]*

*/*  
*GROUP\_NO*  
*=*  
*g\_noeu [l\_gr\_noeud]*

***TITRATE = title [l\_Kn]***

***);***

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***3 Operands***

***3.1 Operand***

***MATR\_MASS***

***MATR\_MASS = m***

***Stamp of mass of the system.***

***3.2 Operand***

***DIRECTION***

***DIRECTION = (d1, d2, d3, r1, r2, r3)***

***Components of a vector giving the direction of the seism in the total reference mark. It is a list of three realities if the imposed accélérogrammes are only translations. If one imposes***

*also accelerations of rotations, one awaits a list of six realities (valid for modelings with discrete elements).*

### **3.3**

*Description of the movement of drive*

#### **3.3.1 Operand**

**MONO\_APPUI**

*/MONO\_APPUI = "YES"*

*The structure is uniformly excited in all the supports (movement of drive of body solid).*

#### **3.3.2 Excitation multi supports**

*In this case, the accelerations undergone by the whole of the points of anchoring of the studied structure are not inevitably identical and in phase.*

##### **3.3.2.1 Operand**

**MODE\_STAT**

*/  
MODE\_STAT = mode*

*Static modes of the structure: concept of the mode\_stat type produces by the operator MODE\_STATIQUE [U4.52.14] with option MODE\_STAT. They correspond to the 6 nb\_supports static modes where nb\_supports is the number of accélérogrammes different undergone by the structure.*

*Note:*

*If the structure is requested only by translations, there are then 3 nb\_supports static modes.*

##### **3.3.2.2 Operands**

**NODE/GROUP\_NO**

*/NODE = noe*

*/  
GROUP\_NO =*

## ***g\_noeu***

***List nodes (noeu) or groups of nodes (g\_noeu) of the structure subjected to the seismic excitation: these nodes support the ddl supports of the structure which are applied the imposed movements.***

### ***3.4 Operand***

***TITRATE***

***TITRATE***

***= title***

***Titrate attached to the concept produced by this operator [U4.03.01].***

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## ***4 Examples***

***The two examples which follow illustrate the employment of operator CALC\_CHAR\_SEISME in the cases***

***of a seismic excitation mono support and in the case multi supports (identical acceleration then different on each support).***

### ***4.1***

***Calculation of a second member in mono support***

***One considers seismic modeling beam of the building engine 1300 MW of the nuclear thermal power station***



***CIVAUX (case test SDLL109B) as presented in the documentation of the operator POST\_ELEM [U4.81.22].***

***One wishes to determine efforts at the time of the transitory dynamic response of the structure to a seism in direction X. the transitory calculation of answer is carried out here by modal recombination by DYNA\_TRAN\_MODAL [U4.53.21].***

***One calculates the modes of vibrations of the structure of the model resting on only one elastic support (comes out from ground):***

***# --- seek clean modes of vibration -----***

***MODES = MODE\_ITER\_SIMULT (MATR\_A = RIGIDITY, MATR\_B = MASS,  
CALC\_FREQ = \_F (OPTION = "PLUS\_PETITE",  
NMAX\_FREQ = 33));***

***One defines the accélérogramme seism:***

***# --- excitation -----***

***LBNSNL1 = DEFI\_FONCTION (NOM\_RESU = "ACCE", NOM\_PARA = "INST",  
PROL\_GAUCHE = "EXCLUDED", PROL\_DROIT = "EXCLUDED",  
VALE = (***

***0.00000E+00 9.98700E-02 1.00000E-02 6.60700E-02  
2.00000E-02 -5.65000E-03 3.00000E-02 -9.46800E-02***

***-----  
1.19800E+01 1.68110E-01 1.19900E+01 8.80300E-02  
1.20000E+01 0.00000E+00 9.98700E-02 0.00000E+00)***

***);***

***ACCELERO = CALC\_FONCTION (COMB = \_F (FONCTION= LBNSNL1, COEF= 1.47));***

***One calculates the second member (field with the nodes of the inertias of drive) and one defines direction of the seism***

***DIRSEISM = CALC\_CHAR\_SEISME (MATR\_MASS = MASS,  
MONO\_APPUI = "YES",  
DIRECTION = (-1. , 0. , 0. ));***

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*One carries out the calculation of the transitory response in modal space*

*# --- projection of the matrices and vector assembled on the modes*

```
MACRO_PROJ_BASE (BASE=MODE,  
NB_VECT=33, MATR_ASSE_GENE= (  
_F (  
STAMP = CO ("MASSGENE"),  
MATR_ASSE = MASS),  
_F (  
STAMP = CO ("RIGIGENE"),  
MATR_ASSE = RIGIDITY)),  
VECT_ASSE_GENE=_F (  
VECTOR = CO ("VECTGENE"),  
VECT_ASSE = SEISM)  
);
```

*# --- calculation by modal combination -----*

```
LISTAMOR= (0.055, 0.055, 0.070, 0.070, 0.071, 0.072, 0.157, 0.085, 0.086,  
0.070, 0.076, 0.074, 0.071, 0.072, 0.115, 0.073, 0.076, 0.086,  
0.081, 0.070, 0.072, 0.075, 0.074, 0.070, 0.152, 0.148, 0.074,  
0.297, 0.074, 0.075, 0.089, 0.138, 0.118, )
```

```
TRANGENE=DYNA_TRAN_MODAL (MASS_GENE=MASSGENE, RIGI_GENE=RIGIGENE,  
METHODE=METHODE,  
AMOR_REDUIT=LISTAMOR,  
INCREMENT=_F (INST_INIT = 0. ,
```

*INST\_FIN = 4. , NOT = 0.002,  
VERI\_PAS = "NOT"),  
EXCIT=\_F (VECT\_GENE = VECTGENE,  
FONC\_MULT = ACCELERO),*

*))  
One used the accélérogramme here imposed movement.*

*One passes by again in physical space:*

*# --- restitution in physical base -----*

*LISTINST=DEFI\_LIST\_REEL (DEBUT=1.334,  
INTERVALLE=\_F (JUSQU\_A = 3.154, A NUMBER = 1))*

*TRANPHYS=REST\_BASE\_PHYS (RESU\_GENE=TRANGENE,  
CRITERE=' RELATIF', PRECISION=1.E-06,  
LIST\_INST=LISTINST, TOUT\_CHAM=' OUI')*

## **4.2**

### ***Calculation of a second member in multi supports***

*The example which follows watch the calculation of the second members when the seisms are different on supports.*

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*One considers modeling in elements of beam of the line of following piping on which one seism is applied in direction X:*

P1

Z

X

P2

P3

*One calculates the static modes to express the vector of drive like a combination linear of those.*

```
MODST = MODE_STATIQUE (MATR_RIGI = RG,
MATR_MASS = MS,
MODE_STAT = _F (NODE = ("P1", "P2", "P3"),)
(AVEC_CMP = "DX"),);
```

*One must calculate three second members different (field with the nodes from the inertias of drive) for each node or node subjected to the same seismic signal groups.*

```
SMP1 = CALC_CHAR_SEISME (MATR_MASS = MS,
DIRECTION = (1. , 0. , 0.),
MODE_STAT = MODST,
NODE = "P1");
```

```
SMP2 = CALC_CHAR_SEISME (MATR_MASS = MS,
DIRECTION = (1. , 0. , 0.),
MODE_STAT = MODST,
NODE = "P2");
```

```
SMP3 = CALC_CHAR_SEISME (MATR_MASS = MS,
DIRECTION = (1. , 0. , 0.),
MODE_STAT = MODST,
NODE = "P3");
```

*In accordance with what is explained in the reference document [R4.05.01] the operator CALC\_CHAR\_SEISME calculates the following expression:*

- **M** (

+

+

*P1, X*  
*P2, X*  
*P,*  
*3 X) S*

*with S (1. , 0. , 0.), direction of the seism.*

*Calculation of the transitory response (without damping) with three different seismic signals ACCELP1, ACCELP2 and ACCELP3:*

```
TRANGENE = DYNA_LINE_TRAN (MATR_MASS = MS,  
MATR_RIGI = RG,  
NEWMARK = _F (),  
LIST_INST = LI,  
EXCIT = (  
_F (VECT_ASSE = SMP1, FONC_MULT = ACCELP1),  
_F (VECT_ASSE = SMP2, FONC_MULT = ACCELP2),  
_F (VECT_ASSE = SMP3, FONC_MULT = ACCELP3),  
)  
);
```

*One will be able to find other examples of multimedia structures subjected to requests seismic by consulting tests SDLD103 and SDND102.*

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*Macro order MACRO\_PROJ\_BASE*

*Date:*

*08/02/05*

*Author (S):*

***E. BOYERE, Y. PONS. J. PIGAT*** *Key*

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*Organization (S): EDF-R & D /AMA*

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*Document: U4.63.11*

*Macro order MACRO\_PROJ\_BASE*

*1 Goal*

*To project matrices and/or vectors assembled on a modal basis or a basis of RITZ. projected matrices and vectors results will be used by the calculation algorithms in components generalized (DYNA\_TRAN\_MODAL [U4.53.21] for example).*

*This macro-order replaces the following sequence controls:*

*.  
NUME\_DDL\_GENE [U4.65.03] which establishes the classification of the generalized degrees of freedom,*

*.  
one or more occurrences of PROJ\_MATR\_BASE [U4.63.12] to project one or*

*several assembled matrices,*

.

*one or more occurrences of PROJ\_VECT\_BASE [U4.63.13] to project one or more assembled vectors.*

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*2 Syntax*

*MACRO\_PROJ\_BASE*

(

*BASE*

=

*Ba, [mode\_meca]*

*[base\_modale]*

*[mode\_gene]*

*NB\_VECT =/9999,*

*[DEFECT]*

/

*Nm,*



**[I]**

**PROFILE**

=

**/“DIAG”,  
[DEFECT]  
/“FULL”,**

**MATR\_ASSE\_GENE**

**=\_F (  
STAMP = CO (“MT”),**

**[matr\_asse\_gene\_R]**

**/MATR\_ASSE = my,**

**[matr\_asse\_DEPL\_R]**

**/**

**MATR\_ASSE\_GENE**

**=**

**my,  
[matr\_asse\_gene\_R]**

**),**

**VECT\_ASSE\_GENE**

*=\_F (VECTOR = CO (“vt”),  
[vect\_asse\_gene]*

*TYPE\_VECT =/“FORC”,  
[DEFECT]*

/

*typ,  
[KN]*

*/VECT\_ASSE = goes,*

*[cham\_no\_DEPL\_R]*

*/VECT\_ASSE\_GENE = goes,  
[vect\_asse\_gene]*

),

***INFORMATION =/1,  
[DEFECT]***

/ 2,

)

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***3 Operands***

***3.1 Operand***

***BASE***

***BASE = Ba***

***Concept of the mode\_meca type, base\_modale or mode\_gene (for the under-structuring), which contains the vectors defining the subspace of projection.***

### **3.2 Operand**

#### ***NB\_VECT***

***NB\_VECT = Nm***

*A number of vectors used in the base (one takes the Nm first). It is checked that number Nm is quite lower than the number of vectors of the base, in the contrary case (Nm = 9999) one uses all provided vectors.*

### **3.3 Operand**

#### ***PROFILE***

***PROFILE =/“DIAG”***

***[DEFECT]***

***/***

***“FULL”***

***Cf NUME\_DDL\_GENE [U4.65.03].***

*If a matrix presents a profile “DIAG” and a another “FULL” profile, two classifications will be created with NUME\_DDL\_GENE.*

### **3.4 Word**

***key***

***MATR\_ASSE\_GENE***

***MATR\_ASSE\_GENE***

*Key word factor defining the name of the projected matrix result and the name of the matrix in to project. This key word must be repeated time as many as there are matrices to project.*

#### **3.4.1 Operand**

##### ***STAMP***

***STAMP = CO (“MT”)***

*Concept of the matr\_asse\_gene\_R type, generalized matrix result.*

#### **3.4.2 Operands**

## ***MATR\_ASSE/MATR\_ASSE\_GENE***

*/MATR\_ASSE = my*

*Concept of the matr\_asse\_DEPL\_R type, assembled matrix which one wishes to project.*

*/  
MATR\_ASSE\_GENE  
=  
my*

*Concept of the matr\_asse\_gene\_R type, assembled matrix resulting from under-structuring, which one wishes to project.*

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### ***3.5 Word***

***key***

***VECT\_ASSE\_GENE***

*VECT\_ASSE\_GENE*

*Key word factor defining the name of the vector projected result and the name of the vector to be projected. It*

*key word must be repeated time as many as there are vectors to project.*

### **3.5.1 Operand VECTOR**

*VECTOR = CO (“vt”)*

*Concept of the vect\_asse\_gene type, vector generalized result.*

### **3.5.2 Operand TYPE\_VECT**

*TYPE\_VECT = typ*

*Character string describing the type of the field represented by the assembled vector, by defect one awaits a field of the type forces “FORC”, the other possibilities are “DEPL”, “QUICKLY” and “ACCE”.*

### **3.5.3 Operands VECT\_ASSE/VECT\_ASSE\_GENE**

*/VECT\_ASSE  
= goes*

*Concept of the cham\_no\_DEPL\_R type, assembled vector which one wishes to project.*

*/  
VECT\_ASSE\_GENE  
=  
goes*

*Concept of the vect\_asse\_gene type, assembled vector resulting from the under-structuring, that one wishes to project.*

### **3.6 Operand INFORMATION**

*INFORMATION  
=  
/  
1  
[DEFECT]*

/ 2

*Level of impression of information for order NUME\_DDL\_GENE (cf [U4.65.03]).*

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## **4 Example of use**

*# DYNAMIC TRANSITORY ON MODAL BASIS SYSTEM MASSES AND ARISES*

*BEGINNING ()*

*RESSORT=LIRE\_MAILLAGE ()*

*MODELE=AFFE\_MODELE (MAILLAGE=RESSORT,  
AFFE=\_F (ALL = "YES", PHENOMENON = "MECHANICAL",  
MODELING = "DIS\_T"))*

*CHAMPCAR=AFFE\_CARA\_ELEM (MODELE=MODELE,  
DISCRET= (  
\_F (MESH = ("E1", "E2", "E3", "E4", "E5", "E6", "E7", "E8", "E9"),*

*CARA = "K\_T\_D\_L", VALE = (1.E5, 1., 1.),*

*\_F (MESH = "E1",  
CARA = "A\_T\_D\_L", VALE = (250., 1., 1.)),*

*\_F (MESH = ("E2", "E3", "E4", "E5", "E6", "E7", "E8"),  
CARA = "A\_T\_D\_L", VALE = (50., 1., 1.)),*

*\_F (MESH = "E9",  
CARA = "A\_T\_D\_L", VALE = (25., 1., 1.)),*

*\_F (MAILLE= ("P1", "P2", "P3", "P4", "P5", "P6", "P7", "P8"),  
CARA = "M\_T\_D\_N", VALE = 10.)) )*

*CHARGE=AFFE\_CHAR\_MECA (MODELE=MODELE, DDL\_IMPO= (  
F (ALL = "YES", DY = 0., DZ = 0.),  
\_F (NODE = ("N1", "N10"), DX = 0.0)) )*

*EFFORT=AFFE\_CHAR\_MECA (MODELE=MODELE,  
FORCE\_NODALE=\_F (NODE = "N5", FX = 1.) )*

*RIGIELEM=CALC\_MATR\_ELEM (MODELE=MODELE, OPTION=' RIGI\_MECA',  
CARA\_ELEM=CHAMPCAR, CHARGE=CHARGE)*

*MASSELEM=CALC\_MATR\_ELEM (MODELE=MODELE, OPTION=' MASS\_MECA',  
CARA\_ELEM=CHAMPCAR, CHARGE=CHARGE)*

*AMORELEM=CALC\_MATR\_ELEM (MODELE=MODELE, OPTION=' AMOR\_MECA',  
CARA\_ELEM=CHAMPCAR, CHARGE=CHARGE)*

*EFFOELEM=CALC\_VECT\_ELEM (CHARGE=EFFORT, OPTION=' CHAR\_MECA',  
CARA\_ELEM=CHAMPCAR)*

*NUMEROTA=NUME\_DDL (MATR\_RIGI=RIGIELEM)*

*MATRRIGI=ASSE\_MATRICE (MATR\_ELEM=RIGIELEM, NUME\_DDL=NUMEROTA)*

*MATRMASS=ASSE\_MATRICE (MATR\_ELEM=MASSELEM, NUME\_DDL=NUMEROTA)*

*MATRAMOR=ASSE\_MATRICE (MATR\_ELEM=AMORELEM, NUME\_DDL=NUMEROTA)*

*VECTASS=ASSE\_VECTEUR (VECT\_ELEM=EFFOELEM, NUME\_DDL=NUMEROTA)*

*MODES=MODE\_ITER\_INV (MATR\_A=MATRRIGI, MATR\_B=MATRMASS,  
CALC\_FREQ=\_F (OPTION = "ADJUSTS",*



FREQ = (5. , 10. , 15. , 20. , 24. , 27. , 30. , 32. ,))

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08/02/05

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**E. BOYERE, Y. PONS. J. PIGAT** *Key*

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*FONCTIO1=DEFI\_FONCTION (NOM\_PARA=' INST', NOM\_RESU=' ALPHA',  
VALE=(0. , 1. , 1. , 1. , 1.0000001, 0. ,),  
PROL\_DROITE=' CONSTANT')*

*MACRO\_PROJ\_BASE (BASE=MODES,*

*MATR\_ASSE\_GENE= (*

*\_F (*

*STAMP = CO ("MASSEGEN"),*

*MATR\_ASSE = MATRMASS),*

*\_F (*

*STAMP = CO ("RIGIDGEN"),*

*MATR\_ASSE = MATRRIGI),*

*\_F (*

*STAMP = CO ("AMORTGEN"),*

*MATR\_ASSE = MATRAMOR,*

*PROFILE = "FULL")),*

*VECT\_ASSE\_GENE=*

*\_F (*

*VECTOR = CO ("EFFOGENE"),*

*VECT\_ASSE = VECTASS))*

```

DYNAMODA=DYNA_TRAN_MODAL (MASS_GENE=MASSEGEN, RIGI_GENE=RIGIDGEN,
AMOR_GENE=AMORTGEN,
EXCIT=_F (VECT_GENE = EFFOGENE,
FONC_MULT = FONCTIO1),
INCREMENT=_F (INST_INIT = 0. ,
INST_FIN = 1.5, NOT = 0.00001)
)
END ()

```

*# Sequence of the orders equivalent to macro-order MACRO\_PROJ\_BASE:*

```

_0000000 = NUME_DDL_GENE

```

```

(
BASE=MODES,
STOCKAGE='DIAG'
)

```

```

MASSEGEN = PROJ_MATR_BASE (BASE=MODES,
NUME_DDL_GENE
=_0000000,
MATR_ASSE=MATRMASS
)

```

```

RIGIDGEN = PROJ_MATR_BASE (BASE=MODES,
NUME_DDL_GENE
=_0000000,
MATR_ASSE=MATRRIGI
)

```

```

_0000001 = NUME_DDL_GENE

```

```

(
BASE=MODES,
STOCKAGE='PLEIN'
)

```

```

AMORTGEN = PROJ_MATR_BASE (BASE=MODES,
NUME_DDL_GENE
=_0000001,
MATR_ASSE=MATRAMOR
)

```

```

EFFOGENE = PROJ_MATR_BASE (BASE=MODES,
NUME_DDL_GENE

```

=\_0000001,  
VECT\_ASSE=VECTASS)

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**Code\_Aster** ®

*Version*

7.4

*Titrate:*

*Operator PROJ\_MATR\_BASE*

*Date:*

21/01/05

*Author (S):*

**E. BOYERE, Y. PONS, O. Key NICOLAS**

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*Organization (S): EDF-R & D /AMA*

***Instruction manual***  
***U4.6- booklet: Elementary matrices/Vectors and assembly***  
***Document: U4.63.12***

## ***Operator PROJ\_MATR\_BASE***

### ***1 Goal***

***To project a matrix assembled on a base of mechanical clean modes or a basis of RITZ. The projected matrix result will be used by the calculation algorithms in generalized components (DYNA\_TRAN\_MODAL [U4.53.21] for example).***

***One can use MACRO\_PROJ\_BASE [U4.63.11] to treat several matrices simultaneously.***

***Product a concept stamps generalized of matr\_asse\_gene\_R type if the matrix assembled with to project is of matr\_asse\_depl\_R type or matr\_asse\_gene\_R type.***

***Product a concept stamps generalized of matr\_asse\_gene\_C type if the matrix assembled with to project is of matr\_asse\_depl\_C type or matr\_asse\_gene\_C type.***

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***Version***

***7.4***

***Titrate:***

***Operator PROJ\_MATR\_BASE***

***Date:***

***21/01/05***

***Author (S):***

***E. BOYERE, Y. PONS, O. Key NICOLAS***

***:***

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### ***2 Syntax***

*matgene [matr\_asse\_gene\_X] = PROJ\_MATR\_BASE*

*(BASE*  
*=*  
*Ba,*  
*/*  
*[mode\_meca]*  
*/*  
*[base\_modale]*  
*/*  
*[mode\_gene]*  
*/*  
*[mode\_stat]*

*NUME\_DDL\_GENE*  
*=*  
*nu\_gene,*  
*[nume\_ddl\_gene]*

*/MATR\_ASSE*  
*= my,*  
*[matr\_asse\_DEPL\_X]*  
*/*  
*MATR\_ASSE\_GENE*  
*=*  
*my,*

*[matr\_asse\_gene\_X]*

)

*X = R or C*

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Titrate:

Operator *PROJ\_MATR\_BASE*

Date:

21/01/05

Author (S):

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### **3 Operands**

#### **3.1 Operand**

***BASE***

***BASE = Ba***

***Concept of the mode\_meca type, base\_modale, mode\_stat, or mode\_gene (for under-structuring) which contains the vectors defining the subspace of projection.***

#### **3.2 Operand**

***NUME\_DDL\_GENE***

***NUME\_DDL\_GENE = nu\_gene***

***Classification associated with the generalized model.***

#### **3.3 Operands**

***MATR\_ASSE/MATR\_ASSE\_GENE***

***/MATR\_ASSE = my***

***Concept of the matr\_asse\_DEPL\_R type or matr\_asse\_DEPL\_C, assembled matrix that one wish to project.***

***/MATR\_ASSE\_GENE = my***

***Concept of the matr\_asse\_gene\_R type or matr\_asse\_gene\_C, assembled matrix resulting from the under-structuring, which one wishes to project.***

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***Titrate:***

***Operator PROJ\_MATR\_BASE***

***Date:***

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***Titrate:***

***Operator PROJ\_VECT\_BASE***

***Date:***

***21/01/05***

***Author (S):***

***E. BOYERE, Y. PONS, O. Key NICOLAS***

***:***

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***Organization (S): EDF-R & D /AMA***

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***Document: U4.63.13***

***Operator PROJ\_VECT\_BASE***

## ***1 Goal***

***To project a vector assembled on a base of mechanical clean modes or a basis of RITZ. projected vector could be used by the calculation algorithms in generalized components (DYNA\_TRAN\_MODAL for example [U4.53.21]).***

***One can use MACRO\_PROJ\_BASE [U4.63.11] for these projections.***

***Product a concept of the vect\_asse\_gene type.***

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***Code\_Aster ®***

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***Titrate:***

***Operator PROJ\_VECT\_BASE***

***Date:***

***21/01/05***

***Author (S):***

***E. BOYERE, Y. PONS, O. Key NICOLAS***

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## ***2 Syntax***

***vecgene [vect\_asse\_gene] = PROJ\_VECT\_BASE***

***(BASE =***

***Ba,***

***/***

***[mode\_meca]***

/

**[base\_modale]**

/

**[mode\_gene]**

/

**[mode\_stat]**

**NUME\_DDL\_GENE**

=

**nu\_gene,**

**[nume\_ddl\_gene]**

**/VECT\_ASSE**

= **goes,**

**[cham\_no\_DEPL\_R]**

**/VECT\_ASSE\_GENE**

=

**goes,**

**[vect\_asse\_gene]**

***TYPE\_VECT***

***=***

***/***  
***“FORC”, [DEFECT]***

***/***  
***“DEPL”,***

***/***  
***“QUICKLY”,***

***/***  
***“ACCE”***

***)***

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***Date:***

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***Author (S):***

***E. BOYERE, Y. PONS, O. Key NICOLAS***

***:***

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***3 Operands***

***3.1 Operand***

***BASE***

***BASE = Ba***

***Concept of the mode\_meca type or base\_moda, mode\_stat or mode\_gene for under-structuring which contains the vectors defining the subspace of projection.***

***3.2 Operand***

***NUME\_DDL\_GENE***

***NUME\_DDL\_GENE = nu\_gene***

***Classification associated with the generalized model.***

***3.3 Operands***

***VECT\_ASSE/VECT\_ASSE\_GENE***

***/VECT\_ASSE = goes***

***Concept of the cham\_no\_DEPL\_R type, assembled vector which one wishes to project.***

***/VECT\_ASSE\_GENE = goes***

***Concept of the vect\_asse\_gene type, assembled vector resulting from the under-structuring, that one wish to project.***

***3.4 Operand***

***TYPE\_VECT***

***TYPE\_VECT = typ***

***Character string describing the type of the field represented by the assembled vector, defect one awaits a field of the type forces “FORC” the other possibilities are “DEPL”, “QUICKLY”, and “ACCE”.***

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***Operator PROJ\_VECT\_BASE***

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**Author (S):**

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***Titrate:***

***Operator PROJ\_SPEC\_BASE***

**Date:**

**27/01/05**

**Author (S):**

**A. Key ADOBES**

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**Organization (S): EDF-R & D /MFTT**

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**Document: U4.63.14**

**Operator PROJ\_SPEC\_BASE**

**1 Goal**

**To project one or more spectra of turbulence on one (or several) bases (S) modal (S). Spectra are defined by operator DEF1\_SPEC\_TURB [U4.44.31]. (Or them) bases (S) modal (S) can or (can) to be defined by:**

- a concept of the melasflu type produces by operator CALC\_FLUI\_STRU [U4.66.02],**
- a concept of the mode\_meca type produces by operator MODE\_ITER\_INV [U4.52.04] or MODE\_ITER\_SIMULT [U4.52.03],**

· a list of concepts of the *cham\_no\_depl\_r* type corresponding to the deformations.

Allows to calculate for each definite modal base a matrix interspectrale of excitations generalized. An option makes it possible if necessary to calculate only the autospectres.

The produced concept is of *tabl\_intsp* type.

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## **2 Syntax**

***tinsp [tabl\_intsp]***

**=**

***PROJ\_SPEC\_BASE***

**(**

***SPEC\_TURB***

**=**

***l\_spec***

**,**

***[l\_spectre]***

***/BASE\_ELAS\_FLUI = baseflui***

**,**



**[melasflu]**

/  
**MODE\_MECA**

=  
**basemeca**

,  
**[mode\_meca]**

/  
**CHAM\_NO =**  
**l\_cham**

,  
**[l\_cham\_no\_DEPL\_R]**

**MODELE\_INTERFACE**

=  
**model**

,  
**[model]**

**GROUP\_MA**

=  
**grma**

,  
**[gr\_maille]**

**VECT\_X**

=  
**l\_cmpx**

,  
**[l\_R]**

**VECT\_Y**

=  
**l\_cmpy**

,  
**[l\_R]**

**ORIG\_AXE**

=  
**l\_coor**

,  
**[l\_R]**

**FREQ\_INIT**

=  
**f<sub>i</sub>**  
**, [R]**

**FREQ\_FIN**

=  
**FF,**

**[R]**

**NB\_POIN**

=  
**Np,**

**[I]**

***OPTION***

=

/

***“ALL”***

***[DEFECT]***

/

***“DIAG”***

,

***TITRATE***

=

***titrate***

***, [TXM]***

);

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***3 Operands***

### 3.1 Operand *SPEC\_TURB*

*SPEC\_TURB = l\_spec*

*List concepts of the spectrum type produced by operator **DEFI\_SPEC\_TURB** [U4.44.31] defining several spectra of turbulent excitation.*

*Note:*

#### 1) *The operand*

*SPEC\_TURB allows the taking into account of several spectra of excitation turbulent. The interspectres of generalized excitations are calculated for each one of provided physical spectra then are added.*

*2) The spectra of turbulence of the type “length of correlation” apply only to tubes of Steam Generator. It is possible to project several spectra of turbulence of the type “length of correlation” simultaneously, but zones of excitation of each spectrum from/to each other must be strictly disjointed. The zones on which apply these excitations are defined for each spectrum, with the order **DEFI\_SPEC\_TURB** [U4.44.31].*

*3) The spectra of turbulence of the type “length of correlation” cannot be combined with spectra of another type.*

### 3.2 Operand *BASE\_ELAS\_FLUI*

*Operand **BASE\_ELAS\_FLUI** is employed when one wishes to carry out the projection of a spectrum defined by one of the key words **SPEC\_LONG\_COR\_n** factors, **SPEC\_FONC\_FORME** or **SPEC\_EXCI\_POINT** of operator **DEFI\_SPEC\_TURB** [U4.44.31].*

*/BASE\_ELAS\_FLUI*

*=*

*baseflui*

*Concept of the **melasflu** type produces by the operator **CALC\_FLUI\_STRU** [U4.66.02], who defines one or a whole of modal bases on which or (which) the spectra are projected, as well as the discretization of speed.*

*For each speed **K**, the operator calculates a matrix of interspectres of excitations generalized **S***

***K***

***fij** ()*

*The concept **melasflu** provides moreover the name of the concept type **\_flui\_stru** produces in*

## ***beginning***

***of study by order `DEFI_FLUI_STRU` [U4.25.01]. The concept type `_flui_stru` contains all information characteristic of the studied configuration: one finds there between others data necessary to the dimensionnalisation of the projected excitation.***

## ***3.3 Operands***

***`MODE_MECA` or `CHAM_NO`***

***Operands `MODE_MECA` or `CHAM_NO` are employed when one wishes to carry out projection of a spectrum of pressure defined by one of the key words `SPEC_CORR_CONV_n` factors of the operator***

***`DEFI_SPEC_TURB` [U4.44.31].***

***/***

***`MODE_MECA`***

***=***

***`basemeca`***

***Concept of the `mode_meca` type produces by operator `MODE_ITER_INV` [U4.52.04] or `MODE_ITER_SIMULT` [U4.52.03], which defines the modal base on which the spectra are projected. This modal base was possibly calculated by taking account of an effect of mass added fluid, by recourse to operator `CALC_MATR_AJOU` [U4.66.01] or `MACRO_MATR_AJOU` [U4.66.11].***

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***Operator `PROJ_SPEC_BASE`***

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***/***

**CHAM\_NO**

=

***l\_cham***

*List concepts of the cham\_no\_depl\_r type, which define the deformations of the base modal on which the spectra are projected.*

*This manner of defining the modal base makes it possible to impose on the structure a particular type of movement; a similar step is adopted in operator CALC\_MATR\_AJOU [U4.66.01], where figure also operand CHAM\_NO.*

**Note:**

*The operator determines the matrix of mutual acceptance connecting the spectrum of pressure to the matrix interspectrale of generalized excitations acting on the structure:*

$$[S_{fij}] = S_p \times [JA_{ij}]$$

*where*

*·*

*S<sub>p</sub> is the spectral concentration of power of pressure,*

*·*

*[JA<sub>ij</sub>] is the matrix of mutual acceptance,*

*·*

*[S<sub>fij</sub>] is the matrix of the interspectres of generalized excitations.*

*The theoretical precise details are given in internal report HP-51/97/027/B.*

### **3.4 Operand**

**MODELE\_INTERFACE**

*Operand MODELE\_INTERFACE is employed when one wishes to carry out the projection of a spectrum*

*of pressure defined by one of the key words SPEC\_CORR\_CONV\_n factors of the operator DEFI\_SPEC\_TURB [U4.44.31], if the user made a calculation of mass added with operator CALC\_MATR\_AJOU [U4.66.01].*

**MODELE\_INTERFACE**

=

***model***

*Concept of the model type produced by operator AFFE\_MODELE [U4.41.01], defining the model*

*(thermics) of interface enters the structure and the fluid.*

**Note:**

*If a model of interface is defined, the calculation of the coefficients of acceptance be carried out using this model, which characterizes the wet surface of the structure, while making the assumption of a homogeneous turbulence on all the interface fluid-structure.*

*In the contrary case, the coefficients of acceptance are calculated on the structure, in condition that this one is modelled in thin hulls of type DKT.*

### **3.5 Operand GROUP\_MA**

*Operand GROUP\_MA is employed when one wishes to carry out the projection of a spectrum of pressure defined by one of the key words SPEC\_CORR\_CONV\_n factors of operator DEFI\_SPEC\_TURB [U4.44.31].*

**GROUP\_MA**

=

*grma*

*Name of the group of meshes of the grid corresponding to the interface fluid-structure if a model of interface is defined (operand MODELE\_INTERFACE above), or with the structure alone in the contrary case.*

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Author (S):

**A. Key ADOBES**

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### **3.6 Operand**

#### **VECT\_X**

*Operand VECT\_X is employed when one wishes to carry out the projection of a spectrum of pressure defined by one of the key words SPEC\_CORR\_CONV\_n factors of operator DEFI\_SPEC\_TURB [U4.44.31], if the correlations of CORCOS or AU\_YANG are used.*

VECT\_X

=

*l\_cmpx*

*List of three components of an unit vector X defining:*

- direction of the flow on the surface of the plane structure, in the case of one correlation of CORCOS,*
  - direction of the axis of revolution of the cylindrical structure of circular section, in case of a correlation of AU\_YANG.*
- (see diagrams hereafter)*

### **3.7 Operand**

#### **VECT\_Y**

*Operand VECT\_Y is employed when one wishes to carry out the projection of a spectrum of pressure defined by one of the key words SPEC\_CORR\_CONV\_n factors of operator DEFI\_SPEC\_TURB [U4.44.31], if the correlation of CORCOS is used.*

VECT\_Y

=



*l\_cmpy*

*List of the three components of an unit vector defining the orthogonal direction **in it** in direction of the flow on the surface of the plane structure (see diagrams hereafter).*

### **3.8 Operand**

#### **ORIG\_AXE**

*Operand ORIG\_AXE is employed when one wishes to carry out the projection of a spectrum of pressure defined by one of the key words SPEC\_CORR\_CONV\_n factors of operator DEFI\_SPEC\_TURB [U4.44.31], if the correlation of AU\_YANG is used.*

*ORIG\_AXE*

*=*

*l\_coor*

*List of the three co-ordinates defining the position of an origin O on the axis of revolution of cylindrical structure of circular section (see diagrams hereafter).*

*X*

*X*

*U*

*X*

*y*

*X*

*y*

*O*

*CORCOS*

*AU\_YANG*

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### **3.9 Operands**

***FREQ\_INIT, FREQ\_FIN and NB\_POIN***

*FREQ\_INIT =  $f_i$*

*FREQ\_FIN*

=

*FF*

*NB\_POIN*

=

*Np*

*These operands define the frequency band and the number of points of discretization frequential of the interspectres to be calculated.*

*The number of points of discretization must be equal to a power of 2, in order to allow postprocessings of type FFT (Fast Fourier Transform).*

*The default values of the frequencies of beginning and run-out are calculated in the manner following: if ( $K$*

*$K$*

*$F, \dots, F$*

*1*

*NR) indicate the frequencies of the modes of the kème bases structure*

*then:*

*$K$*

*$K$*

*$F$*

*$F$*

*min 1*

*$K$*

*1*

*FREQ\_INIT =*

*FINE FREQ\_*

*max F*

*NR*

$K$ 

2

=

+

 $K$ 

2

The default value of the number of points of discretization is deduced from the minimum step in frequency defined by:

$$df = \min \left( \frac{K}{2 \mu \times F K}, I \right)$$

$I, K$

where  $K$

$\mu_i$  indicates the reduced damping of the  $i$ ème mode of the  $k$ ème bases modal.

### 3.10 Operand

#### OPTION

OPTION = "ALL" or "DIAG"

Indicator of the choice of calculation to be realized:

· "ALL"

if one wishes to calculate all the interspectres generalized excitations (default option),

· "DIAG"

if one wishes to calculate only the autospectres generalized excitations.

### 3.11 Operand

#### TITRATE

TITRATE = title

*Argument of the text type defining the title attached to the concept tabl\_intsp at exit.*

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*Titrate:*

*Operator REST\_BASE\_PHYS*

*Date:*

*08/02/05*

*Author (S):*

***E. BOYERE, Key Fe WAECKEL***

*:*

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*Organization (S): EDF-R & D /AMA, SINETICS*

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***U4.63.21 document***

***Operator REST\_BASE\_PHYS***

## ***1 Goal***

***To restore in the physical base of the results in generalized co-ordinates.***

***This operator allows, starting from results on a frame of reference generalized obtained by methods of modal recombination `tran_gene`, methods of under cyclic structuring `mode_cycl`, of under dynamic structuring `mode_gene` or of harmonic structuring `harm_gene`, to restore the results in the initial physical system.***

***The produced concept is a concept of the type:***

***.  
dyna\_trans if the generalized results come from a calculation by modal recombination or following the extrapolation of experimental results of measurement on a digital model (it concept of entry is of `tran_gene` type),***

***.  
mode\_meca following a calculation by cyclic under-structuring (`mode_cycl`), under-structuring dynamics (`mode_gene`) or if calculation corresponds to the restitution of a concept `mode_meca` on a new grid of visualization,***

***.  
dyna\_harmo following a calculation by harmonic under-structuring (`harm_gene`).***

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***08/02/05***

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***2 Syntax***

***resphy = REST\_BASE\_PHYS***

***[\*]***

***(***  
***/***  
***RESULT,***  
***[mode\_meca]***  
***/***  
***RESU\_GENE***  
***=***  
***tg,***

***/[tran\_gene]***

*/[mode\_cycl]*

*/[mode\_gene]*



*/[harm\_gene]*

*MODE\_MECA*

=

*mode,*

*[mode\_meca]*

/

*TOUT\_ORDRE = "YES",*

/

*NUME\_ORDRE = num*

,

*[I\_I]*

/

*TOUT\_INST = "YES",*

/

*LIST\_INST*

=

*list,*  
*[listr8]*  
*/*  
*INST*

=  
*inst,*  
*[l\_R]*  
*/*  
*FREQ*

=  
*freq,*  
*[l\_R]*  
*/*  
*LIST\_*  
*FREQ=*  
*list,*  
*[listr8]*

*/TOUT\_CHAM*  
*= "YES",*

*/NOM\_CHAM = (/ "DEPL",*  
*/*  
*"QUICKLY",*  
*/*

**“ACCE”, [DEFECT]**

/  
**“ACCE\_ABSOLU”,**  
  
/  
**“EFGE\_ELNO\_DEPL”,**  
  
/  
**“SIPO\_ELNO\_DEPL”,**  
  
/  
**“SIGM\_ELNO\_DEPL”,**  
  
/  
**“FORC\_NODA”,**  
),

**Interpol =**  
**/“FLAX”,**  
  
/  
**“NOT”,**  
**[DEFECT]**

**CRITERION =/“ABSOLUTE”,**  
  
/  
**'RELATIVE,**  
**[DEFECT]**

**PRECISION**

=  
/

*prec,*  
**[R]**  
/  
**1.E-03, [DEFECT]**

/  
**SECTOR**  
=  
/  
**1,**  
**[DEFECT]**  
/  
**numsec, [I]**

/  
**SKELETON**  
=  
**squel,**  
**[skeleton]**

/  
**SOUS\_STRUC**  
=  
**nom\_sstruc,**  
**[KN]**

**MULT\_APPUI =/"YES",**

/  
**“NOT”,**  
**[DEFECT]**

**ACCE\_MONO\_APPUI =gamma, [function]**

**DIRECTION = (dx, Dy, dz), [l\_R]**

**CORR\_STAT =/“YES”,**  
/  
**“NOT”,**  
**[DEFECT]**

/  
**NODE**  
=  
**lno,**  
**[l\_co]**

/  
**GROUP\_NO**  
=  
**lgrno,**

**[l\_co]**

**TITRATE**

= *title*,

**[l\_Kn]**

)

*If RESU\_GENE of the tran\_gene type then*

*[\*] = dyna\_trans*

*If RESU\_GENE of the mode\_cycl type then*

*[\*] = mode\_meca*

*If RESU\_GENE of the mode\_gene type then*

*[\*] = mode\_meca*

*If RESU\_GENE of the harm\_gene type then*

*[\*] = dyna\_harmo*

*If RESULT of the mode\_meca type then*

*[\*] = mode\_meca*

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### **3 Operands**

#### **3.1 Operands**

**RESU\_GENE/RESULT**

/

**RESU\_GENE = tg**

/

*concept of the tran\_gene type containing for various moments of the vectors generalized of displacement type, speed and acceleration. If the results come extrapolation of results of measurement on a digital model (order PROJ\_MESU\_MODAL), the generalized vectors are of displacement type, deformation and constraint. In this case, the base of recombination can be of base\_modale type or mode\_meca.*

/

*concept of the mode\_cycl type containing the generalized vectors of the calculated modes by under cyclic structuring.*

/

*concept of the mode\_gene type containing the generalized vectors of the calculated modes by under dynamic structuring.*

/

*concept of the harm\_gene type containing the generalized vectors of type displacement, speed and acceleration of the harmonic response of a structure calculated by under structuring.*

**/RESULT**

*This key word can be used following a calculation by under - dynamic structuring. One restores initially, a result resulting from a calculation by under-structuring dynamics on a first skeleton (grid of visualization). One definite then one enriched skeleton in which one amalgamated the nodes with the interfaces of under structures and recovered whole or part of the groups of nodes or meshes of the initial grid. The key word result corresponds then to the restitution of a concept mode\_meca on new*

*enriched skeleton (cf example with [§5]).*

### **3.2 Operand**

**MODE\_MECA**

**MODE\_MECA = mode**

*Concept of the mode\_meca type containing a base of clean modes obtained by dynamic under-structuring.*

*This operand is used in the case of a restitution in the physical system of a result of transitory calculation carried out on modal basis calculated by dynamic under-structuring. The base modal contained in the concept mode\_meca was obtained by a precedent REST\_BASE\_PHYS. It is thus about a double restitution, after having made a double projection (cf example with [§5]).*

### **3.3 Operands TOUT\_ORDRE/NUME\_ORDRE/TOUT\_INST/ LIST\_INST/INST**

**/TOUT\_ORDRE = "YES"**

*To restore on all the modes of the concept mode\_cycl or mode\_gene.*

**/NUME\_ORDRE = num**

*List entireties containing the numbers of the modes on which the restitution takes place.*

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***/TOUT\_INST = “YES”***

***If one wishes to restore over every moment contained in the generalized result (tran\_gene).***

***/LIST\_INST = list***

***List real crescents of the listr8 type containing the moments for which one wishes to carry out the restitution.***

***/INST = inst***

***List the real ones containing the moments over which the restitution takes place.***

***For a transitory calculation, one checks that the moments required by option LIST\_INST are well in the field of definition of the tran\_gene.***

***The results at one unspecified moment can be obtained by linear interpolation between two moments results of calculation actually contained by the tran\_gene.***

### ***3.4 Operands***

***FREQ/LIST\_FREQ***

***These operands are used in the case of a restitution on the basis of physical harmonic calculation generalized (harm\_gene).***

***/FREQ = freq***

***Frequency to which one wishes to restore harmonic calculation***

***/LIST\_FREQ = list***

***List the real ones containing the frequencies for which one wishes to carry out the restitution.***

***For each frequency indicated, one restores the fields obtained at the frequency of calculation more near. There is no interpolation.***

### ***3.5 Operands***

***TOUT\_CHAM/NOM\_CHAM***

***/TOUT\_CHAM = “YES”***

*Allows to restore the fields of reference symbol DEPL, QUICKLY and ACCE contained in generalized result (tran\_gene, harm\_gene).*

/  
*NOM\_CHAM = nomcha*

*List reference symbols of field which one wishes to restore: "DEPL", "QUICKLY", "ACCE" and possibly if they were calculated, "ACCE\_ABSOLU", "EFGE\_ELNO\_DEPL", "SIPO\_ELNO\_DEPL", "SIGM\_ELNO\_DEPL" or "FORC\_NODA".*

*Restitution of fields "EFGE\_ELNO\_DEPL", "SIPO\_ELNO\_DEPL", "SIGM\_ELNO\_DEPL" and "FORC\_NODA" are not available in under-structuring and in multi-supports.*

### *3.6 Operand Interpol*

*Interpol  
=*

*"FLAX": an interpolation is authorized between two moments; this interpolation is not usable that enters two moments of calculation, but can lead to errors if both moments of filing [U4.53.21] are separated from a very long time with respect to periods of the studied phenomena.*

*"NOT": the restitution must be made strictly speaking.*

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### 3.7 Operands

#### ***PRECISION/CRITERION***

***PRECISION = prec***

#### ***CRITERION***

=

***When Interpol is worth “NOT” indicates with which precision the research of the moment to be restored must be done***

***“ABSOLUTE”:***

***interval of research [Inst - prec, Inst + prec],***

***“RELATIVE”:***

***interval of research [(1 - prec). Inst, (1 + prec). Inst]***

***Inst being the moment of restitution.***

### 3.8 Operand

#### ***SECTOR***

***/SECTOR***

***Number of sector of the cyclic structure on which the result (of mode\_cycl type) will be restored in the physical system in cyclic under-structuring.***

### 3.9 Operand

#### ***SKELETON***

***/***

***SKELETON***

***Name of the grid skeleton of the total structure on which the result will be restored: to see operator DEFI\_SQUELETTE [U4.24.01].***

### 3.10 Operand

#### ***SOUS\_STRUC***

***/SOUS\_STRUC = nom\_sstruc***

***Name of the substructure on which the result will be restored: to see the operator***

## **DEFI\_MODELE\_GENE [U4.65.02].**

### **3.11 Operand**

#### **MULT\_APPUI**

*After the transitory calculation of the generalized seismic response of a structure, the user must indicate*

*“YES” under key word MULT\_APPUI to restore displacements (and/or speeds and/or accelerations) absolute. If it does not specify anything, the operator restores the relative sizes.*

### **3.12 Operands**

#### **ACCE\_MONO\_APPUI and DIRECTION**

*After the calculation of the generalized seismic response of an excited mono structure, the user indicates*

*the name of the imposed accélérogramme (key word ACCE\_MONO\_APPUI) and direction of the seism (key word*

*DIRECTION) to restore absolute accelerations (accelerations only). If it does not specify anything, the operator restores the relative sizes.*

#### **Note:**

*The accélérogramme imposed under ACCE\_MONO\_APPUI must be the same one as that imposed under*

*key word FONC\_MULT of order DYNA\_TRAN\_MODAL.*

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### **3.13 Operand CORR\_STAT**

*After the transitory calculation of the generalized seismic response of a structure, provided that the user asked “for CORR\_STAT” = “YES” in DYNA\_TRAN\_MODAL, it can then restore them displacements (and/or speeds and/or accelerations) with correction by the static modes of truncation of the modal base. The user must indicate “YES” under key word CORR\_STAT. If it specify anything, the operator restores the sizes without static correction.*

### **3.14 Operand NODE/GROUP\_NO**

*/NODE = lno*

*/GROUP\_NO = lgrno*

*After a transitory calculation of dynamics on modal basis, the user can restore fields kinematics on a part only of the nodes of the grid.*

*List names of the nodes or groups of nodes corresponding to the places where the user wants to restore fields kinematics.*

### **3.15 Operand TITRATE**

*TITRATE = title*

*Titrate attached to the concept produced by this operator [U4.03.01].*

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## **4 Examples**

### **4.1 Restitution**

*of one*

*mode\_meca on an enriched skeleton: use of  
 key word RESULT*

*One proposes Ci below an example of use of the key word RESULT. The command file  
 complete corresponds to the case test SDLS106A.*

*First stage: calculation of the generalized clean modes (obtained by dynamic under-structuring)  
 total structure*

```
resgen = MODE_ITER_SIMULT (MATR_A = risgen,  

MATR_B = masgen,  

CALC_FREQ = _F (OPTION = "PLUS_PETITE",  

NMAX_FREQ = 6))
```

*% definition of the first grid of visualization of the calculated sizes*

```
squel = DEFI_SQUELETTE (MODELE_GENE = modege,  

SOUS_STRUC = _F (NAME = "carre1", ALL = ' OUI'),  

SOUS_STRUC = _F (NAME = "carre2", ALL = ' OUI'))
```

*% restitution of the mode\_gene on this first skeleton:*

```
modglo = REST_BASE_PHYS (RESU_GENE = resgen,  

SKELETON = squel,  

TOUT_ORDRE = "YES", TOUT_CHAM = "YES")
```

*% definition of the enriched skeleton in which one amalgamated the nodes with the interfaces of  
under*

*structures and recovered whole or part of the groups of nodes or meshes of the initial grid:*

```
squelbis = DEFI_SQUELETTE (MODELE_GENE = modege,  

SKELETON = squel,  

RECO_GLOBAL = -F (TOUT=' OUI', DIST_REFE = 0.1))
```

*% restitution of the first mode\_meca on the new skeleton:*

```
modglbis = REST_BASE_PHYS (SKELETON = squelbis,  

RESULT = modglo)
```

### **4.2 Restitution of a transitory computation result carried out on basis**

*modal calculated by dynamic under-structuring*

*: double*

*restitution*

***K***

***1***

***Modal calculation on a generalized model:  $(K - M2) = 0$  with  $K =$***

***K2***

***and***

***O***

***M***

***1***

***M =***

***M2***

***and equations of connection  $L = 0$***

***O***

***modgene***

***=***

***MODE\_ITER\_SIMULT***

***(***

***MATR\_A***

***=***

***K,***

***MATR\_B***

***=***

***M***

)

*A generalized modal base is obtained: the clean modes of the total structure are linear combinations of the clean modes of the substructures: it is on this modal basis generalized that one projects the generalized assembled matrices (double projection).*

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**K**

= *T K operator PROJ\_MATR\_BASES*

**M**

= *T M*

**C**

= *T C*

= *T F*

**F**

*ext.*

*operator PROJ\_VECT\_BASES*

*ext.*

*Transitory calculation on the modal basis obtained by dynamic under-structuring.*

*trangen*

=

*DYNA\_TRAN\_MODAL*

(

*MASS\_GENE*

=

**M**,

*RIGI\_GENE*

=

**K**,

*AMOR\_GENE*

=

**C,**  
**EXCIT**  
**=**  
**\_F (VECT\_GENE**  
**=**  
**Fext))**

*Restitution of the modal base in the initial physical system:*

*modmeca = REST\_BASE\_PHYS*  
*(RESU\_GENE = modgene,*  
*SKELETON*  
*=*  
*squel)*

*Restitution of transitory calculation in the initial physical system:*

*tran = REST\_BASE\_PHYS (RESU\_GENE = trangen,*  
*MODE\_MECA*  
*=*  
*modmeca*  
*)*

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*Operator REST\_SPEC\_PHYS*

*1 Goal*

*To calculate the response of a structure in the physical base. Calculation is carried out from one interspectre of modal answer, in certain selected nodes of the grid.*

*The operator carries out calculation, with four alternatives, of the spectra of response in the physical base.*

*The user can choose a response in displacements, speeds, accelerations and under some conditions in generalized efforts, constraints or forces nodal. The produced result is a concept of tabl\_intsp type.*

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***2 Syntax***

***tinsp [tabl\_intsp] = REST\_SPEC\_PHYS***

***(***

***/***

***BASE\_ELAS\_FLUI***

***=***

***baseflui***

***, [melasflu]***

***/***

***MODE\_MECA***

***=***

***basemeca***

***, [mode\_meca]***

***/NUME\_ORDRE = l\_nuor***

***,***

***[l\_I]***

***/***

***BANDAGE***

***=***

***(f1,***

***f2)***

***, [l\_R]***

**INTE\_SPEC\_GENE**

=

**repmoda**

,

**[tabl\_intsp]**

**NODE**

=

**l\_no\_rep**

**, [l\_noeud]**

**NET**

=

**l\_ma\_rep**

**, [l\_maille]**

**NOM\_CHAM**

=

/

**“DEPL”**

/

**“QUICKLY”**

/

**“ACCE”**

/

**“EFGE\_ELNO\_DEPL”**

/

**“SIPO\_ELNO\_DEPL”**

/

**“SIGM\_ELNO\_DEPL”**

/

**“FORC\_NODA”**

,

***NOM\_CMP*** =/"DX"

/

**"DY"**

/

**"DZ"**

/

**"SMFY"**

/

**"SMFZ"**

,

***MODE\_STAT***

=

***modestat***

, [***mode\_stat***]

***EXCIT*** = ***\_F***

(

***NODE***

=

***l\_no***

,

[***l\_noeud***]

***NOM\_CMP*** =

***l\_ncmp***

,

[***l\_TXM***]

)

*MOVEMENT*

=

/

“ABSOLUTE”

[DEFECT]

/

“RELATIVE”

/

“DIFFERENTIAL”

,

*OPTION*

=

/

“DIAG\_DIAG”

[DEFECT]

/

“DIAG\_TOUT”

/

“TOUT\_DIAG”

/

“TOUT\_TOUT”

,

*TITRATE*

=

*titrate*

, [TXM]



);

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### **3 Operands**

#### **3.1 Operands**

**BASE\_ELAS\_FLUI and MODE\_MECA**

**/BASE\_ELAS\_FLUI = baseflui**

***Concept of the melasflu type produces by the operator CALC\_FLUI\_STRU [U4.66.02], who defines a whole of modal bases associated the various rates of flow of the fluid.***

***The modal response of the structure for a rate of flow considered is broken up on the basis corresponding at this speed.***

**/MODE\_MECA = basemeca**

***Concept of the mode\_meca type produces by operator MODE\_ITER\_INV [U4.52.04] or***

***MODE\_ITER\_SIMULT [U4.52.03], which defines the base on which the answer is broken up modal.***

***Note:***

***Operands BASE\_ELAS\_FLUI and MODE\_MECA can be used simultaneously if one wishes to calculate a response in constraints of a telegraphic structure subjected to the action of a flow.***

***This calculation case is determined by the data of a concept of the melasflu type under operand BASE\_ELAS\_FLUI, defining the modal bases of the structure in various rates of flow, and the choice of the physical field of answer "SIPO\_ELNO\_DEPL" under operand NOM\_CHAM. The data complementary to one concept of the mode\_meca type under operand MODE\_MECA becomes obligatory then, so to define the field of the modal constraints in the nodes of the structure.***

***The modal constraints are calculated upstream by operator CALC\_ELEM [U4.81.01], option "SIPO\_ELNO\_DEPL", using the normalized modal deformations. The operator NORM\_MODE [U4.52.11] makes it possible to carry out the standardization of the deformations beforehand modal.***

### ***3.2 Operands***

***NUME\_ORDRE and BAND***

***These operands should be used only if the base on which is broken up modal answer is defined by a concept of the mode\_meca type.***

***/NUME\_ORDRE = l\_nuor***

***List sequence numbers of the modes of the concept of the mode\_meca type which are indeed taken into account for the calculation of the physical answer.***

***/BAND = (f1, f2)***

***The modes which are taken into account for the calculation of the physical answer are the modes of concept of the mode\_meca type whose frequency is in the band defined by (f1 f2).***

### ***3.3 Operand***

***INTE\_SPEC\_GENE***

***INTE\_SPEC\_GENE = repmoda***

***Concept of the tabl\_intsp type produces by operator DYNA\_SPEC\_MODAL [U4.53.23] or DYNA\_ALEA\_MODAL [U4.53.22], which defines the interspectres modal answer, i.e them***

*interspectres of generalized displacements.*

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*Titrate:*

*Operator REST\_SPEC\_PHYS*

*Date:*

*27/01/05*

*Author (S):*

*A. Key ADOBES*

*:*

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*3.4 Operand*

*NODE*

*NODE = l\_no\_rep*

*List nodes of the grid where the interspectres of physical answer are calculated.*

*3.5 Operand*

*NET*

*NET = l\_ma\_rep*

*List meshes of the grid where the interspectres of physical answer are calculated, in the case where the field of answer is a field with the elements.*

*3.6 Operand*

*NOM\_CHAM*

*NOM\_CHAM =*

*“DEPL” or “QUICKLY” or “ACCE” or “EFGE\_ELNO\_DEPL” or*

**“SIPO\_ELNO\_DEPL” or “SIGM\_ELNO\_DEPL” or “FORC\_NODA”**

*Name of the physical field of answer to calculate.*

**Note:**

*The choice of the physical field of answer “SIPO\_ELNO\_DEPL” for a telegraphic structure under flow requires the simultaneous use of operands BASE\_ELAS\_FLUI and MODE\_MECA (cf [§3.1]).*

### **3.7 Operand**

**NOM\_CMP**

**NOM\_CMP = “DX” or “DY” or “DZ” or “SMFY” or “SMFZ”**

*Names of the components of the physical field of answer having to be actually calculated.*

**Note:**

*Components “DX”, “DY”, and “DZ” are valid for fields “DEPL”, “QUICKLY” or “ACCE”. Components “SMFY” and “SMFZ” are valid for the field “SIPO\_ELNO\_DEPL”.*

### **3.8 Operand**

**MODE\_STAT**

**MODE\_STAT = modestat**

*Concept of the mode\_stat type produces by the operator MODE\_STATIQUE [U4.52.14], who defines them*

*static modes taken into account in the case of a seismic calculation multi-supports where the excitation fact on the DDL.*

### **3.9 Key word**

**EXCIT**

**EXCIT**

*Key word factor allowing to define the DDL to which the excitation is applied, in the case of a seismic calculation multi-supports.*

***NODE = l\_no***

***List nodes where the excitation is applied.***

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***NOM\_CMP = l\_ncmp***

***List components to which the excitation is applied.***

***Note:***

***These components must correspond to degrees of freedom of the nodes of supports.***

***Example: “NEAR”, “DRZ”, “PHI”...***

***In all the cases, one needs as many arguments under the operand NODE under the operand NOM\_CMP.***

***For the fluid sources, it is the component “CLOSE” which is excited.***

***3.10 Operand***

***MOVEMENT***

***MOVEMENT = “ABSOLUTE” or “RELATIVE” or “DIFFERENTIAL”***

***Indicator characterizing the physical answer to calculate, in the case of a seismic calculation multi-supports: absolute response (“ABSOLUTE”) by defect, dynamic contribution (“RELATIVE”) or***

*differential (“DIFFERENTIAL”) of the answer.*

### **3.11 Operand OPTION**

*OPTION = “DIAG\_DIAG” or “DIAG\_TOUT” or “TOUT\_DIAG” or “TOUT\_TOUT”*

*Indicator specifying the choice of calculation to be realized:*

- calculation of the autospectres to the nodes by means of the modal autospectres;*
- calculation of the autospectres to the nodes by means of all modal interspectres;*
- calculation of all interspectres to the nodes by means of the modal autospectres;*
- calculation of all interspectres to the nodes by means of all modal interspectres.*

*Note:*

*If the modal answer were calculated by DYNA\_SPEC\_MODAL [U4.53.23], the choice of calculation must be coherent with that retained upstream in this operator. Indeed, them options “DIAG\_TOUT” or “TOUT\_TOUT” cannot be carried out if one chose “DIAG” in DYNA\_SPEC\_MODAL [U4.53.23].*

*The choice by defect is thus “DIAG\_DIAG”, which corresponds to the simplest calculation case realizable whatever the choice selected upstream.*

### **3.12 Operand TITRATE**

*TITRATE = title*

*Argument of the text type defining the title attached to the concept tabl\_intsp at exit.*

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***Titrate:***

***Operator DEFI\_INTERF\_DYNA***

***Date:***

***10/02/05***

***Author (S):***

***O. NICOLAS, E. BOYERE Key***

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***Organization (S): EDF-R & D /AMA***

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***Document: U4.64.01***

***Operator DEFI\_INTERF\_DYNA***

***1 Goal***

***To define the interfaces of a structure and to affect a type to them.***

***Employed within the framework of methods of modal recombination, or dynamic under-structuring by modal synthesis. Also count, without calculating them (task carried out by the operator***



**DEFI\_BASE\_MODAL** [U4.64.02]), deformations static corresponding to the definite interfaces.

Product a structure of data of the **interf\_dyna\_clas** type.

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**2 Syntax**

**inter [interf\_dyna\_clas] = DEFI\_INTERF\_DYNA**

**(NUME\_DDL = naked**

**,**

**[nume\_ddl]**

**INTERFACE=**

**\_F (NAME**

**=**

**“nom\_int”,**

**[KN]**

***TYPE***

=

***/"MNEAL",***

***/***

***/"CRAIGB",***

***/***

***/"CB\_HARMO",***

***/***

***/"NONE",***

***[DEFECT]***

***/NODE***

=

***/"lno",***

***[l\_noeud]***

***/GROUP\_NO = "lgno", [l\_gr\_noeud]***

***DDL\_ACTIF***

=  
“*lddl*”, [*l\_cmp*]

***MASK***  
=  
“*lddl*”, [*l\_cmp*]

),

***FREQ***  
=  
/  
*val\_freq*,  
[*R8*]

/*1*,  
[*DEFECT*]

***INFORMATION***  
=  
/  
*1*,  
[*DEFECT*]

/ 2,

)

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### **3 Operands**

#### **3.1 Operand**

**NUME\_DDL**

**NUME\_DDL** = *naked*

*Name of the concept `nume_ddl` of the structure.*

#### **3.2 Word**

*key*

**INTERFACE**

**INTERFACE**

*Key word factor for the definition of the interfaces.*

##### **3.2.1 Operand**

**NAME**

**NAME** = “*nom\_int*”

*Name of the interface. It is obligatory for each interface. If for an occurrence of the word key factor **INTERFACES** any name is not given, then this occurrence comes to supplement definition of the interface previously named (concatenation of the list of the nodes with continuation of those already existing). This makes it possible to use key words **NODE** and*

## **GROUP\_NO for**

*the same interface, or to give various arguments to the key words MASKS and DDL\_ACTIF within the same interface.*

### **3.2.2 Operand**

#### **TYPE**

**TYPE =**

*It makes it possible to specify the kind of the modal base corresponding to the interface.*

**“MNEAL”**

:

*interface correspondent at a modal base of type MAC-NEAL which includes/understands clean modes and of the modes of fastener. The modes of fastener are not entered, with the interface, that on the not blocked and not masked degrees of freedom.*

**“CRAIGB”**

:

*interface correspondent at a modal base of type CRAIG-BAMPTON which includes/understands clean modes and constrained modes. The constrained modes are not entered, with the interface, that on the degrees of freedom blocked by dualisation and not masked.*

**“CB\_HARMO”**

:

*interface correspondent at a modal base of harmonic type CRAIG\_BAMPTON which includes/understands clean modes and constrained harmonic modes (displacement unit imposed harmonic). The frequency used is that given in argument of the word key frequency “FREQ”.*

*The harmonic constrained modes are not entered, with the interface, that on degrees of freedom blocked by dualisation and not masked.*

**“NO”**

:

*free interface. No static deformation will be calculated; the modal base will comprise that clean modes.*

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**Operator** *DEFI\_INTERF\_DYNA*

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**O. NICOLAS, E. BOYERE** *Key*

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### **3.2.3 Operands**

**NOEUD/GROUP\_NO**

**NODE = "lno"**

*List ordered nodes of the grid composing the interface. The use of the key words **NODE** and **GROUP\_NO** are exclusive in the same occurrence of the key word factor **INTERFACES**.*

**GROUP\_NO = "lgn"**

*List ordered groups of nodes of the grid composing the interface. The final list of nodes is obtained by concatenation of the groups of nodes in the order given by the user, at the time of the definition of the groups.*

### **3.2.4 Operands**

**DDL\_ACTIF/MASQUE**

**DDL\_ACTIF = "lddl"**

*List active degrees of freedom to the interface. Conditions of continuity of displacements*

*between the two interfaces of two structures will be expressed only on the degrees of freedom credits (it is thus necessary to take care of coherence definitions of two interfaces intended for to be connected). By defect if the key word does not appear, all the degrees of freedom are regarded a priori as credits. List of the active degrees of freedom given by the user are withdrawn the blocked degrees of freedom (ddl blocked of an interface of the MAC type NEAL or ddl masked of an interface of the type CRAIG-BAMPTON).*

**MASK = "lddl"**

*List ddl for the current nodes which should not generate static deformations (ddl masked).*

### **3.3 Operand FREQ**

**FREQ = val\_freq**

*Value of the frequency used for the calculation of the harmonic constrained modes.*

### **3.4 Operand INFORMATION**

**INFORMATION =**

*Level of information provided in the file "MESSAGE":*

**1**

*no impression,*

**2**

*writing of the definitions of the interfaces (kind, nodes), and of the static deformations listed (allows to properly check the list of the static deformations before their calculation known as).*

### **3.5**

*Case of a node common to several interface*

*When a node is common to several interfaces (for example the center of a circular structure), that often leads to a singular system in the calculation of the clean modes of the complete structure. One circumvents this problem by eliminating the common node. That led of course to an error on total modes but if the grid is rather fine, it is not sensitive (see the case test SDLS01).*



## **4 Example**

**An example of use of the order is given in the documentation of the operator  
DEFI\_SQUELETTE [U4.24.01].**

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**Titrate:**

**Operator DEFI\_BASE\_MODAL**

**Date:**

**31/01/06**

**Author (S):**

**O. NICOLAS, E. BOYERE Key**

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**Organization (S): EDF-R & D /AMA**

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**Document: U4.64.02**

## ***Operator DEF1\_BASE\_MODAL***

### ***1 Goal***

***To define the base of a dynamic under-structuring or a modal recombination.***

***The modal base obtained by this operator is of the type: “TRADITIONAL” if the modal base is composed of dynamic clean modes and the static deformations calculated by the operator with to start from a concept of the interf\_dyna\_clas type produces by DEF1\_INTERF\_DYNA [U4.64.01]. Option DIAG\_MASS makes it possible to recompute a classification for the static modes of such kind that the matrix of mass is diagonal. the base is RITZ in the other cases.***

***Product a concept of the base\_modale type.***

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### ***2 Syntax***

***bamo [base\_modale] = DEFI\_BASE\_MODAL (***

***/TRADITIONAL = \_F (  
INTERF\_DYNA=  
intdyn, [interf\_dyna\_clas]***

***MODE\_MECA = modes,***

***[mode\_meca]***

***NMAX\_MODE =/nbmode,***

***[I]  
/  
10,  
[DEFECT]***

***),***

***/  
RITZ =  
\_F (  
MODE\_MECA = modes,***

***[l\_mode\_meca]***

/  
**MODE\_STAT = modesta,**  
**[mode\_stat\_\*]**

/  
**MULT\_ELAS = multelas,**  
**[mult\_elas]**

/ **BASE\_MODALE=**  
**bamo,**  
**[base\_modale]**

**NMAX\_MODE =/nbmode,**

**[I]**  
/  
999,  
**[DEFECT]**

)  
/  
**DIAG\_MASS = \_F (|**  
**MODE\_MECA = modes,**  
**[l\_mode\_meca]**

/  
**MODE\_STAT = modesta,**  
**[mode\_stat\_\*]**

),  
/  
**ORTHO\_BASE = \_F (BASE = modes,**  
**[l\_mode\_meca, base\_modale]**

**STAMP = matrix,**  
**[matr\_asse\_\*]**

),  
  
**INTERF\_DYNA**  
=  
*intdyn, [interf\_dyna\_clas]*

**NUME\_REF**  
=  
*numddl, [nume\_ddl]*

**TITRATE**  
=  
*titrate,*  
*[l\_Kn]*

**INFORMATION**  
=  
/  
1,  
**[DEFECT]**  
/  
2,

)

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**3 Operands**

**3.1 Word**

**key**

**TRADITIONAL**

*/TRADITIONAL*

*Key word factor for the definition of a modal base of “TRADITIONAL” type.*

**3.1.1 Operand**

**INTERF\_DYNA**

*INTERF\_DYNA = intdyn*

*Name of the concept of the interf\_dyna\_clas type produces by DEFI\_INTERF\_DYNA [U4.64.01].*

*The operator calculates the static deformations corresponding to the various defined interfaces, while being based on the classification used for the calculation of the clean modes.*

**3.1.2 Operands**

**MODE\_MECA/NMAX\_MODE**

*MODE\_MECA = modes*

*Name of the concept of the mode\_meca type containing the clean modes of the structure.*

*NMAX\_MODE = nbmode*

*A number of modes suitable to use in the modal base. Clean modes corresponding with the nbmode the lowest frequencies are taken into account.*

**3.2 Word**

**key**  
**RITZ**

*/RITZ*

*Key word factor allowing to build a modal base of substructure of the type “RITZ”.  
They is made up starting from 2 occurrences of key word RITZ.*

### **3.2.1 Word**

**key**  
**MODE\_MECA**

*1st occurrence of key word RITZ. Name of the concept of the mode\_meca type containing the clean modes dynamic of the treated substructure. One can give a list of mode\_meca obtained each one by restitution of a mode\_gene on a different substructure.*

### **3.2.2 Word**

**key**  
**MODE\_STAT**

*2nd occurrence of key word RITZ. Name of the concept of the mode\_stat\_\* type produces by the operator MODE\_STATIQUE [U4.52.14] which contains the static modes calculated with the interface of substructure.*

### **3.2.3 Word**

**key**  
**MULT\_ELAS**

*Name of the concept of the mult\_elas type produces by the operator MACRO\_ELAS\_MULT [U4.51.02] who contains the static modes given by this operator.*

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### **3.2.4 Word**

*key*

**BASE\_MODAL**

*Name of concept of the base\_modale type produces by a preceding call of the operator of DEF1\_BASE\_MODAL [U4.64.02]. It can have entered only at the time of the first occurrence of the key word*

*RITZ. The second occurrence of key word RITZ will then contain obligatorily the key word MODE\_STAT. The name of concept base\_modale result of the operator can be different from this one or identical (it is then réentrant).*

### **3.2.5 NMAX\_MODE**

*A number of modes to be retained in the dynamic modes (or statics) given by one of the key words precedents under the occurrence of key word RITZ.*

### **3.2.6 Operand**

**INTERF\_DYNA**

*Interface dynamic substructure (to be informed possibly and only if one uses “RITZ”).*

### **3.2.7 Operand**

**NUME\_REF**

*Classification of reference on which all fields of displacement (dynamic modes and statics) constituting the base of “RITZ” will be reordered.*

### **3.3 Word**

*key*

**DIAG\_MASS**

**/DIAG\_MASS**

*Key word allowing to recompute the static modes by eliminating the dynamic contribution and while proceeding to a orthogonalisation of Graam-Schmidt.*

### **3.3.1 Word**

*key*

**MODE\_MECA**

*Name of the concept of the mode\_meca type containing the dynamic clean modes of the substructure treated.*

### **3.3.2 Word**

*key*

**MODE\_STAT**

*Name of the concept of the mode\_stat\_\* type produces by the operator MODE\_STATIQUE [U4.52.14] who contains the static modes.*

### **3.4 Word**

*key*

**ORTHO\_BASE**

**/ORTHO\_BASE**

*Key word allowing of réorthonormaliser the modes of a base while proceeding to one orthogonalisation of Graam-Schmidt.*

### **3.4.1 Word**

*key*

**BASE**

*Name of the concept of the mode\_meca type or bases modal containing dynamic clean modes.*

### **3.4.2 Word**

*key*

**STAMP**

*Name of the concept of the matr\_asse\_\* type which contains will be taken into account for the scalar products at the time of the reorthogonalisation.*

### **3.5 Operand**

**TITRATE**

*TITRATE = title*

*Titrate concept created.*

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### **3.6 Operand INFORMATION**

*INFORMATION =*

*Level of the information provided in the file "MESSAGE":*

1

*no impression,*

2

*writing of the general information (concepts upstream, basic standard),*

### **4 Example**

*An example of use of the order is given in the documentation of the operator  
DEF1\_SQUELETTE [U4.24.01].*

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**Operator MACR\_ELEM\_DYNA**

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**Author (S):**

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**Organization (S): EDF-R & D /AMA**

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**Operator MACR\_ELEM\_DYNA**

## **1 Goal**

***To define a dynamic macronutrient of under-structuring.***

***Within the framework of a transitory analysis, modal or harmonic, with dynamic under-structuring operator MACR\_ELEM\_DYNA carries out the projection of the matrices of rigidity, mass and possibly of damping (analyzes harmonic) on the basis of modal definite substructure by DEFI\_BASE\_MODAL [U4.64.02], and the extraction of the matrices of connection of the interfaces. The result is consisted of the projected matrices and matrices of connection. It can be used several times with different orientations in the same model (cf DEFI\_MODELE\_GENE [U4.65.02]). It can be printed on file by order IMPR\_MACR\_ELEM [U7.04.33].***

***Product a concept of the macr\_elem\_dyna type.***

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## **2 Syntax**

***macro\_dyna [macr\_elem\_dyna] = MACR\_ELEM\_DYNA***

(  
***BASE\_MODAL*** = *bamo*,  
***[base\_modale]***)

***MATR\_RIGI*** = *Mr.*,  
***[matr\_asse\_DEPL\_R]***

***MATR\_MASS*** = *mm*,  
***[matr\_asse\_DEPL\_R]***

/  
***MATR\_AMOR*** =  
*my*,  
***[matr\_asse\_DEPL\_R]***

/  
***AMOR\_REDUIT***  
=  
,  
***[l\_R]***

***OPTION***  
=  
/  
***“TRADITIONAL”***,  
***[DEFECT]***

/  
***“RITZ”***,

*/“DIAG\_MASS”,  
TITRATE = title,  
[KN],  
INFORMATION =/1,  
[DEFECT]  
/  
2,  
)*

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**Code\_Aster** ®

Version

7.4

Titrate:

Operator *MACR\_ELEM\_DYNA*

Date:

10/02/05

Author (S):

**O. NICOLAS, E. BOYERE** Key

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### **3 Operands**

#### **3.1 Operand**

***BASE\_MODALE***

***BASE\_MODALE = bamo***

***Name of the concept base\_modale produces by operator *DEFI\_BASE\_MODALE* [U4.64.02].***

#### **3.2 Operand**

***MATR\_RIGI***

***MATR\_RIGI = Mr.***

***Name of the concept stamps assembled of *matr\_asse\_DEPL\_R* type produced by the operator *ASSE\_MATRICE* [U4.61.22] or macro-order *MACRO\_MATR\_ASSE* [U4.61.21] corresponding to the matrix of rigidity of the substructure.***

#### **3.3 Operand**

***MATR\_MASS***

***MATR\_MASS = mm***

***Name of the concept stamps assembled of *matr\_asse\_DEPL\_R* type produced by the operator *ASSE\_MATRICE* [U4.61.22] or macro-order *MACRO\_MATR\_ASSE* [U4.61.21] corresponding to the matrix of mass.***

*These two operands are to be employed if one uses option “RITZ”.*

### **3.4 Operand**

**MATR\_AMOR/AMOR\_REDUIT**

/  
**MATR\_AMOR = my**

*Name of the concept stamps assembled of matr\_asse\_DEPL\_R type produced by the operator ASSE\_MATRICE [U4.61.22] or macro-order MACRO\_MATR\_ASSE [U4.61.21] corresponding to the matrix of damping viscous, specific to the macronutrient. This damping must be of RAYLEIGH type by element (combination linear of rigidity and mass on the level of the element) and is thus defined by the properties of material (operator: DEFI\_MATERIAU [U4.43.01], operands AMOR\_ALPHA and AMOR\_BETA).*

**/AMOR\_REDUIT =**

*List reduced depreciation (percentage of damping criticizes) correspondent with each mode of vibration of the macronutrient. The length of the list is (with more) equal to a number of clean modes of the modal base; if it is lower, one supplements the list with reduced depreciation equal to the last term of the list entered by the user. None damping is not associated the static modes. The matrix of damping generalized macronutrient K is thus diagonal incomplete (J index of the clean mode):*

**0**  
**C K**  
**J**  
**=**

**0**

**0**

### **3.5 Operand**

**OPTION**

**OPTION =**

*Option of calculation of the projection of the matrix of rigidity on the basis of modal substructure:*

**“TRADITIONAL”**

:

*The property of orthogonality of the normal modes and the static modes compared to the matrix of rigidity is taken into account in the programming and the extra-diagonal terms are not calculated.*

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**“RITZ”**

:

*The base of projection is supposed to thus be able to be unspecified one does not make any assumption on the structure of the projected matrices.*

**“DIAG\_MASS”:**

*The modal base created by DEF1\_BASE\_MODAL makes it possible to have a matrix of projected mass diagonal necessary to couple this calculation with EUROPLEXUS.*

**3.6 Operand**

**TITRATE**

***TITRATE = title***

***Titrate concept created.***

### ***3.7 Operand INFORMATION***

***INFORMATION =***

***Level of the information provided in the file "MESSAGE":***

***1***

***no impression,***

***2***

***writing of the general information (concepts upstream, basic standard),***

### ***4 Example***

***An example of use of this operator is given in the documentation of the operator  
DEFI\_SQUELETTE [U4.24.01].***

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***Operator DEFI\_MODELE\_GENE***

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***Organization (S): EDF-R & D /AMA***

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***Operator DEF1\_MODELE\_GENE***

### ***1 Goal***

***To create the total structure starting from the substructures in dynamic under-structuring.***

***Within the framework of a calculation using the methods of dynamic under-structuring (analyzes modal or harmonic), operator DEF1\_MODELE\_GENE makes it possible to describe the total structure from macronutrients resulting from MACR\_ELEM\_DYNA [U4.65.01] and various connections which bind them substructures ones with the others. A macronutrient can be used for the definition of several substructures, whatever their orientation in the physical reference mark if the coupling is carried out by static modes (“TRADITIONAL” option). This possibility makes it possible to take account of the repetition of a component in the total structure.***

**Product a structure of data of the modele\_gene type.**

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**Operator *DEFI\_MODELE\_GENE***

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**2 Syntax**

***mo\_gene [modele\_gene] = DEFI\_MODELE\_GENE***

**(**  
***SOUS\_STRUC = \_F (NAME***  
**=**  
***nom\_sstruc,***  
***[KN]***

***MACR\_ELEM\_DYNA = macro\_dy,***  
***[macr\_elem\_dyna]***

**ANGL\_NAUT**  
=  
**angl\_naut, [l\_R]**

**TRANS**  
= **trans,**  
**[l\_R]**

),

**CONNECTION =**  
**\_F (**  
**SOUS\_STRUC\_1**  
**= “nom\_sstruc1”, [kN]**

**INTERFACE\_1 = “nom\_int1”,**  
**[KN]**

**SOUS\_STRUC\_2**  
**= “nom\_sstruc2”, [kN]**

***INTERFACE\_2 = “nom\_int2”,  
[KN]***

***GROUP\_MA\_MAIT\_1 = lgma1, [l\_gr\_maille]***

***MAILLE\_MAIT\_1  
= lma1, [l\_maille]***

***GROUP\_MA\_MAIT\_2 = lgma2, [l\_gr\_maille]***

***MAILLE\_MAIT\_2  
= lma2, [l\_maille]***



**OPTION**

=

**/“TRADITIONAL”,  
[DEFECT]**

**/“REDUCED”,**

**),**

**VERIF =**

**\_F (**

**STOP\_ERREUR =  
/“YES”, [DEFECT]  
/“NOT”,**

**PRECISION =/**

**prec**

**,**

**[R]**

**/**

**1.E-3,  
[DEFECT]**

**CRITERION =/  
“RELATIVE”,  
[DEFECT]  
/  
“ABSOLUTE”,**

**),  
)**

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**3 Operands**

**3.1 Word  
key  
SOUS\_STRUC**

**SOUS\_STRUC**

**Key word factor allowing to define all the substructures which make the structure total. The definition of a substructure is done by the data of its name, of the macronutrient**

*who is associated to him and of his orientation in the physical reference mark.*

### **3.1.1 Operand**

**NAME**

**NAME** = “nom\_sstruc”

*Name of 8 characters maximum which will make it possible thereafter to indicate the substructure in:*

.

*operator: DEFI\_MODELE\_GENE [U4.65.02], operands: CONNECTION and SOUS\_STRUC\_1,*

.

*operator: DEFI\_SQUELETTE [U4.24.01], operand: SOUS\_STRUC,*

.

*operator: ASSE\_VECT\_GENE [U4.65.05], operand: SOUS\_STRUC,*

.

*operator: REST\_BASE\_PHYS [U4.63.21], operand: SOUS\_STRUC.*

### **3.1.2 Operand**

**MACR\_ELEM\_DYNA**

**MACR\_ELEM\_DYNA** = macro\_dyna

*Name of the concept macr\_elem\_dyna resulting from the operator MACR\_ELEM\_DYNA [U4.65.01]*

*who*

*indicate the condensed model of the substructure. It is pointed out that a macronutrient can to be used for the definition of several substructures.*

### **3.1.3 Operand**

**ANGL\_NAUT**

**ANGL\_NAUT** = angl\_naut

*List of the 3 nautical angles, in degrees, which make it possible to pass from the orientation of the model*

*having given rise to the macronutrient with that of the substructure.*

*One will refer to operator AFFE\_CARA\_ELEM [U4.42.01]: Operand ORIENTATION for the definition and the use of the nautical angles.*

### **3.1.4 Operand**

**TRANS**

**TRANS = trans**

**List of 3 components of translation which make it possible to build a new substructure starting from the model having given rise to the macronutrient, while applying an overall translation.**

### **3.2 Word**

**key**

**CONNECTION**

**CONNECTION**

**Key word factor allowing to define all the interfaces of connection between substructures. One connection is defined by the names of the two substructures in opposite, and for each one among them, the name of the corresponding interface.**

**In the case of an incompatibility of grid between the two substructures in opposite, it is necessary to indicate that of both whose interface will be considered as Master (key words **GROUP\_MA\_MAIT\*** and/or **MAILLE\_MAIT**). The nodes slaves which are projected on the interface**

**Master are as a preliminary defined by **DEFI\_INTERF\_DYNA [U4.64.01]**. The “sticking together” of the 2**

**interfaces will be done by writing of linear relations between the **ddl**s of the 2 faces.**

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*Displacements of the nodes of the face slave will be connected to displacements of their projections on the face Master. For each node of the face slave, one will write 2 (in 2D) or 3 (in 3D) linear relations.*

*An application of this functionality is for example the sticking together of a formed grid linear elements (P1) on another quadratic grid (P2). In this case it is rather advised to choose like face “slave” the quadratic face.*

*It is possible to define a connection by reduced modes (or modes of interface) by the key word **OPTION**.*

### **3.2.1 Operand**

**SOUS\_STRUC\_1**

**SOUS\_STRUC\_1 = “nom\_sstruc1”**

*Name of the first of the substructures brought into play on both sides of the connection. It must to have been as a preliminary defined by the key word: **SOUS\_STRUC**.*

### **3.2.2 Operand**

**INTERFACE\_1**

**INTERFACE\_1 = “nom\_int1”**

*Name of the interface of the first substructure intervening in the connection. It must have been defined as a preliminary by operator **DEFI\_INTERF\_DYNA [U4.64.01]** for the macronutrient support of the substructure.*

### **3.2.3 Operand**

**GROUP\_MA\_MAIT\_1, MAILLE\_MAIT\_1**

**GROUP\_MA\_MAIT\_1 = lgma1**

**MAILLE\_MAIT\_1**

**= lma1**

*These key words make it possible to define the whole of the meshes of the interface of the first substructure considered as Master where they with respect to the nodes will be sought of face slave pertaining to the second substructure.*

**Caution:**

*In 3D, one should not give meshes of surface, but the meshes voluminal adjacent with the face. The specified meshes are “candidates” for the research of points opposite. One can give too much of it, that is not awkward.*

*In the same way, in 2D, the meshes “Masters” must be surface (QUAD, SORTED) and not linear*

### **3.2.4 Operand** **SOUS\_STRUC\_2**

**SOUS\_STRUC\_2 = “nom\_sstruc2”**

*Name of the second of the substructures brought into play on both sides of the connection. It must have been as a preliminary defined by key word SOUS\_STRUC.*

### **3.2.5 Operand** **INTERFACE\_2**

**INTERFACE\_2 = “nom\_int2”**

*Name of the interface of the second substructure intervening in the connection. It must have summer defined as a preliminary by operator DEFI\_INTERF\_DYNA [U4.64.01] for macronutrient support of the substructure.*

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### **3.2.6 Operand**

**GROUP\_MA\_MAIT\_2, MAILLE\_MAIT\_2**

**GROUP\_MA\_MAIT\_2 = lgma2**

**MAILLE\_MAIT\_2**

**= lma2**

*These key words make it possible to define the whole of the meshes of the interface of the second substructure considered as Master where they with respect to the nodes will be sought of face slave pertaining to the first substructure.*

**Caution:**

*In 3D, one should not give meshes of surface, but the meshes voluminal adjacent with the face. The specified meshes are “candidates” for the research of points opposite. One can give too much of it, that is not awkward.*

*In the same way, in 2D, the meshes “Masters” must be surface (QUAD, SORTED) and not linear*

### **3.2.7 Operand**

**OPTION**

**OPTION**

**=**

**/“TRADITIONAL”,**

**/“REDUCED”,**

*Allows to choose between a traditional under-structuring by static modes (method Mac-Neal, harmonic Craig-Bampton or not) or by modes of interface.*

### **3.3 Word**

**key**

**VERIF**

**VERIF**

*Key word factor allowing to check the coherence of the generalized model: it is checked that the connection*

*is compatible with the orientations and the translations assigned to the substructures. Nodes of the two interfaces do not have to be ordered a priori so that they are two to two*

*confused. If the nodes of the interfaces are not in opposite two to two, the code detects this state and reorders the nodes in order to give them in opposite.*

### **3.3.1 Operand**

#### **STOP\_ERREUR**

*Allows to carry out or not the checking of coherence of the generalized model.*

### **3.3.2 Operands**

#### **PRECISION/CRITERION**

*Indicate the threshold of precision to beyond which the connections are incompatible. It is about the distance*

*(relative or absolute following CRITERION) beyond which the nodes of connection are considered as too distant to be actually connected.*

## **4 Phase of execution**

*The operator proceeds to a certain number of checks on the coherence of the connections if the connection*

*do not present an incompatibility of grid:*

*·  
an identical number of nodes on both sides of the connection,*

*·  
coherence, in each node, after orientation of the active degrees of freedom on both sides connection.*

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**5 Matrices and conditions of connections calculated by  
DEFI\_MODELE\_GENE**

**5.1**

**In the case of the "TRADITIONAL" option**

**The operator calculates the matrices of directed connection intervening in the generalized model:**

**$L_k$   
 $= B_k R K K$   
 $J$**

**directed  
 $J$**

**where:**

**the exhibitor  $K$  characterizes the substructure,**

**the index  $J$  characterizes the interface of connection,**

**$B_{kj}$  is the matrix of extraction of the ddl of the connection  $J$ ,**

**$R_k$   
is the matrix of rotation which makes it possible to pass from the orientation of the model having  
given rise to the macronutrient with that of the substructure,**

**$K$  is the matrix column of the clean vectors of the substructure  $K$ .**

**Conditions of connection between substructures 1 and 2 being written:**

**$q_1$   
 $= q_2$**

**with  $q_k$**

**$= L_k$   
 $K$**

***J***

***directed***

***J directed***

***J directed***

***J directed***

***where:***

***qkj***

***is the vector column of the physical co-ordinates of the connection J of substructure K,***

***K***

***is the vector column of the generalized co-ordinates of the substructure K.***

**5.2**

***In the “REDUCED” case of the option***

***The operator calculates the matrices of directed connection intervening in the generalized model:***

***K***

***K***

***K***

***L***

***B***

***= I***

***J directed***

***J***

***where:***

***the exhibitor K characterizes the substructure,***

***the index J characterizes the interface of connection,***

***Bkj is the matrix of extraction of the ddl of the connection J,***

***K***

***I***

***is the matrix identity***

***In the case of the option “REDUCED”, it is thus not possible to apply changes of reference mark***

*what is normal because the modes of interfaces for both substructures are identical to the interface.*

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***Operator NUME\_DDL\_GENE***

***Date:***

***27/01/05***

***Author (S):***

***O. NICOLAS, E. BOYERE Key***

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***Document: U4.65.03***

***Operator NUME\_DDL\_GENE***

## ***1 Goal***

***To number the ddl total structure starting from classification of the substructures.***

***Within the framework of a calculation using the methods of dynamic under-structuring (analyzes modal or***

***harmonic), operator NUME\_DDL\_GENE (with key word MODELE\_GENE) defines the bijection enters,***

***on the one hand, numbers of the generalized ddl of each substructure and numbers of the ddl of connection of each connection and, in addition, numbers of the final ddl (i.e. indices of line or of column of the generalized matrices).***

***Within the framework of projection on a modal basis (key word BASES NUME\_DDL\_GENE), one classification is given to calculate a full added matrix or to solve a problem transient on modal basis resulting from a concept of the mode\_meca type.***

***The classification obtained in all the cases is of the type “line of sky”, the operator builds them tables of addressing necessary to the effective storage of the terms of the generalized matrices assemblies, which are considered with a profile either “line of sky”, or “full” or “diagonal”, with this classification.***

***Product a structure of data of the nume\_ddl\_gene type.***

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**2 Syntax**

***nu\_gene [nume\_ddl\_gene] = NUME\_DDL\_GENE***

( /

***MODELE\_GENE = mo\_gene,***

***[modele\_gene]***

***STORAGE =***

***/"LIGN\_CIEL",***

***[DEFECT]***

/

***"FULL",***

/

***BASE***

=

***base,***

/

***[mode\_gene]***

/

***[mode\_meca]***

/

***[base\_modale]***

/

***[mode\_stat]***

*STORAGE* =  
*'DIAG,*  
*/*  
*,*  
*PLEIN,*  
*[DEFECT]*

*NB\_VECT* =  
*/nbvect,*  
*/*  
*9999*  
*,*  
*[DEFECT]*

)

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### **3 Operands**

#### **3.1 Operand**

***MODELE\_GENE***

***MODELE\_GENE = mo\_gene***

***Name of the concept of the modele\_gene type produces by operator DEFI\_MODELE\_GENE [U4.65.02] with to leave whose classification is carried out.***

##### **3.1.1 Storage of the matrices for *MODELE\_GENE***

#### **STORAGE**

***Choice of a mode of storage of the matrices which one will assemble with this classification. Currently, only the mode of storage “line of sky” is accessible.***

***“LIGN\_CIEL”:***

***storage “line of sky” per blocks, the assembled matrix will be stored block columns per block of columns starting from the 1st term likely to be not no one for each column. In the assembled matrix, a term A (I, J) is likely to be nonnull if and only if the ddl I and the ddl J (respectively ième and jème modes of the total structure) are resulting from even substructure or are connected by at least a ddl LAGRANGE of two substructures connected by a connection.***



**“FULL”:**

*storage “line of sky” of the assembled matrices generalized per blocks, but with a full profile (one stores all the elements of the triangular part higher of the matrix).*

### **3.2 Operand BASE**

*This operand is used to identify the modal base on which one projects the matrices.*

#### **3.2.1 Storage of the matrices**

### **STORAGE**

*Choice of a mode of storage of the matrices which one will assemble with this classification. Currently, only the mode of storage “line of sky” is accessible.*

**“FULL”:**

*storage “line of sky” of the assembled matrices generalized per blocks, but with a full profile (one stores all the elements of the triangular part higher of the matrix). This type of storage must be employed if one wants to calculate the generalized added matrices (mass, rigidity, damping) who are full, like all the generalized matrices to which they are added.*

*For the matrices of rigidity and damping, the assembly is done always starting from a nume\_ddl\_gene resulting from a mode\_meca.*

**“DIAG”:**

*storage “line of sky” of the diagonal terms of the matrices projected on base modal. This type of storage is to be employed when one wants to do one calculation by modal recombination without fluid coupling/structure with matrices projected on a modal basis resulting from a mode\_meca or one mode\_gene.*

### **3.2.2 Operand NB\_VECT**

*Behind this key word, one awaits the number of basic vectors of projection, possibly smaller than the number of modes defined in the base specified by the key word BASES.*

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**4 Phase**

**of execution**

***No optimization of bandwidth is carried out during classification. The order of appearance of the substructures in classification corresponds to the order of their definition in generalized model (operator DEFI\_MODELE\_GENE). The user can thus limit the bandwidth by defining in a judicious order the substructures of the generalized model.***

***The degrees of freedom, resulting from the double dualisation, are then assembled on both sides them generalized degrees of freedom of the second substructure assembled (among both substructures brought into play by the connection).***

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**Titrate:**

**Operator ASSE\_MATR\_GENE**

**Date:**

**10/02/05**

**Author (S):**

**O. NICOLAS, E. BOYERE Key**

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***Organization (S): EDF-R & D /AMA***

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***Document: U4.65.04***

***Operator ASSE\_MATR\_GENE***

***1 Goal***

***To assemble the matrix of rigidity or overall assets starting from the substructures.***

***Within the framework of a calculation using the methods of dynamic under-structuring (analyzes modal or***

***harmonic), this operator creates the generalized matrix of rigidity or mass or possibly of damping (analyzes harmonic or transitory), by assembly of the matrices generalized of macr\_elem\_dyna type corresponding (cf operator MACR\_ELEM\_DYNA [U4.65.01]) contained in a list defined during the creation of the model generalized (cf operator DEFI\_MODELE\_GENE***

**[U4.65.02]). The assembled generalized matrix is real and symmetrical (storage of the part triangular lower). It is built on a classification of the generalized degrees of freedom and stored in form "line of sky". The tables of addressing are those calculated as a preliminary by operator NUME\_DDL\_GENE [U4.65.03].**

**The concept result produced by this operator is of type: matr\_asse\_gene\_R.**

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**Code\_Aster ®**

**Version**

**7.4**

**Titrate:**

**Operator ASSE\_MATR\_GENE**

**Date:**

**10/02/05**

**Author (S):**

**O. NICOLAS, E. BOYERE Key**

**:**

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**2 Syntax**

**ma\_gene [matr\_asse\_gene\_R] = ASSE\_MATR\_GENE**

**(  
NUME\_DDL\_GENE**

**=**

**nu\_gene,**

**[nume\_ddl\_gene]**

**OPTION =/“RIGI\_GENE”,**

**/**

**“MASS\_GENE”,**

**/**

**“AMOR\_GENE”,**

**)**

***Instruction manual***

***U4.6- booklet: Elementary matrices/Vectors and assembly***

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***3 Operands***

***3.1 Operand***

***NUME\_DDL\_GENE***

***NUME\_DDL\_GENE = nu\_gene***

***Name of the concept nume\_ddl\_gene resulting from the operator NUME\_DDL\_GENE [U4.65.03]***

*who defines*

*classification of the equations of the assembled generalized system, mode of storage of coefficients of the assembled generalized matrix (line of sky) and the generalized model on which the operations of diagonal, or full assembly are carried out.*

### **3.2 Operand**

#### **OPTION**

#### **OPTION**

*The option makes it possible to determine the list of the macronutrients, contained in the concept `modele_gene` resulting from `DEFI_MODELE_GENE` [U4.65.02], to assemble. It defines, by consequent, the type of the generalized matrix assembled calculated by the operator `ASSE_MATR_GENE`.*

*“RIGI\_GENE”: calculation of the matrix of assembled generalized stiffness, including terms associated with the multipliers with `LAGRANGE`,*

*“MASS\_GENE”: calculation of the matrix of assembled generalized mass,*

*“AMOR\_GENE”: calculation of the matrix of damping generalized assembled.*

### **4 Phase**

*of execution*

*The terms corresponding to the projected matrices are assembled without treatment.*

*On the other hand, the terms corresponding to the dualisation of the connections are the subject of a conditioning*

*simple. They are multiplied by a definite factor in a single way which is such as the absolute value maximum of the terms of dualisation is equal to the maximum absolute value of the terms of rigidity macronutrients (matrices of the projected substructures).*

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Operator `ASSE_MATR_GENE`

*Date:*

*10/02/05*

*Author (S):*

***O. NICOLAS, E. BOYERE** Key*

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*Operator ASSE\_VECT\_GENE*

*Date:*

10/02/05

Author (S):

**O. NICOLAS, E. BOYERE** Key

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Organization (S): EDF-R & D /AMA

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**Document: U4.65.05**

**Operator ASSE\_VECT\_GENE**

**1 Goal**

**To project the loadings on the basis of modal substructure.**

**Within the framework of a harmonic calculation using the methods of under-structuring, the operator**

**ASSE\_VECT\_GENE carries out the projection of the loadings of the cham\_no\_DEPL\_R type**



*resulting from*

*ASSE\_VECTEUR [U4.61.23], on the basis of modal substructure defined by DEFI\_BASE\_MODAL [U4.64.02]. The generalized vectors thus obtained are assembled starting from the definition of the model*

*generalized resulting from DEFI\_MODELE\_GENE [U4.65.02]. The final assembled generalized vector is built*

*on the classification of the generalized degrees of freedom established as a preliminary by the operator*

*NUME\_DDL\_GENE [U4.65.03].*

*The concept result produced by this operator is of vect\_asse\_gene type.*

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*Operator ASSE\_VECT\_GENE*

*Date:*

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*Author (S):*

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*:*

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*2 Syntax*

*vect\_gene [vect\_asse\_gene] = ASSE\_VECT\_GENE*

*(*

*NUME\_DDL\_GENE*

*=*

*nu\_gene,*

*[nume\_ddl\_gene]*

***CHAR\_SOUS\_STRUC = \_F (SOUS\_STRUC = “nom\_sstruc”, [kN]***

***VECT\_ASSE = vecas,***

***[cham\_no\_DEPL\_R]***

***),***

***)***

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***Titrate:***

## ***Operator ASSE\_VECT\_GENE***

### ***Date:***

***10/02/05***

### ***Author (S):***

***O. NICOLAS, E. BOYERE Key***

***:***

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## ***3 Operands***

### ***3.1 Operand***

***NUME\_DDL\_GENE***

***NUME\_DDL\_GENE = nu\_gene***

***Name of the concept nume\_ddl\_gene resulting from the operator NUME\_DDL\_GENE [U4.65.03] who defines classification of degrees of freedom to be used for the assembled generalized vector.***

### ***3.2 Word***

***key***

***CHAR\_SOUS\_STRUC***

***CHAR\_SOUS\_STRUC***

***Key word factor allowing to define the loadings applied to the structure. The definition of loading is done by the data of the assembled vector which is associated to him and of the name of substructure to which it applies.***

### ***3.2.1 Operand***

***SOUS\_STRUC***

***SOUS\_STRUC = "nom\_sstruc"***

***Name of the substructure to which the loading is applied. It must be defined in precondition by operator DEFI\_MODELE\_GENE [U4.65.02].***

### ***3.2.2 Operand***

***VECT\_ASSE***

***VECT\_ASSE = vecas***

***Name of the concept `cham_no_DEPL_R` resulting from `ASSE_VECTEUR` [U4.61.23] which defines the distribution***

***space of the loading applied to the substructure.***

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***Titrate:***

***Operator `ASSE_VECT_GENE`***

***Date:***

***10/02/05***

***Author (S):***

***O. NICOLAS, E. BOYERE Key***

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Titrate:

Operator *CALC\_MATR\_AJOU*

Date:

19/01/05

Author (S):

**NR. GREFFET, F. STIFKENS, G. Key ROUSSEAU**

:

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Organization (S): *EDF-R & D /AMA, EDF-DPN/UTO*

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**Document: U4.66.01**

Operator *CALC\_MATR\_AJOU*

**1 Goal**

*To calculate matrices of mass [R4.07.03], damping or rigidity added.*

*The matrices are induced by a fluid true, incompressible, at rest or in potential flow, on a structure in 2D, axisymmetric 2D or in 3D.*

*The terms of these matrices are calculated on the basis of modal structure in the vacuum.*

*The calculation of the terms of the matrices is carried out by resolution of the equations of LAPLACE within the framework*

*of a thermal analogy. The calculated temperature plays the part of a pressure in the field fluid. Guard thus should be taken to define fluid material by thermal characteristics, and to assign a thermal model to the part of the grid which represents the fluid.*

*Thanks to this operator, one can determine for example, the added matrices of a beam of tubes, regarded as only one structure immersed in the same fluid.*

*Within the framework of a calculation by dynamic under-structuring, it is also possible to evaluate stamp of mass added on a generalized model.*

*For systematic uses of this order and to simplify the drafting of the file of orders, macro-order MACRO\_MATR\_AJOU [U4.66.11] will be used effectively.*

*Product a structure of data of the matr\_asse\_gene\_R type.*

*Case-tests FDLV106 [V8.01.106] and FDLV107 [V8.01.107] present examples of use of this operator.*

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*Operator CALC\_MATR\_AJOU*

*Date:*

*19/01/05*

*Author (S):*

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*:*

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## 2 Syntax

*massaj [matr\_asse\_gene\_R] = CALC\_MATR\_AJOU*

(  
*MODELE\_FLUIDE*  
=  
*fluid*  
*[model]*

*MODELE\_INTERFACE*  
=  
*interf*  
*[model]*

*CHAM\_MATER*  
=  
*matflui [cham\_mater]*

*CHARGE*  
=  
*charge*  
*[char\_ther]*

/  
*MODE\_MECA*  
=



***modes***

***[mode\_meca]***

/  
***CHAM\_NO =***  
***chamno***  
***[cham\_no\_DEPL\_R]***

/  
***MODELE\_GENE***  
***=***  
***modgen***  
***[modele\_gene]***

***NUME\_DDL\_GENE***  
***=***  
***numgen***  
***[nume\_ddl\_gene]***

***DIST\_REFE***  
***=***  
***outdistance***  
***[R]***  
***1.E-2***  
***[DEFECT]***

***AVEC\_MODE\_STAT***  
***=***  
***“YES”***  
***[DEFECT]***

**/“NOT”**

**NUME\_MODE\_MECA**

**=**

**nume**

**[I\_I]**

**INFORMATION**

**=**

**/**

**1**

**[DEFECT]**

**/ 2**

**OPTION**

**= / “MASS\_AJOU”**

**/ “AMOR\_AJOU”**

/ “RIGI\_AJOU”

**POTENTIAL**

=

**phi**

**[evol\_ther]**

**SOLVEUR**

=

**to see**

**[U4.50.01]**

**NOEUD\_DOUBLE**

=/“YES”

/

**“NOT”**

**[DEFECT]**

);

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**3 Operands**

**3.1 Operand**

**MODELE\_FLUIDE**

**MODELE\_FLUIDE = fluid**

***Thermal model which one assigns to the part of the grid which corresponds to the fluid. Elements of edge with the fluid interface/structure must be present in the fluid model. It is on this model that one solves the equation of Laplace with boundary condition of the type “flow fluid”, to have it field of pressure in all the fluid and a fortiori the field of pressure to the interface fluid/structure.***

***The nodes of the elements of the fluid grid must all be numbered so that it jacobien of the element is of positive sign on all the fluid grid.***

**3.2 Operand**

**MODELE\_INTERFACE**

**MODELE\_INTERFACE = interf**

***Thermal model of interface gathering all the elements of edge defining the interface fluid/structure. It is on this model that one calculates the terms of the added matrices.***

***Calculation depends on the orientation of the normal of these elements of interface. It is necessary to take care of it that this normal is directed towards all these elements, from the structure towards the fluid (convention adopted).***

***If the fluids bathing the structure are different densities, the model should be defined interfaces by as many groups of meshes not confused geometrically than there are fluids with the contact structure. For example, a piping can have its interior surface in contact with a fluid of density 1, and its surface external in contact with a fluid of density 2. The model interface is***

*thus built on two groups of meshes not confused geometrically, one in contact with fluid of density 1 (interfa1) and the other in contact with the fluid of density 2 (interfa2).*

*interfa2*

*I*

*NR*

*interfa1*

*T*

*fluid 1*

*E*

*R*

*F*

*With*

*C*

*E*

*fluid 2*

*structure*

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*3.3 Operands*

*CHAM\_MATER/LOAD*

*CHAM\_MATER = matflui*

*Material field defining the fluid immersing the structure. This material is defined by*

*equivalent thermal characteristics in operator `DEFI_MATERIAU` [U4.43.01].  
thermal conductivity (key word `LAMBDA`) is always taken equalizes to 1. Specific heat  
(key word `RHO_CP`) the role of density of the fluid plays.*

*`CHARGE` = load*

*Thermal load of type [`char_ther`] necessary to the resolution of the linear system rising  
equation of Laplace in the fluid. One must impose an unspecified temperature (which plays in  
fact the role of a pressure) on an unspecified node of the fluid grid, in order to return the system  
not singular. This operation is carried out with operator `AFFE_CHAR_THER` [U4.44.02].*

### *3.4 Operands*

*`MODE_MECA/CHAM_NO/MODELE_GENE`*

*`/MODE_MECA` = modes*

*Dynamic modes calculated on the model structure. If there are several structures not  
related immersed in the same fluid, for which one wants to determine the matrices  
added including/understanding the terms of coupling by the fluid, the model structure which one  
defines*

*gather the totality of the immersed structures. The modes used by the operator are them  
modes calculated for the total structure.*

*`/CHAM_NO` = `chamno`*

*Defining field with the nodes of displacements affected on groups of nodes  
the fluid interface/structure. By affecting such a field of displacement on (S) the group (S) of  
nodes of interface thanks to operator `AFFE_CHAM_NO` [U4.44.11], one can for example  
to easily simulate modes of rigid body of the structures. This operand is to be used if  
one wants to estimate the terms of the added matrices and coupling for a plane geometry  
without making as a preliminary modal calculation of the structure in the vacuum, and which one  
wants*

*to affect these terms in discrete elements (modeling `DIS_T`). The operand `INFORMATION` must  
imperatively to be active to print the calculated terms.*

*Caution:*

*The use of this operand excludes that from operand `NUME_DDL_GENE`. One cannot  
thus not to make modal, transitory calculation or harmonic by using the operand  
`CHAM_NO`.*

*Indeed, to make calculation of modes out of water, it is necessary to have a matrix of mass  
generalized and a matrix of rigidity generalized of the structure. This supposes to have  
fact a modal calculation on the structure in the vacuum (what one wants precisely to avoid).*

*This operand is used ultimately only to evaluate the matrix of mass, of rigidity and of damping added, and to use them to couple structures of the type beam by discrete elements of mass, for example.*

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*/MODELE\_GENE = modgen*

*Generalized model built by operator DEF1\_MODELE\_GENE [U4.65.02]. This key word is with to use when one makes a calculation by dynamic under-structuring, and that one wants to calculate stamp of added mass coupling the whole of the substructures. In this case, under structures can be in different files of grid, these files being able to be them same distinct from the fluid file of grid. The substructures which present one repetitivity within the fluid are to be netted only once, but one will take care with level of the fluid grid to net all the interfaces fluid/structure. Moreover, it is necessary to take care so that the nodes of fluid interface coincide as well as possible with the nodes of interface of structure, in order to be able to recopy, on the basis of geometrical criterion of proximity, them values of the fields of displacement of structure on the nodes of fluid interface (see operand DIST\_REFE).*

*Caution:*

*The use of this operand makes compulsory that of operand NUME\_DDL\_GENE.*

*3.5 Operand*

**OPTION**

*This key word specifies the calculation of mass, rigidity or damping added that one wants to make, while using respectively “MASS\_AJOU”, “RIGI\_AJOU”, or “AMOR\_AJOU”. Two last options of calculation require the presence of a potential (thermal) stationary (see operand POTENTIAL).*

**3.6 Operand*****DIST\_REFE***

*Outdistance reference to be informed when one makes a calculation of mass added on a model generalized. This distance is a geometrical absolute criterion intended to recopy values of structural displacements in a thermal fluid model, in order to solve the equation of Laplace there of non stationary field of pressure. By defect, it is equal to 102 Mr.*

**3.7 Operand*****NOEUD\_DOUBLE***

***NOEUD\_DOUBLE = “YES”***

*This operand is to be used when one makes a calculation of mass added starting from a model generalized which includes/understands a substructure with a grid by a telegraphic or surface grid (i. e without thickness like beam or hull) and surrounded by two fluids. It is necessary in this case for the level of grid to duplicate the nodes of the fluid interfaces of those of the structure, in order to be able to calculate the hydrodynamic jump of pressure on both sides of the structure (cf appears below).*

***X X X******X X******X******X******X******X******X******X******Structure with a grid******fluid 1******X******X******(without thickness)******X***



**X**  
**X**  
**X**  
**X**  
**X**

**Duplicated nodes**

**X**  
**X**  
**X**  
**X**  
**X X**

*(nodes having the same ones  
co-ordinates but not it  
fluid 2  
even name)*

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**3.8 Operand**

**POTENTIAL**

**POTENTIAL = phi**

**Potential (thermal) stationary necessary to the calculation of damping and rigidity added structure subjected to a potential flow. This potential is produced by the operator**

***Ther\_Lineaire [U4.54.01].***

### ***3.9 Operand***

***NUME\_DDL\_GENE***

***NUME\_DDL\_GENE = numgen***

***Generalized classification based on the mechanical modes of the total structure. The presence of this operand allows to calculate a matrix of added mass of matr\_asse\_gene\_R type. It must be necessarily present if one wants to make modal, harmonic calculation thereafter or transient.***

### ***3.10 Operand***

***INFORMATION***

***INFORMATION***

***=***

***Indicate the level of impression of the results of the operator on the file MESSAGE.***

***1 :***

***no impression,***

***2 :***

***impression of the higher triangular part of the matrices of added mass, added damping or rigidity.***

***Presentation in column.***

### ***3.11 Key word factor SOLVEUR***

***See [U4.50.01].***

### ***3.12 Operand***

***AVEC\_MODE\_STAT***

***Allows to disconnect the calculation of the terms of mass added on the static modes contained in the modal base of the substructures in the case of a calculation with a generalized model (cf [§3.4]).***

### ***3.13 Operand***

***NUME\_MODE\_MECA***

***Allows to specify a list of numbers of modes retained for calculation.***

## ***4 Phase***

***of execution***

*It is checked that the models fluid and interface are quite thermal.*

*It is checked that the storage of the added matrices is done on a full profile.*

*It is checked that the coefficients of added car-mass (diagonal terms of the matrix) are well all positive. In the contrary case, a message of alarm is transmitted so that the user checks the orientation normals.*

*It is checked that, for a calculation of added damping or rigidity, the POTENTIAL key word is well informed.*

*In the case of a calculation of mass added on a generalized model, one informs the user on recopies of fields of structural displacements in the fluid (a number of recopied values) and one indicate how to change the distance from reference (DIST\_REFE).*

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## *5 Example*

*5.1 Example 1: Calculation of the matrix of mass added of a structure composed of two concentric cylinders separated by a fluid incompressible*

*The cylinders are supported each one by springs. The matrix of added mass is calculated for the first two modes of the structure, namely the modes of rigid body of each cylinder*

*in direction OX (cf diagram).*

*N*  
*R2*  
*M*  
*R*  
*k2*  
*R*  
*k1*

*X*  
*R 1*  
*()*  
*1*  
*m1*  
*()*  
*2*  
*m2*

*1) Definition of fluid material by equivalent thermal characteristics:*

*water = DEFI\_MATERIAU (THER = \_F (LAMBDA = 1. , RHO\_CP = 1000. ))*

*2) Assignment of this fluid material on the fluid grid including the defining group of mesh the fluid interface/structure.*

*chammat1 = AFFE\_MATERIAU (GRID = Maya,  
 AFFE = \_F (GROUP\_MA = "fluid", MATER = water),  
 \_F (GROUP\_MA = "interface", MATER = water))*

*3) Assignment of the fluid thermal model (also including/understanding the interface)*

*fluid = AFFE\_MODELE (GRID = MAYA,  
 AFFE = (\_F (GROUP\_MA = "fluid",  
 MODELING = "PLANE",  
 PHENOMENON = "THERMAL"),  
 \_F (GROUP\_MA = "interface",  
 MODELING = "PLANE",  
 PHENOMENON = "THERMAL"))))*

*4) Assignment of the thermal model of interface*

*interf = AFFE\_MODELE (GRID = MAYA*

***AFFE = \_F (GROUP\_MA = “interface”,  
MODELING = “PLANE”,  
PHENOMENON = “THERMAL”))***

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***5) Assignment of the total model structure (including/understanding the two cylinders and their springs of self-supporting quality)***

***struct = AFFE\_MODELE (GRID = MAYA,  
AFFE = (\_F (GROUP\_MA = “cylinder”,  
MODELING = “D\_PLAN”,  
PHENOMENON = “MECHANICAL”),  
\_F (GROUP\_MA = “cylxt”,  
MODELING = “D\_PLAN”,  
PHENOMENON = “MECHANICAL”),  
\_F (GROUP\_MA = “arises”,  
MODELING = “DIS\_T”,  
PHENOMENON = “MECHANICAL”),  
\_F (GROUP\_MA = “ressorex”,  
MODELING = “DIS\_T”,  
PHENOMENON = “MECHANICAL”))***

***6) Assignment of a temperature imposed in the fluid grid***

***charge = AFFE\_CHAR\_THER (MODEL = fluid,***

***TEMP\_IMPO = \_F (GROUP\_NO = “tempimpo”, TEMP = 0.)***

***7) Calculation of the clean modes of the structure in the vacuum***

***modes = MODE\_ITER\_SIMULT (MATR\_A = matasks,  
MATR\_B = matasms,  
CALC\_FREQ = \_F (OPTION = “PLUS\_PETITE”,  
NMAX\_FREQ = 2))***

***8) Generalized classification based on the calculated mechanical modes***

***numgen = NUME\_DDL\_GENE (MODE\_MECA = modes, STORAGE = “FULL”)***

***9) Calculation of the matrix of added mass of matr\_asse\_gene\_r type (operand NUME\_DDL\_GENE present). So one can then calculate the clean modes of the “wet” structure***

***matraj = CALC\_MATR\_AJOU (MODELE\_FLUIDE = fluid,  
MODELE\_INTERFACE = interf,  
CHAM\_MATER = chammat1,  
CHARGE = load,  
OPTION = “MASS\_AJOU”,  
MODE\_MECA = modes,  
NUME\_DDL\_GENE = numgen,  
INFORMATION =1)***

***10) Calculation of the matrices of mass and stiffness generalized on generalized classification based on the calculated mechanical modes numgen. These matrices are of type [matr\_asse\_gene\_r]***

***MACRO\_PROJ\_BASE (BASE = modes,  
MATR\_ASSE\_GENE = (\_F (MATRIX = matasms,  
MATR\_ASSE = mgene),  
\_F (MATRIX = matasks,  
MATR\_ASSE = riggen)))***

***11) Calculation of the matrix of total mass of the structure (matrix of more generalized mass matrix of added mass)***

***mastot = COMB\_MATR\_ASSE (COMB\_R = (\_F (MATR\_ASSE = mgene,  
COEF\_R = 1. ),  
\_F (MATR\_ASSE = matraj,  
COEF\_R = 1. )))***

***12) Calculation of the modes of the immersed structure.***

***modhumi = MODE\_ITER\_SIMULT (MATR\_A = riggen,***

*MATR\_B = mastot,  
CALC\_FREQ = \_F (OPTION = "PLUS\_PETITE",  
NMAX\_FREQ = 2))*

*13) Restitution of the modes "wet" on physical basis.*

*mode\_mou = REST\_BASE\_PHYS (RESU\_GENE = modhumi, MODE\_MECA = modes)*

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*Date:*

*19/01/05*

*Author (S):*

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*5.2*

*Example 2: Use of operand CHAM\_NO: Calculation of the matrix  
of mass added for a line of 3 tubes in a fluid channel*

*Are three tubes plunged in a fluid channel (see diagram). One wants to determine the matrix of mass  
added including/understanding the terms of following coupling inter-tubes for the modes of rigid  
body*

*direction OX of the three tubes. Without making modal calculation on the structure in the vacuum, to  
simulate these*

*three modes of rigid body, one assigns a field to the nodes of unit displacement on each  
group nodes defining the fluid interface structure of the three tubes.*

*GROUP\_NO tube1*

*GROUP\_NO tube2*

*GROUP\_NO tube3*

*fluid*

**1) Assignment on the groups of nodes of interface of a field to the nodes of unit displacement according to OX. It is obligatory to support this field with the nodes on the classification of the ddl of the model structure.**

**chamno1 = CREA\_CHAM (GRID = Maya,  
TYPE\_CHAM = "NOEU\_DEPL\_R",  
OPERATION = "AFFE",  
AFFE = \_F (GROUP\_NO = "tube1",  
NOM\_CMP = ("DX", "DY"),  
VALE = (1. , 0.) )  
NUME\_DDL = nustruct)**

**chamno2 = CREA\_CHAM (GRID = Maya,  
TYPE\_CHAM = "NOEU\_DEPL\_R",  
OPERATION = "AFFE",  
AFFE = \_F (GROUP\_NO = "tube2",  
NOM\_CMP = ("DX", "DY"),  
VALE = (1. , 0.) )  
NUME\_DDL = nustruct)**

**chamno3 = CREA\_CHAM (GRID = Maya,  
TYPE\_CHAM = "NOEU\_DEPL\_R",  
OPERATION = "AFFE",  
AFFE = \_F (GROUP\_NO = "tube3",  
NOM\_CMP = ("DX", "DY"),  
VALE = (1. , 0.) )  
NUME\_DDL = nustruct)**

**2) Call**

**with**

**CALC\_MATR\_AJOU: the operator calculates the matrix 3\*3 of mass added of the three tubes. It is impossible to make modal, harmonic, or transitory calculation thereafter.**

**matraj = CALC\_MATR\_AJOU (MODELE\_FLUIDE = fluid,  
MODELE\_INTERFACE = interf,  
CHAM\_MATER = chammat1,  
CHARGE = load,  
OPTION = "MASS\_AJOU",  
CHAM\_NO = (chamno1, chamno2, chamno3),  
INFORMATION =2)**

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**3) The terms of the matrix of added mass can be read on the file “MESSAGE” and be used in another model describing the structure. The terms of added mass calculated here translate it coupling by the fluid in a transverse plan with the three tubes. If from now on one wants to study it coupling of the tubes modelled by beams, one can affect the terms of mass of the matrix calculated in discrete elements of mass (modeling DIS\_T) which connect the elements of beam in opposite.**

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Operator *CALC\_FLUI\_STRU*

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Organization (S): *EDF-R & D /MFTT*

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Operator *CALC\_FLUI\_STRU*

**1 Goal**

***To calculate the modal parameters of a structure subjected to a flow. Allows to hold account forces fluid-rubber bands which are represented by a matrix of transfer complexes connecting them***

*with modal displacements. For certain configurations, the matrix of transfer can be broken up into three real matrices of coefficients of mass, damping and rigidity added.*

*The disturbances of the modal characteristics of the complex structure depend on the speed of the flow. Thus the terms of the matrix of transfer of the efforts fluid-rubber bands depend on speed of the fluid and the frequency of the movement via the parameter fallback speed  $V_r = V(f.D)$ .*

*The operator calculates a modal base modified by coupling, for each mean velocity of the fluid studied. The produced concept is of melasflu type.*

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*2 Syntax*

*melf*

*[melasflu] = CALC\_FLUI\_STRU*

*(*

*VITE\_FLUI*

*= \_F*

*(*

**VITE\_MIN**

=

**VI**

,

**[R]**

**VITE\_MAX**

=

**VM**

,

**[R]**

**NB\_POIN = Np**

,

**[I]**

),

**BASE\_MODALE**

=  
***\_F (***

***MODE\_MECA***

=  
***mode***  
,  
***[mode\_meca]***

***NUME\_ORDRE = l\_nuor***

,  
***[l\_I]***

***/AMOR\_REDUIT = l\_amor***

, ***[l\_R]***

/  
***AMOR\_UNIF***

=  
***amor***

,

**[R]**

**AMOR\_REDUIT\_CONN = l\_amor\_c,**  
**[l\_R]**

),

**TYPE\_FLUI\_STRU**  
=  
**typeflui**  
**, [type\_flui\_stru]**

**IMPRESSION = \_F (**

**PARA\_COUPLAGE**  
=  
/  
**“YES” [DEFECT]**

/

**“NOT”**

,

***DEFORMATION***

=

/

**“NOT” [DEFECT]**

/

**“YES”**

,

),

);

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### ***3 Operands***

#### ***3.1 Key word***

***VITE\_FLUI***

***VITE\_FLUI***

***Key word factor which makes it possible to define the beach studied fluid speeds and discretization.***

***VITE\_MIN = VI***

***First value the speed for which the parameters of coupling will be calculated.***

***VITE\_MAX=***

***VM***

***Last value the speed for which the parameters of coupling will be calculated.***

***NB\_POIN=***

***Np***

***The number of points defines of speed (the step of discretization is constant).***

#### ***3.2 Key word***

***BASE\_MODAL***

***BASE\_MODAL***

***Key word factor which makes it possible to define the modal base of concept mode\_meca for which parameters of coupling are calculated. The coupling modifies the Eigen frequencies and the terms***



*of damping reduces associated with each mode (key word AMOR\_REDUIT or AMOR\_UNIF).*

*MODE\_MECA = mode*

*Modal base of type of concept mode\_meca.*

*NUME\_ORDRE = l\_nuor*

*Allows to select the modes of the modal base of mode\_meca type to be taken in count for the calculation of the coupling.*

*/AMOR\_REDUIT = l\_amor*

*List reduced depreciation (percentage of damping criticizes) correspondent with each mode of the structure.*

**Note:**

*They must be in a number identical to the number of modes taken into account (these modes are defined by key word NUME\_ORDRE).*

*/  
AMOR\_UNIF = amor*

*One applies to all the modes of the modal base same reduced damping.*

*AMOR\_REDUIT\_CONN = l\_amor\_c*

*List reduced depreciation (percentage of damping criticizes) correspondent with each mode of the structure for the method of Connors (see [R4.07.04]).*

**Note:**

*As for key word AMOR\_REDUIT, they must be in a number identical to a number of modes taken into account.*

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### **3.3 Key word**

#### **TYPE\_FLUI\_STRU**

*TYPE\_FLUI\_STRU = typeflui*

*Concept of the type\_flui\_stru type. It makes it possible to define the studied configuration, i.e. them coefficients of coupling used for the modeling of the forces fluid-rubber bands.*

**Note:**

*In the case of a configuration of the type “beam of tubes under axial flow” (key word factor FAISCEAU\_AXIAL), the calculation of the parameters of coupling of structure with the fluid in at-rest state, is taken into account. This calculation is carried out whatever the fluid beach speed that the user informed by the key word VITE\_FLUI.*

*In this case of fluid at rest, the matrix of transfer representing the force fluid-rubber band exerted on the structure, is put in the shape of a matrix of added damping.*

### **3.4 Key word**

#### **IMPRESSION**

*IMPRESSION*

*Key word factor allowing the user to choose information which it wishes to make write in the file RESULT.*

*PARA\_COUPLAGE*

*= “YES” or “NOT”*

*By this key word, the user can ask for the impression of tables of results giving for each mode evolutions fallback speed, frequency and reduced damping*

*modal according to the rate of flow of the fluid. The default value is “YES”.*

*DEFORMATION = “YES” or “NOT”*

*By this key word the user can request the impression from the format “RESULT” of the fields displacements corresponding to the modal deformations. The default value is “NOT”.*

#### **4 Remarks**

*In the case of a configuration of the type “beams of tubes under transverse flow”, it is possible to define several zones of interaction enters the fluid and the structure, each one of these zones being modélisable independently others. The calculation of the modal parameters of the structure subjected to a flow takes then account of each one of these zones, defined explicitly in order *DEFI\_FLUI\_STRU* [U4.25.01].*

*The concept produced by *CALC\_FLUI\_STRU* contains, in the form of table, the matrices of mass, of damping and rigidity for each speed of fluid. The table, representing the modal base modified, can be recovered by *RECU\_TABLE* in order to be injected into a calculation *DYNA\_TRAN\_MODAL*. This sequence of calculation is implemented in the case test *SDLL118A*.*

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**19/01/05**

**Author (S):**

**NR. GREFFET, G. DEVESA, D. NUNEZ Key**

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**Organization (S): EDF-R & D /AMA, CS IF**

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### ***Operator CALC\_FORC\_AJOU***

#### ***1 Goal***

***This order makes it possible to calculate the effect of hydrodynamic overpressure due to the movement***

*of drive of the structure in seismic analysis where one breaks up the total movement into movement of drive and relative movement. The calculation of this force is carried out like that of mass added by analogy thermal, but instead of taking into account only the movement relative, one obtains a force added to the second member, also projected on the modes of structure without the fluid, to take into account the movement of drive.*

*The calculation of the masses added [R4.07.03] by CALC\_MATR\_AJOU [U4.66.01] and that of the forces*

*added by CALC\_FORC\_AJOU can be launched simultaneously using the macro-order MACRO\_MATR\_AJOU [U4.66.11].*

*Product a concept of the vect\_asse\_gene\_R type*

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## 2 Syntax

*forceaj*

*[vect\_asse\_gene\_R] = CALC\_FORC\_AJOU*

(  
*MODELE\_FLUIDE*

=

*fluid*

*[model]*

*MODELE\_INTERFACE*

=

*interf*

*[model]*

*CHAM\_MATER*

=

*matflui [cham\_mater]*

*CHARGE*

=

*charge*

*[char\_ther]*

/

*MODE\_MECA*

=

*modes*

*[mode\_meca]*

/

*MODELE\_GENE*

=

*modgen*

*[modele\_gene]*

*NUME\_DDL\_GENE=*

*numgen*

*[nume\_ddl\_gene]*

*DIST\_REFE*

=

/

*outdistance*

*[R]*

/

*1.E-2*

*[DEFECT]*

*AVEC\_MODE\_STAT*

=

/

*“YES”*

*[DEFECT]*

*/“NOT”*

*DIRECTION*

= *to dir*

*[l\_R]*

*/MONO\_APPUI*

=

*“YES”*

/

*MODE\_STAT*

=

*mode*

*[mode\_stat\_depl]*

/

*NODE*

=

*No [l\_noeud]*

/  
*GROUP\_NO*  
=  
*grno*  
[*l\_gr\_noeud*]

*NUME\_MODE\_MECA*  
=  
*nume*  
[*l\_I*]

*INFORMATION*  
=  
/  
*1*  
[*DEFECT*]

/ 2

*POTENTIAL*  
=  
*phi*  
[*evol\_ther*]

*SOLVEUR*  
=  
*to see*  
[*U4.50.01*]



*NOEUD\_DOUBLE*

=/"YES"

/

"NOT"

[DEFECT]

);

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### **3 Operands**

#### **3.1 Operand**

**MODELE\_FLUIDE**

**MODELE\_FLUIDE = fluid**

***Thermal model which one assigns to the part of the grid which corresponds to the fluid. Elements of edge with the fluid interface/structure must be present in the fluid model. It is on this model that one solves the equation of Laplace with boundary condition of the type "flow fluid", to have it field of pressure in all the fluid and a fortiori the field of pressure to the interface fluid/structure.***

***The nodes of the elements of the fluid grid must all be numbered so that it***

*jacobien of the element is of positive sign on all the fluid grid.*

### **3.2 Operand**

#### **MODELE\_INTERFACE**

**MODELE\_INTERFACE = interf**

*Thermal model of interface gathering all the elements of edge defining the interface fluid/structure. It is on this model that one calculates the terms of the added matrices.*

*Calculation depends on the orientation of the normal of these elements of interface. It is necessary to take care of it that this normal is directed towards all these elements, from the structure towards the fluid (convention adopted).*

*If the fluids bathing the structure are different densities, the model should be defined interfaces by as many groups of meshes not confused geometrically than there are fluids with the contact structure. For example, a piping can have its interior surface in contact with a fluid of density 1, and its surface external in contact with a fluid of density 2. The model interface is thus built on two groups of meshes not confused geometrically, one in contact with fluid of density 1 (interfa1) and the other in contact with the fluid of density 2 (interfa2).*

*interfa2*

*I*

*NR*

*interfa1*

*T*

*fluid 1*

*E*

*R*

*F*

*With*

*C*

*E*

*fluid 2*

*structure*

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## **3.3 Operands**

**CHAM\_MATER/LOAD**

**CHAM\_MATER = matflui**

*Material field defining the fluid immersing the structure. This material is defined by equivalent thermal characteristics in operator **DEFI\_MATERIAU [U4.43.01]**. thermal conductivity (key word **LAMBDA**) is always taken equalizes to 1. Specific heat (key word **RHO\_CP**) the role of density of the fluid plays.*

**CHARGE = load**

*Thermal load of type [char\_ther] necessary to the resolution of the linear system rising equation of Laplace in the fluid. One must impose an unspecified temperature (which plays in fact the role of a pressure) on an unspecified node of the fluid grid, in order to return the system not singular. This operation is carried out with operator **AFFE\_CHAR\_THER [U4.44.02]**.*

## **3.4 Operands**

**MODE\_MECA/MODELE\_GENE**

**/MODE\_MECA = modes**

*Dynamic modes calculated on the model structure. If there are several structures not related immersed in the same fluid, for which one wants to determine the matrices added including/understanding the terms of coupling by the fluid, the model structure which one defines gather the totality of the immersed structures. The modes used by the operator are them modes calculated for the total structure.*

***/MODELE\_GENE = modgen***

***Generalized model built by operator DEFI\_MODELE\_GENE [U4.65.02]. This key word is with to use when one makes a calculation by dynamic under-structuring, and that one wants to calculate stamp of added mass coupling the whole of the substructures. In this case, under structures can be in different files of grid, these files being able to be them same distinct from the fluid file of grid. The substructures which present one repetitivity within the fluid are to be netted only once, but one will take care with level of the fluid grid to net all the interfaces fluid/structure. Moreover, it is necessary to take care so that the nodes of fluid interface coincide as well as possible with the nodes of interface of structure, in order to be able to recopy, on the basis of geometrical criterion of proximity, them values of the fields of displacement of structure on the nodes of fluid interface (see operand DIST\_REFE).***

### ***3.5 Operand DIST\_REFE***

***Outdistance reference to be informed when one makes a calculation of force added on a generalized model.***

***This distance is a geometrical absolute criterion intended to recopy values of displacements structural in a thermal fluid model, in order to solve there the equation of Laplace of the field of non stationary pressure. By defect, it is equal to 102 Mr.***

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### 3.6 Operand

#### ***NOEUD\_DOUBLE***

***NOEUD\_DOUBLE = "YES"***

***This operand is to be used when one makes a calculation of force added starting from a model generalized which includes/understands a substructure with a grid by a telegraphic or surface grid (i.e without thickness like beam or hull) and surrounded by two fluids. It is necessary in this case for the level of grid to duplicate the nodes of the fluid interfaces of those of the structure, in order to be able to calculate the hydrodynamic jump of pressure on both sides of the structure (cf appears below).***

***X X X***

***X X***

***X***

***X***

***X***

***X***

***X***

***X***

***Structure with a grid***

***fluid 1***

***X***

***X***

***(without thickness)***

***X***

***X***

***X***

***X***

***X***

***X***

***Duplicated nodes***

***X***

***X***

***X***

***X***

***X X***

***(nodes having the same ones***

***co-ordinates but not it***

*fluid 2*  
*even name)*

### **3.7 Operand** **POTENTIAL**

**POTENTIAL = phi**

*Potential (thermal) stationary necessary to the calculation of damping and rigidity added structure subjected to a potential flow. This potential is produced by the operator THER\_LINEAIRE [U4.54.01].*

### **3.8 Operand** **DIRECTION**

**DIRECTION = (d1, d2, d3, r1, r2, r3)**

*Components of a vector giving the direction of the seism of drive in the total reference mark. It is a list of three realities if the imposed accélérogrammes are only translations. If one also imposes accelerations of rotations, one awaits a list of six realities (valid for modelings with discrete elements).*

### **3.9** **Description of the movement of drive**

#### **3.9.1 Operand** **MONO\_APPUI**

**/MONO\_APPUI = "YES"**

*The structure is uniformly excited in all the supports (movement of drive of body solid).*

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### **3.9.2 Excitation multi supports**

***In this case, the accelerations undergone by the whole of the points of anchoring of the studied structure are not inevitably identical and in phase.***

#### **3.9.2.1 Operand**

**MODE\_STAT**

**/**  
**MODE\_STAT = mode**

***Static modes of the structure: concept of the mode\_stat\_depl type produced by operator MODE\_STATIQUE [U4.52.14] with option DDL\_IMPO. They correspond to the 3 or 6\*nb\_supports static modes where nb\_supports is the number of accélérogrammes different undergone by the structure.***

**Note:**

***If the structure is requested only by translations, there are then 3 nb\_supports static modes.***

#### **3.9.2.2 Operands**

**NODE/GROUP\_NO**

**/NODE = No**

**/**  
**GROUP\_NO = grno**

***List nodes (No) or groups of nodes (grno) of the structure subjected to the excitation seismic: these nodes support the ddl supports of the structure to which are applied imposed movements.***

### **3.10 Operand**

**NUME\_DDL\_GENE**

**NUME\_DDL\_GENE = numgen**

*Generalized classification based on the mechanical modes of the total structure. presence of this operand makes it possible to calculate a matrix of added mass of type **matr\_asse\_gene\_R**. It must be necessarily present if one wants to make thereafter modal, harmonic or transitory calculation.*

### **3.11 Key word factor SOLVEUR**

*See [U4.50.01].*

### **3.12 Operand**

**AVEC\_MODE\_STAT**

*Allows to disconnect the calculation of the terms of mass added on the static modes contained in the modal base of the substructures in the case of a calculation with a generalized model (cf [§3.4]).*

### **3.13 Operand**

**NUME\_MODE\_MECA**

*Allows to specify a list of numbers of modes retained for calculation.*

### **3.14 Operand**

**INFORMATION**

**INFORMATION**

=

*Indicate the level of impression of the results of the operator on the file **MESSAGE**.*

*1: no impression*

*2: impression of the terms of added force.*

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Titrate:

Macro-order *MACRO\_MATR\_AJOU*

Date:

19/01/05

Author (S):

**N.GREFFET**, F. STIFKENS, G. Key ROUSSEAU

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Organization (S): *EDF-R & D /AMA, EDF-DPN/UTO*

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**Document: U4.66.11**

Macro-order *MACRO\_MATR\_AJOU*

**1 Goal**

*To calculate in a way more condensed than with `CALC_MATR_AJOU` of the matrices of mass, of added damping or rigidity [R4.07.03]. The matrices are induced by a true fluid, incompressible, at rest or in potential flow, on a structure in 2D, axisymmetric 2D or in 3D.*

*The terms of these matrices are calculated on the basis of modal structure in the vacuum.*

*One can also calculate by the launching of `CALC_FORC_AJOU` [U4.66.03] the vectors of the forces added induced by a seismic movement of drive also calculated on the modal basis structure in the vacuum.*

*The interest of this macro-order is primarily to mask the calls to the operators of linear thermics which calculates the hydrodynamic pressures caused by the vibration of structure in the fluid. The user should from now on inform only the characteristics of sound fluid field and clean modes in air of the structure, the operator giving the responsibility themselves to calculate them added matrices.*

*The possibilities of the order preserve those of operator `CALC_MATR_AJOU` [U4.66.01].*

*An example of use of macro-order `MACRO_MATR_AJOU` is presented in the case-test `FDLV106` [V8.01.106].*

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*7.4*

*Titrate:*

*Macro-order `MACRO_MATR_AJOU`*

*Date:*

*19/01/05*

*Author (S):*

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*2 Syntax*

**MACRO\_MATR\_AJOU**

(  
**GRID**  
=  
**netted**  
[grid]

**GROUP\_MA\_FLUIDE**

=  
**fluid**  
[gr\_ma]

**GROUP\_MA\_INTERFACE**

=  
**interf**  
[gr\_ma]

**MODELING =/"3D"**

/  
**"PLANE"**  
/  
**"AXIS"**

**FLUID**  
= **\_F** (  
**RHO** =  
**rho**  
[R]

***ALL =***  
***“YES”***

***GROUP\_MA***  
***=***  
***grma***  
***[group\_ma]***

***NET***  
***=***  
***net***  
***[mesh]***

)

***DDL\_IMPO***  
***= \_F (***  
***/PRES\_FLUIDE = pfluide***  
***[R]***

/

**PRES\_SORTIE**

=

**psortie**

**[R]**

**/NODE = node**

**[node]**

/

**GROUP\_NO**

=

**grno**

**[group\_no]**

)

**FLOW**

=

**\_F (**

**VNOR\_1 = vnor1**

**[R]**

***VNOR\_2 = vnor2***

***[R]***

***GROUP\_MA\_1***

=

***grma1***

***[group\_ma]***

***GROUP\_MA\_2***

=

***grma2***

***[group\_ma]***

***POTENTIAL = phi [evol\_ther]***

)

/  
**MODE\_MECA**  
=  
**modes**  
**[mode\_meca]**

/  
**DEPL\_IMPO**  
=  
**chamno**  
**[cham\_no\_DEPL\_R]**

/  
**MODELE\_GENE**  
=  
**modgen**  
**[modele\_gene]**

**NUME\_DDL\_GENE**  
=  
**numgen**  
**[nume\_ddl\_gene]**

**DIST\_REFE**  
=  
/  
**outdistance**

**[R]**

/

1.0

**D-2 [DEFECT]**

**I MATR\_MASS\_AJOU = massaj**

**[matr\_asse\_gene\_R]**

**I MATR\_RIGI\_AJOU =**

**rigiaj**

**[matr\_asse\_gene\_R]**

**I MATR\_AMOR\_AJOU =**

**amoraj**

**[matr\_asse\_gene\_R]**

**/MONO\_APPUI = "YES"**

/

**MODE\_STAT**

=

**mode**

**[mode\_stat\_depl]**

**FORC\_AJOU = \_F (NODE**

=

**No**

**[l\_noeud]**



**GROUP\_NO**

=

**grno**

**[l\_group\_no]**

**DIRECTION**

=

**direction [l\_R]**

**VECTOR = vector**

**[vect\_asse\_gene]**

)

**SOLVEUR = to see [U4.50.01]**

**INFORMATION**

=  
/  
1  
[DEFECT]

/2

*NOEUD\_DOUBLE*  
=/"YES"  
/  
"NOT"  
[DEFECT]

*AVEC\_MODE\_STAT=*  
/  
"YES"  
[DEFECT]  
/  
"NOT"

);  
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*Macro-order MACRO\_MATR\_AJOU*

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### **3 Operands**

#### **3.1 Operand**

##### **GRID**

*Name of the grid containing the fluid field and the fluid interface/structure. This grid can too to include the structure.*

#### **3.2 Operand**

##### **GROUP\_MA\_FLUIDE**

**GROUP\_MA\_FLUIDE = fluid**

*Groups of meshes (plane meshes in 2D and axisymmetric 2D, voluminal meshes in 3D) representing the fluid field acting on the studied structure.*

#### **3.3 Operand**

##### **GROUP\_MA\_INTERFACE**

**GROUP\_MA\_INTERFACE = interf**

*Groups of meshes representing the interface enters the fluid and the structure (plane meshes or telegraphic). It should be stressed that this group of meshes can be one of those used to model surface structure, in particular if this one is modelled by elements of hull. It is not not always necessary to create a group of meshes of interface specific with meshes to whole share.*

#### **3.4 Operand**

##### **MODELING**

*Type of modeling to be assigned to the fluid field and the fluid interface/structure. Currently, them modelings “PLAN” (fluid field 2D), “3D” (voluminal fluid field) and “AXIS” (fluid field axisymmetric) are only authorized.*

#### **3.5 Word**

*key*

**FLUID**

***Key word factor where one affects the fluid material characteristics. If density of the fluid vary on the fluid field, it is necessary to specify these various densities by several occurrences of the key word FLUID factor.***

### ***3.5.1 Operand***

***RHO***

***RHO = rho***

***Value of the density of the fluid to be affected on the below definite topological entities.***

### ***3.5.2 Operands***

***ALL/GROUP\_MA/MESH***

***Meshs, group of meshs or totality of the fluid field where one affects density RHO.***

### ***3.6 Word***

***key***

***DDL\_IMPO***

***Key word factor by which one specifies the boundary conditions of the fluid (of Dirichlet type).***

### ***3.6.1 Operands***

***NODE/GROUP\_NO***

***Nodes or groups of nodes where one imposes the boundary conditions on the fluid field.***

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**3.6.2 Operand****PRES\_FLUIDE**

*Key word under which one specifies the value that one imposes on the hydrodynamic pressure (i.e. disturbance of pressure created by the vibration of the structure) on the given topological entity above. This key word must appear at least once because it makes it possible to calculate the fields of pressure non stationary generators of the added mechanical magnitudes.*

**3.6.3 Operand****PRES\_SORTIE**

*Pressure of exit to be imposed on a permanent flow. Key word to employ (in an occurrence different from the key word factor DDL\_IMPO where one used PRES\_FLUIDE) to specify the conditions with the limits on the permanent sizes to calculate (like the potential fluid speeds permanent characterizing a permanent flow disturbed by the vibrations). This key word is not with to use that if one wants to calculate the matrices of added damping and rigidity which require it calculation of a presumedly potential permanent flow.*

**3.7 Word***key***FLOW**

*This key word factor makes it possible to determine the boundary conditions of the Neumann type when one wants to calculate a presumedly potential permanent flow, to be able to calculate damping and rigidity added.*

**3.7.1 Operands****GROUP\_MA\_1/GROUP\_MA\_2**

*Names of the groups of meshes respectively of entry and exit of the fluid field where one imposes conditions normal speed of entry or exit of the fluid.*

**3.7.2 Operands****VNOR\_1/VNOR\_2**

*Actual values normal speeds of the fluid respectively at the entry and the exit of the field fluid.*

**3.7.3 Operand****POTENTIAL**

*Name given by the user to the potential permanent fluid speeds if he wants possibly it post-to treat.*

### **3.8 Operands**

**MODE\_MECA/DEPL\_IMPO/MODELE\_GENE**

**/MODE\_MECA = modes**

*Dynamic modes calculated on the model structure. If there are several structures not related immersed in the same fluid, for which one wants to determine the matrices added including/understanding the terms of coupling by the fluid, the model structure which one defines gather the totality of the immersed structures. The modes used by the operator are them modes calculated for the total structure.*

**/DEPL\_IMPO = chamno**

*Fields with the nodes of displacements affected on groups of nodes defining the fluid interface/structure. By affecting such a field of displacement on (S) the group (S) of nodes of interface thanks to operator AFFE\_CHAM\_NO [U4.44.11], one can for example to easily simulate modes of rigid body of the structures. This operand is to be used if one wants to estimate the terms of the added matrices and coupling for a plane geometry without making as a preliminary modal calculation of the structure in the vacuum, and which one wants to affect these terms in discrete elements (modeling DIS\_T). The operand INFORMATION must imperatively to be active to visualize the calculated terms.*

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**U4.66.11-D Page****: 5/10****Caution:**

*The use of this operand excludes that from operand NUME\_DDL\_GENE. One cannot thus not make modal, transitory calculation or harmonic by using the operand CHAM\_NO.*

*Indeed, to make calculation of modes out of water, it is necessary to have a matrix of mass generalized and a matrix of rigidity generalized of the structure. This supposes to have fact a modal calculation on the structure in the vacuum (what one wants precisely to avoid).*

*This operand is used ultimately only to evaluate the matrix of mass, of rigidity and of damping added, and to use them to couple structures of the type beam by discrete elements of mass, for example.*

**/MODELE\_GENE = modgen**

*Generalized model built by operator DEF1\_MODELE\_GENE [U4.65.02]. This key word is with to use when one makes a calculation by dynamic under-structuring, and that one wants to calculate stamp of added mass coupling the whole of the substructures. In this case, under structures can be in different files of grid, these files being able to be them same distinct from the fluid file of grid. The substructures which present one repetitivity within the fluid are to be netted only once, but one will take care with level of the fluid grid to net all the interfaces fluid/structure. Moreover, it is necessary to take care so that the nodes of fluid interface coincide as well as possible with the nodes of interface of structure, in order to be able to recopy, on the basis of geometrical criterion of proximity, them values of the fields of displacement of structure on the nodes of fluid interface (see operand DIST\_REFE).*

**3.9 Operands**

**MATR\_MASS\_AJOU/MATR\_AMOR\_AJOU/MATR\_RIGI\_AJOU**

*These key words specify the name user of the matrices of mass, rigidity or added damping (E) that one wants to calculate. One needs at least one of these key words to operate calculation. 3 key words*

*can be used simultaneously, but in the case of the use of MATR\_AMOR\_AJOU or MATR\_RIGI\_AJOU, it is necessary to inform key words FLOW and DDL\_IMPO with PRES\_SORTIE.*

**3.10 Operand**

**DIST\_REFE**

*Outdistance reference to be informed when one makes a calculation of mass added on a model generalized. This distance is a geometrical absolute criterion of proximity intended to recopy values of structural displacements in a fluid field, in order to solve the equation of Laplace there non stationary field of pressure. By defect, it is equal to 102.*

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*3.11 Operand*

*NOEUD\_DOUBLE*

*NOEUD\_DOUBLE = "YES"*

*This operand is to be used when one makes a calculation of mass added starting from a model generalized which includes/understands a substructure with a grid by a telegraphic or surface grid (i.e without thickness like beam or hull) and surrounded by two fluids. It is necessary in this case for the level of grid to duplicate the nodes of the fluid interfaces of those of the structure, in order to be able to calculate the hydrodynamic jump of pressure on both sides of the structure (cf appears below).*

*X X X*

*X X*

*X*

*X*

*X*



X  
X  
X

*Structure with a grid*

*fluid 1*

X  
X

*(without thickness)*

X  
X  
X  
X  
X  
X  
X

*Duplicated nodes*

X  
X  
X  
X  
X X

*(nodes having the same ones  
co-ordinates but not it*

*fluid 2*

*even name)*

### **3.12 Operand**

**AVEC\_MODE\_STAT**

**AVEC\_MODE\_STAT = "NOT"**

*This operand makes it possible to disconnect the calculation of the terms of mass added on the modes statics contained in the modal base of the substructures in the case of a calculation with one generalized model (cf [§3.8]).*

### **3.13 Operand**

**NUME\_DDL\_GENE**

**NUME\_DDL\_GENE = numgen**

*Generalized classification based on the mechanical modes of the total structure. The presence of this operand allows to calculate a matrix of added mass of matr\_asse\_gene\_R type. It must be necessarily present if one wants to make modal, harmonic calculation thereafter or*

*transient.*

### **3.14 Description of the seismic movement of drive**

#### **3.14.1 Operand MONO\_APPUI**

**/MONO\_APPUI = "YES"**

*The structure is uniformly excited in all the supports (movement of drive of body solid).*

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#### **3.14.2 Excitation multi supports: operand MODE\_STAT**

*In this case, the accelerations undergone by the whole of the points of anchoring of the studied structure*

*are not inevitably identical and in phase.*

**/**  
**MODE\_STAT = mode**

*Static modes of the structure: concept of the mode\_stat\_depl type produced by operator MODE\_STATIQUE [U4.52.14] with option DDL\_IMPO. They correspond to the 3 or 6\*nb\_supports static modes where nb\_supports is the number of accélérogrammes different undergone by the structure.*

**Note:**

*If the structure is requested only by translations, there are then 3 nb\_supports static modes.*

**3.15 Added forces due to the seismic movement of drive:**  
key word **FORC\_AJOU**

**3.15.1 Operands NODE/GROUP\_NO**

**/NODE = noeu**

**/**  
**GROUP\_NO = g\_noeu**

*List nodes (noeu) or groups of nodes (g\_noeu) of the structure subjected to the excitation seismic: these nodes support the ddl supports of the structure to which they are applied imposed movements.*

**3.15.2 Operand DIRECTION**

**DIRECTION = (d1, d2, d3, r1, r2, r3)**

*Components of a vector giving the direction of the seism of drive in the total reference mark. It is a list of three realities if the imposed accélérogrammes are only translations. If one also imposes accelerations of rotations, one awaits a list of six realities (valid for modelings with discrete elements).*

**3.15.3 Operand VECTOR**

**VECTOR = vector**

**[vect\_asse\_gene]**

*Name of the vector forces added created by the launching of operator CALC\_FORC\_AJOU [U4.66.03].*

*It there as many vectors created of occurrences of key word FORC\_AJOU.*

**3.16 Word**

**key**

**SOLVEUR**

*Key word factor specifying the technique of resolution of system linear appearing here in calculation non stationary fields of pressure. See [U4.50.01].*

**3.17 Operand**

## **INFORMATION**

## **INFORMATION**

=

*Indicate the level of impression of the results of the operator,*

*1 :*

*no impression,*

*2 :*

*impression of the higher triangular part of the matrices of added mass, added damping or rigidity.*

*Presentation in column.*

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*4 Phase*

*of execution*

*It is checked that the storage of the added matrices is done on a full profile.*

*It is checked that the coefficients of car masses added (diagonal terms of the matrix) are well all positive. In the contrary case, a message of alarm is transmitted so that the user checks the orientation normals.*

*In the case of a calculation of mass added on a generalized model, one informs the user on recopies of fields of structural displacements in the fluid (a number of recopied values) and one indicate how to change the distance from reference (DIST\_REFE).*

## **5 Example**

### **5.1 Example 1: Calculation of the matrix of mass added of a structure composed of two concentric cylinders separated by a fluid incompressible**

*The cylinders are supported each one by springs. The matrix of added mass is calculated for the first two modes of the structure, namely the modes of rigid body of each cylinder in direction OX (cf diagram).*

*N*  
*R2*  
*M*  
*R*  
*k2*  
*R*  
*k1*

*X*  
*R 1*  
*()*  
*1*  
*m1*  
*()*  
*2*  
*m2*

*1) Assignment of the total model structure (including/understanding the two cylinders and their springs of self-supporting quality).*

```
struct = AFFE_MODELE (GRID = MAYA,
AFFE = _F (GROUP_MA = "cylinder",
MODELING = "D_PLAN",
PHENOMENON = "MECHANICAL"),
_F (GROUP_MA = "cylxxt",
MODELING = "D_PLAN",
PHENOMENON = "MECHANICAL"),
_F (GROUP_MA = "arises",
```

**MODELING = "DIS\_T",**  
**PHENOMENON = "MECHANICAL"),**  
**\_F (GROUP\_MA = "ressorex",**  
**MODELING = "DIS\_T",**  
**PHENOMENON = "MECHANICAL"),)**

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**2) Calculation of the clean modes of the structure in the vacuum**

**modes = MODE\_ITER\_SIMULT (MATR\_A = matasks,**  
**MATR\_B = matasms,**  
**CALC\_FREQ = \_F (OPTION = "PLUS\_PETITE",**  
**NMAX\_FREQ = 2))**

**3) Generalized classification based on the calculated mechanical modes**

**numgen = NUME\_DDL\_GENE (MODE\_MECA = modes,**  
**STORAGE = "FULL")**

**4) Calculation of the matrix of added mass of matr\_asse\_gene\_r type (operand NUME\_DDL\_GENE present). So one can then calculate the clean modes of the "wet" structure**

**MACRO\_MATR\_AJOU (GRID = Maya,**  
**GROUP\_MA\_FLUIDE = "grfluide",**  
**MODELE\_INTERFACE = grinter,**  
**MODELING = "PLANE",**

***FLUID = \_F (RHO = rho,  
GROUP\_MA = “grtotal”),  
DDL\_IMPO = \_F (GROUP\_NO = “noflui”,  
PRES\_FLUIDE = 0. ),  
MATR\_MASS\_AJOU = massaj,  
MODE\_MECA = modes,  
NUME\_DDL\_GENE = numgen,  
INFORMATION =1)***

***5) Calculation of the matrices of mass and stiffness generalized on generalized classification based on the calculated mechanical modes numgen. These matrices are of type [matr\_asse\_gene\_r]***

***MACRO\_PROJ\_BASE (BASE = modes,  
\_F (MATRIX = CO (“matasms”),  
MATR\_ASSE = mgene),  
\_F (MATRIX = CO (“matasks”),  
MATR\_ASSE = riggen))***

***6) Calculation of the matrix of total mass of the structure (matrix of more generalized mass matrix of added mass)***

***mastot = COMB\_MATR\_ASSE (COMB\_R = \_F (MATR\_ASSE = mgene,  
COEF\_R = 1. ),  
\_F (MATR\_ASSE = matraj,  
COEF\_R = 1. ))***

***7) Calculation of the modes of the immersed structure.***

***modhumi = MODE\_ITER\_SIMULT (MATR\_A =riggen,  
MATR\_B: mastot,  
CALC\_FREQ = \_F (OPTION = “PLUS\_PETITE”,  
NMAX\_FREQ = 2))***

***8) Restitution of the modes “wet” on physical basis.***

***mode\_mou = REST\_BASE\_PHYS (RESU\_GENE = modhumi,  
MODE\_MECA = modes)***

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***5.2***

***Example 2: roll subjected to an annular flow***

***This case (cf case-test FDLV106 [V8.01.106]) implements the calculation of mass, damping added, and of rigidity added on a cylindrical structure subjected to an annular flow which one supposes potential. One calculates mass and damping initially added by the flow on structure for various speeds upstream (4 m/s, 4.24 m/s and 6 m/s), this on a model 3D for fluid and hull for the structure. The structure has a displacement of rotation around a pivot located at the downstream end of the cylinder compared to the flow.***

***L***

***V0***

***Z***

***entry N***

***IH***

***N left***

***y***

***R***

***X***

***E***

***C***

***X***

***not***

***swivelling***

***roll fixed intern***

***fluid***

***external cylinder***

***mobile in rotation around the pivot C***



*1) After having modelled the cylindrical structure and having calculated its modes in air, the order MACRO\_MATR\_AJOU makes it possible to calculate the mass, the rigidity and damping added by the fluid in flow on this structure:*

```
MACRO_MATR_AJOU (GRID = Maya,  
GROUP_MA_FLUIDE = "grfluide",  
MODELE_INTERFACE = grinter,  
MODELING = "3D",  
FLUID = _F (RHO = rho,  
GROUP_MA = "grtotal"),  
DDL_IMPO = (_F (GROUP_NO = "noflui",  
PRES_FLUIDE = 0. ),  
_F (GROUP_NO = "nosortie",  
PRES_SORTIE = 0. )),  
FLOW = _F (GROUP_MA_1 = "entered",  
GROUP_MA_2 = "left",  
VNOR_1 = 4. ,  
VNOR_2 = -4. ),  
MATR_MASS_AJOU = "massaj",  
MATR_AMOR_AJOU = "amoraj",  
MATR_RIGI_AJOU = "rigiaj",  
MODE_MECA: = modes,  
NUME_DDL_GENE = numgen,  
INFORMATION = 1)
```

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**A. Key ADOBES**

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*Organization (S): EDF-R & D /MFTT*

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***Operator MODI\_BASE\_MODALÉ***

***1 Goal***

*To define the modal base of a structure under flow. This base is obtained after a calculation of coupling fluid-rubber band carried out using operator CALC\_FLUI\_STRU [U4.66.02]. The concept product is of mode\_meca type*

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*Operator MODI\_BASE\_MODAL*

*Date:*

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*:*

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*2*

*Syntax*

*mode [mode\_meca] = MODI\_BASE\_MODAL (*

*BASE*

*=*

*mode*

*,*

*[mode\_meca]*

*BASE\_ELAS\_FLUI*

*=*

*bef*

*,*

*[melasflu]*

**NUME\_VITE\_FLUI**

=

**numv**

,

**[I]**

**NUME\_ORDRE = l\_nuor**

,

**[l\_I]**

**/AMOR\_REDUIT**

=

**l\_amor**

,

**[l\_R]**

/

**AMOR\_UNIF**

=

**amor**

,

**[R]**

**INFORMATION =/1 [DEFECT]**

**/2 ,**

**[I]**

**TITRATE**

=

**titrate**

**, [TXM]**

)

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***Version***

***7.4***

***Titrate:***

***Operator MODI\_BASE\_MODAL***

***Date:***

***19/01/05***

***Author (S):***

***A. Key ADOBES***

***:***

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***3 Operands***

***BASE = mode***

***Concept of the type [mode\_meca] which defines the modal characteristics before taking into account of coupling fluid-rubber band. According to the choice of the user, the operator modifies this concept of entry or creates a new concept of the type [mode\_meca].***

***BASE\_ELAS\_FLUI = bef***

***Concept of the type [melasflu] which defines the new characteristics of the modes taken into account for the coupling fluid-rubber band, various rates of flow.***

***NUME\_VITE\_FLUI = numv***

***Allows to point on the characteristics of the modes taken into account for the coupling fluidelastic, for a rate of flow given.***

***NUME\_ORDRE = l\_nuor***

*If one modifies the concept of entry of the type [mode\_meca]: list sequence numbers of the modes nondisturbed to which one wishes to affect a reduced damping.*

*If one creates a new concept of the type [mode\_meca] at exit: list sequence numbers of nondisturbed modes which are actually retained to rebuild the modal base.  
possibility of affecting a damping reduced to these modes is maintained, while resorting to operands AMOR\_REDUIT or AMOR\_UNIF below.*

*Note:*

*By defect, one selects all the modes which were not taken into account for the coupling fluid-rubber band. Not to give in this list of the sequence numbers corresponding to coupled modes.*

*The constitution of [mode\_meca] the result according to the choices for the operands NUME\_ORDRE, AMOR\_REDUIT and AMOR\_UNIF are specified in paragraph [§4].*

*/AMOR\_REDUIT = l\_amor*

*List affected reduced depreciation with the nondisturbed modes.*

*/  
AMOR\_UNIF = amor*

*Affected reduced damping identically with the nondisturbed modes.*

*INFORMATION = 1 or 2*

*Inactive operand. To obtain the impression of the results, the order should be used IMPR\_RESU [U4.91.01].*

*TITRATE = title*

*Argument of the type text [TXM] defining the title attached to the concept [mode\_meca] at exit.*

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*Titrate:*

*Operator MODI\_BASE\_MODALÉ*

*Date:*

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*4*

*Specified for the use: contents of the concept*

*[mode\_meca] result*

*MODIFICATION OF the CONCEPT Of ENTRY BY MODI\_BASE\_MODALÉ*

*&mode*

*NUMÉ\_ORDRE*

*Ncf modes*

*Na modes selected*

*disturbed by*

*yes*

*not*

*informed?*

*coupling*

*+*

*AMOR\_REDUIT*

*One affects to*

*AMOR\_REDUIT*

*NT-Ncf modes*

*or*

*Na modes*

*nondisturbed*

*or*

*selected*

*AMOR\_UNIF*

*not*

*with assignment*

*AMOR\_UNIF*

*and with the others*

*of damping*  
*not*

*informed?*  
*NT (Ncf+Na)*

*informed?*

*no one*

*modes*

*yes*

*yes*

*nondisturbed*

*a value*

*of damping*

*tiny room null*

*AMOR\_UNIF*

*AMOR\_REDUIT*

*AMOR\_REDUIT*

*AMOR\_UNIF*

*One affects to*

*A number of elements*

*NT-Ncf modes*

*Error*

*A many elements One affect to*

*in the list equal not*

*not*

*nondisturbed*

*fatal*

*in the list equal*

*Na first modes*

*with NT-Ncf?*

*the value*

*with Na?*

*nondisturbed*

*of damping*

*selected*

*yes*

*yes*

*tiny room definite*

*the value*

*of damping*



*Assignment*  
*Assignment*  
*tiny room definite*  
*values*  
*values*  
*and a value*  
*&mode*  
*of damping*  
*of damping*  
*null with the others*

*defined in*  
*modes not*  
*&mode*  
*with the modes*  
*Ncf modes*  
*Na first disturbed modes*

*nondisturbed*  
*disturbed by*  
*Ncf modes*  
*nondisturbed*  
*coupling*  
*disturbed by*  
*selected*

+

*coupling*  
*and of a value*  
*Na modes*

+

*of damping*  
*nondisturbed*  
*NT-Ncf modes*  
*null with the others*  
*with assignment*  
*nondisturbed*  
*modes not*  
*of damping*  
*with assignment*  
*disturbed*

+

*of damping*  
*NT (Ncf+Na) modes*

*nondisturbed with  
null damping  
CREATION Of a NEW CONCEPT BY MODI\_BASE\_MODAL  
NUME\_ORDRE*

*Na modes selected  
yes  
not  
informed?*

*modecf  
AM*

*One affects to  
OR\_REDUIT  
With*

*MOR\_REDUIT  
Na modes*

*or  
or  
Ncf modes  
nondisturbed  
AMOR\_UNIF  
not  
AMOR\_UNIF  
disturbed by  
selected  
not*

*coupling  
informed?  
a value  
informed?  
of damping  
yes  
yes  
tiny room null  
AMOR\_UNIF  
AMOR\_REDUIT  
AMOR\_UNIF*

## **AMOR\_REDUIT**

**One affects to**

**A number of elements**

**NT-Ncf modes**

**Error**

**A number of elements**

**One affects to**

**in the list equal not**

**not**

**nondisturbed**

**fatal**

**in the list equal**

**Na modes**

**with NT-Ncf?**

**the value**

**with Na?**

**nondisturbed**

**of damping**

**selected**

**yes**

**yes**

**tiny room definite**

**the value**

**of damping**

**Assignment**

**Assignment**

**tiny room definite**

**values**

**values**

**of damping**

**of damping**

**modecf**

**with the modes**

**with the modes**

**nondisturbed**

**nondisturbed**

**modecf**

**Ncf modes**

**selected**

**disturbed by**

*Ncf modes  
coupling  
disturbed by  
+  
coupling  
NT-Ncf modes  
+  
nondisturbed  
Na modes  
with assignment  
nondisturbed  
of damping  
with assignment  
of damping*

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*Titrate:*

*Selection in a Structure of Data RESULT*

*Date:*

*27/01/05*

*Author (S):*

***J.P. LEFEBVRE, A.M. DONORE, G. Key NICOLAS***

*:*

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*Organization (S): EDF-R & D /AMA, SINETICS*

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***Selection of one or more fields in  
a Structure of Data RESULT***

***1 Goal***

***Description of the key words of access to the fields of sizes of a structure of data of the type result.***

***To extract a field from sizes in a concept result one has two types indicators: the reference symbols and variables of access.***

***This document describes the whole of the key words giving access the fields of size contents in a structure of data result and used in orders CALC\_ELEM [U4.81.01], CALC\_NO [U4.81.02], CALC\_G\_THETA\_T [U4.82.03], CALC\_G\_LOCAL\_T [U4.82.04], COMB\_SISM\_MODAL [U4.84.01], EXTR\_MODE [U4.52.12], IMPR\_CLASSI [U7.04.21], IMPR\_GENE [U4.91.03], IMPR\_RESU [U4.91.01], LIRE\_RESU [U7.02.01], POST\_ELEM [U4.81.22], POST\_RCCM [U4.83.11], POST\_RELEVE\_T [U4.81.21], RECU\_FONCTION [U4.32.03], TEST\_RESU [U4.92.01].***

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***2 Syntax***

***%***  
***Choice***  
***of***  
***results***  
***derived***

***SENSITIVITY =***

***(... to see [U4.50.02])***

***% Extraction of a field of size of resu***

***/***  
***TOUT\_CHAM***  
***=***

*/“YES”, [DEFECT]*

*/“NOT”,*

*/*  
*NOM\_CHAM*  
*=*  
*L\_NOMSYMB, [L\_K16]*

*/*  
*TOUT\_ORDRE =*  
*“YES”,*  
*[DEFECT]*

*/*  
*/*  
*NUME\_ORDRE =*  
*LORDRE, [L\_I]*

*/*

***LIST\_ORDRE =***  
***LENTI,***  
***[listis]***

/

***TOUT\_MODE***  
***=***  
***“YES”,***

/

***NUME\_MODE***  
***=***  
***LMODE,***  
***[l\_I]***

/

***LIST\_MODE***  
***=***  
***LENTI,***  
***[listis]***

/

***NOEUD\_CMP***  
***=***  
***LNOECMP,***  
***[l\_K16]***

/



**NOM\_CAS =**  
**NCAS,**  
**[K16]**

/

**ENG**

=

**LANGL,**  
**[l\_R]**

/

**FREQ**

=

**LFREQ,**  
**[l\_R]**

/

**LIST\_FREQ**

=

**LREEL,**  
**[listr8]**

/

**TOUT\_INST**

=

**“YES”,**

/

**INST**

=

**LINST,**  
**[l\_R]**

/

**LIST\_INST**

=

**LREEL,**  
**[listr8]**

***I PRECISION***

=

/

***PREC,***

***[R]***

/

***1.0D-3***

***or***

***1.0D-6, [DEFECT]***

***I CRITERION =/“RELATIVE”, [DEFECT]***

/

***“ABSOLUTE”***

,

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### **3 Operand SENSITIVITY**

*SENSITIVITY: sensitive parameter list*

*This key word is followed of a sensitive parameter list. It specifies that one is not interested in result in itself, but with derived from the result compared to a parameter. Thus one sequence of this type:*

*RESULT  
=  
RESU,  
SENSITIVITY =  
(PS),  
NOM\_CHAMP  
= "DEPL"*

*mean that one will operate on the derivative of the field of displacement of result RESU by report/ratio with the parameter PS.*

*See [U4.50.02] for the details on the parameters associated with the key word.*

### **4 Extraction of a field of size**

#### **4.1 Choice of the reference symbols: Operands TOUT\_CHAM/NOM\_CHAM**

*/TOUT\_CHAM  
=/"YES"  
[DEFECT]*

*This key word indicates that one wants to reach (X) the field (S) of sizes actually calculated (S) for the concept result RESU. If operand NOM\_CHAM is not used, this operand is taken by defect with "YES".*

*The possible fields are described in specific documentations of the concepts result (cf [U5]).*

*Example: the possible fields are for a result of the evol\_elas type [U4.51.01]:*

*DEPL*  
*SIGM\_ELNO\_DEPL*  
*EPSI\_ELNO\_DEPL*  
... ..

*/NOM\_CHAM = L\_NOMSYMB*  
*[l\_K16]*

*A concept result can be composed of several fields of sizes of the field type with nodes or field by element. This key word makes it possible to choose a list of reference symbols of field among the whole of possible (cf TOUT\_CHAM).*

**Note:**  
*Key words TOUT\_CHAM and NOM\_CHAM cannot be used simultaneously.*

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**4.2**  
***Choice of the sequence numbers: Operands TOUT\_ORDRE/NUME\_ORDRE***  
***/LIST\_ORDRE***

*/TOUT\_ORDRE = "YES"*  
*[DEFECT]*

*This key word gives access (X) the field (S) for all the already calculated sequence numbers.*

*Example:*

.  
*every moment for a result of the evol\_type...*

.  
*all clean modes for a result of the mode\_meca type.*

*/NUME\_ORDRE: LORDRE*  
*[l\_I]*

*This key word makes it possible to reach only (X) the field (S) correspondent a list of sequence numbers LORDRE (plural is employed here for the case where one chose TOUT\_CHAM = "YES").*

*Example: RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = "YES", NUME\_ORDRE= (3,6))*

*One will reach all the computed fields with the third and the sixth sequence number.*

*/LIST\_ORDRE: LENTI*

*[listis]*

*Key word LIST\_ORDRE indicates that one wants to reach (X) the field (S) correspondent with a list sequence numbers LENTI, defined by operator DEFI\_LIST\_ENTI [U4.34.02] (LENTI is thus a concept of the listis type).*

*Example:*

*LIST*

*=*  
*DEFI\_LIST\_ENTI*

*(*  
*VALE = (3,6))*

*RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = "YES",*  
*LIST\_ORDRE= LISTS)*

*One will reach all the computed fields with the third and the sixth sequence number.*

## **4.3**

***Other ways of choosing the sequence numbers: variables of access***

### **4.3.1 Operands**

## ***TOUT\_MODE/NUME\_MODE/LIST\_MODE/NOEUD\_CMP***

***/TOUT\_MODE***

= "YES"

*This key word indicates that one wants to reach all the fields for all the numbers of mode already calculated.*

*It is licit only for the types of concept result (statics mode or dynamic) having for variable of access NUME\_MODE (cf [U5]).*

***/  
NUME\_MODE***

=

***LMODE***

***[l\_I]***

*This key word indicates that one wants to reach (X) the field (S) correspondent with a list of numbers of mode LMODE. These numbers are those affected by the calculation algorithm.*

*It is licit only for the types of concept result (statics mode or dynamic) having for variable of access NUME\_MODE (cf [U5]).*

*Example: RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = `OUI', NUME\_MODE=(3,6))*

*One will reach all the fields corresponding to the third and the sixth mode.*

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*27/01/05*

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/  
**LIST\_MODE**  
 =  
**LENTI**  
 [listis]

*Key word LIST\_MODE indicates that one wants to reach (X) the field (S) correspondent with a list numbers of modes LENTI, defined by operator DEFI\_LIST\_ENTI [U4.34.02] (LENTI is thus a concept of the listis type). It is valid only for the types of concept result having for variable of access NUME\_MODE.*

*Example:*

**LIST**  
 =  
**DEFI\_LIST\_ENTI**  
 (  
 VALE = (3,6))

**RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = "YES", LIST\_MODE= LISTS)**

*One will reach all the fields corresponding to the third and the sixth mode.*

**/NOEUD\_CMP**  
 = **LNOECMP [l\_K16]**

*The results of the base\_modale type or mode\_stat have as a variable of access NOEUD\_CMP. value of these variables of access is obtained by concaténant the name of the node and the name of component. To specify a value of the variable of access, the user will give two names, it name of the node followed by the name of the component. A list of N variable of access will be introduced by the data of N couples (name of the node, name of the component).*

*A list of values of this variable of access can be provided by the list (couple1, couple2,...)*

#### **4.3.2 Operand** **NOM\_CAS**

/  
**NOM\_CAS =**  
**NCAS**

[K16]

Key word *NOM\_CAS* indicates that one wants to reach the field corresponding to a case of loading. It is licit only for the concepts result of the *mult\_elas* type which have for variable of accesses *NOM\_CAS* and produced by *MACRO\_ELAS\_MULT* [U4.51.02].

### 4.3.3 Operand

**ENG**

/

ENG

=

LANGL

[l\_R]

The key word *ENG* indicates that one wants to reach (X) the field (S) recombined (S) for a list angles. It is licit only for the concepts result of the *comb\_fourier* type which have for variable of accesses *ENG* and produced by operator *COMB\_FOURIER* [U4.83.31].

### 4.3.4 Operands

**FREQ/LIST\_FREQ**

These operands are licit only for the types of concept result having for variable of access *FREQ* (*mode\_meca*, *dyna\_harm*,...) (cf [U5]).

/

FREQ

=

LFREQ

[l\_R]

Key word *FREQ* indicates that one wants to reach (X) the field (S) correspondent with a list of frequencies *LFREQ*.

Example: *RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = `OUI', FREQ= (3.52, 7.37))*

One will reach all the fields corresponding to frequencies 3.52 and 7.37.

/

LIST\_FREQ

=

LREEL

[listr8]

Key word *LIST\_FREQ* indicates that one wants to reach (X) the field (S) correspondent with a list of



frequencies *LREEL*, defined by operator *DEFI\_LIST\_REEL* (*LREEL* is thus a concept of the type *listr8*).

*Example:*

*LIST*

=

*DEFI\_LIST\_REEL*

(

*VALE = (3.52, 7.37)*)

*RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = "YES", LIST\_FREQ = LIST)*

*One will reach all the fields corresponding to frequencies 3.52 and 7.37.*

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### ***4.3.5 Operands***

#### ***TOUT\_INST/INST/LIST\_INST***

*These operands are licit only for the types of concept result of temporal evolution having for variables of access INST (evol\_noli, evol\_ther, dyna\_trans,...) (cf [U5]).*

*/TOUT\_INST*

= "YES"

*This key word indicates that one wants to reach all the fields for every already calculated moment.*

/  
**INST**  
 =  
**LINST**  
 [l\_R]

*Key word INST indicates that one wants to reach (X) the field (S) correspondent with a list moments LINST.*

*Example: RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = "YES", INST= (3. , 7.))*

*One will reach all the fields corresponding to moments 3. and 7.*

/  
**LIST\_INST**  
 =  
**LREEL**  
 [listr8]

*Key word LIST\_INST indicates that one wants to reach (X) the field (S) correspondent with a list moments LREEL, defined by operator DEFI\_LIST\_REEL (LREEL is thus a concept of the type listr8).*

*Example:*

**LIST**  
 =  
**DEFI\_LIST\_REEL**  
 (  
 VALE = (3. , 7.))

*VALE = (3. , 7.)*

*RESU = (\_F (RESULTAT= RESU, TOUT\_CHAM = "YES", LIST\_INST= LISTS)*

*One will reach all the fields corresponding to moments 3. and 7.*

#### **4.3.6 Operands**

##### **PRECISION/CRITERION**

*These operands make it possible to refine the access by real variables of access of time or the frequency.*

## *I PRECISION*

=

/

*prec*

[*R*]

/

*1.0D-3*

or

*1.0D-6*

[*DEFECT*]

*This key word makes it possible to indicate that one seeks all the fields of which the moment (respectively frequency) is in the interval “inst ± prec” (cf CRITERION).*

*By defect prec = 1.0D-3 or prec = 1.0D-6 (according to the orders).*

## *I CRITERION*

: / “*RELATIVE*” [*DEFECT*]

/

“*ABSOLUTE*”

“*RELATIVE*”: *the interval of research is: [inst (1 - prec), inst (1 + prec)]*

“*ABSOLUTE*”: *the interval of research is: [inst - prec, inst + prec].*

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*Titrate:*

*Operator RECU\_TABLE*

*Date:*

08/03/05

*Author (S):*

*Key COURTEOUS Mr.*

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*Organization (S): EDF-R & D /AMA*

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***Operator RECU\_TABLE***

## ***1 Goal***

***Allows to recover in a table the values of a parameter of a structure of data result, or, to extract a table contained in another structure of data for those which it allow.***

***The table created can then be used in other orders (IMPR\_TABLE for example).***

***Product a structure of data of the type counts.***

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***08/03/05***

***Author (S):***

***Key COURTEOUS Mr.***

***:***

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## ***2 Syntax***

***count = RECU\_TABLE***

***(***

***CO***

***=***

***nomsd***

***,***

[\*]

/  
**NOM\_TABLE**

=  
**nomtab**

,  
**[KN]**

**/NOM\_PARA**

=  
**will lpara**

,  
**[l\_Kn]**

**TITRATE**

= **titr**

,  
**[l\_K80]**

)

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**Operator RECU\_TABLE**

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### **3 Operands**

**CO = nomsd,**

**Name of the structure of data in which one wants to extract a table.**

**/NOM\_TABLE = nomtab,**

**Name of the table stored in the structure of data.**

**Today, only 3 structures of data contain a table which one can extract by  
RECU\_TABLE/NOM\_TABLE**

**1) a structure of data of the evol\_noli type obtained by STAT\_NON\_LINE or  
DYNA\_NON\_LINE, the name of the table are then "OBSERVATION",**

**2) a structure of data of the grid type. The name of the table is then  
"CARA\_GEOM",**

**3) a structure of data of the cabl\_precont type obtained by the order  
DEFI\_CABLE\_BP. The name of the table is then "CABLE\_BP",**

**4) a structure of data of the obstacle type obtained by the order  
MODI\_OBSTACLE; the name of the table is then "OBSTACLE",**

**5) a structure of data of the melasflu type obtained by the order  
CALC\_FLUI\_STRU; the name of the table is then "MATR\_GENE".**

**/NOM\_PARA =  
will lpara,**

**List names of the parameters to be extracted from the SD nomsd RESULT.**

**This functionality makes it possible to extract in the form of a table the evolution from certain  
parameters  
of a SD RESULT, for example the parameter of piloting ETA\_PILOTAGE in the case  
of a SD of the evol\_noli type. The extracted parameters must be of type whole, real or  
complex, excluding from this fact the character strings. The first column of the table  
produced the sequence numbers (NUME\_ORDRE contains) and the following ones contain the**

*evolution  
parameters will lpara.*

*TITRATE = titr,*

*Titrate that one wants to give to the table result.*

*Instruction manual  
U4.7- booklet: Operations on the results and the fields  
HT-66/05/004/A*

---

*Code\_Aster ®*

*Version*

*7.4*

*Titrate:  
Operator RECU\_TABLE*

*Date:  
08/03/05  
Author (S):  
Key COURTEOUS Mr.*

*:  
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*4 Examples*

*1) recovery of some geometrical characteristics of a grid:*

*cargeo = RECU\_TABLE (CO = grid,  
NOM\_TABLE = "CARA\_GEOM",)*

*2) recovery of the values "observed" in order DYNA\_NON\_LINE*

*Order DYNA\_\_NON\_LINE [U4.53.01] makes it possible to choose a whole of meshes or of nodes for which one wishes to observe one or more components of certain fields (key word OBSERVATION).*



*dynl* = *DYNA\_NON\_LINE* (... *OBSERVATION* = *\_F* (...)...)

*tabobs* = *RECU\_TABLE* (*CO* = *dynl*, *NOM\_TABLE* = "OBSERVATION",)

3) recovery of the parameter of piloting of a SD of the *evol\_noli* type

*stnl* = *STAT\_NON\_LINE* (... *PILOTING* = *\_F*  
( ... ) ... )

*etapilo* = *RECU\_TABLE* (*CO* = *stnl*, *NOM\_PARA* = "ETA\_PILOTAGE",)

*Instruction manual*

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***Code\_Aster*** ®

*Version*

7.4

*Titrate:*

*Operator RECU\_GENE*

*Date:*

08/02/05

*Author (S):*

***E. BOYERE, J. PIGAT, Key LIGHT A.C.***

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*Organization (S): EDF-R & D /AMA*

***Instruction manual***  
***U4.7- booklet: Operations on the results and the fields***  
***Document: U4.71.03***

***Operator RECU\_GENE***

***1 Goal***

***To extract from the vectors displacements, speeds or accelerations starting from results in coordinates generalized. Their extraction takes place for moments given.***

***Instruction manual***  
***U4.7- booklet: Operations on the results and the fields***  
***HT-66/05/004/A***

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***Code\_Aster*** ®

***Version***

***7.4***

***Titrate:***

***Operator RECU\_GENE***

***Date:***

***08/02/05***

***Author (S):***

***E. BOYERE, J. PIGAT, Key LIGHT A.C.***

***:***

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## 2 Syntax

*vecgene*

*[vect\_asse\_gene] = RECU\_GENE*

(  
*RESU\_GENE*

=

*tg,*

*[tran\_gene]*

*INST = urgent,*

*[R]*

*NOM\_CHAM*

=

/  
*“DEPL”, [DEFECT]*

/  
*“QUICKLY”,*

/  
*“QUICKLY”,*

/  
*“QUICKLY”,*

**“ACCE”,**

**Interpol =**  
**/“FLAX”,**  
**/**  
**“NOT”,**  
**[DEFECT]**

**CRITERION =**  
**/“ABSOLUTE”,**  
**/**  
**“RELATIVE”, [DEFECT]**

**PRECISION**  
**=**  
**/**  
**prec,**  
**[R]**  
**/**  
**1.E-03, [DEFECT]**

)

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***Code\_Aster*** ®

***Version***

***7.4***

***Titrate:***

***Operator RECU\_GENE***

***Date:***

***08/02/05***

***Author (S):***

***E. BOYERE, J. PIGAT, Key LIGHT A.C.***

***:***

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***3 Operands***

***3.1 Operand***

***RESU\_GENE***

***RESU\_GENE = tg***

***Concept of the tran\_gene type contains for various moments of the generalized vectors of type displacement, speed or acceleration.***

***3.2 Operand***

***INST***

***INST = urgent***

***Moment for which one wishes to extract one or more generalized vectors.***

***3.3 Operand***

***NOM\_CHAM***

***NOM\_CHAM = nomcha***

*Character string indicating the reference symbol of (or of) the fields which one wishes to extract: “DEPL”, “QUICKLY” or “ACCE”.*

### **3.4 Operand Interpol**

**Interpol**

=

**“NOT”:**

*the extraction must be made stricto-sensu,*

**“FLAX”:**

*an interpolation is authorized between two fields: this interpolation can be unacceptable between two moments of filing which do not correspond to moments of consecutive calculations by DYNA-TRAN-MODAL [U4.53.21].*

### **3.5 Operand CRITERION**

**CRITERION**

=

*Indicate with which precision the research of the moment must be done*

**“ABSOLUTE”:**

*interval of research*

*[moment-prec, instant+ prec].*

**“RELATIVE”:** *interval of research*

*[(1-prec) .instant, (1+prec) .instant].*

### **3.6 Operand PRECISION**

**PRECISION = prec**

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**Code\_Aster** ®

Version

7.4

Titrate:

*Operator RECU\_GENE*

*Date:*

*08/02/05*

*Author (S):*

*E. BOYERE, J. PIGAT, Key LIGHT A.C.*

*:*

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***Code\_Aster*** ®

*Version*

*7.4*

*Titrate:*

*Operator EXTR\_RESU*

*Date:*

*31/01/05*

*Author (S):*

*J.P. LEFEBVRE, A.M. DONORE, G. Key NICOLAS*

*:*

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*Organization (S): EDF-R & D /AMA, SINETICS*

*Instruction manual*

*U4.7- booklet: Operations on the results and the fields*

*Document: U4.71.04*

*Operator EXTR\_RESU*

*1 Goal*

*To extract from the fields within a structure of data of the result type. The extraction leads to to reduce the obstruction of the structure of starting data, when the concept result is réentrant.*



*The reduction of the obstruction of the structure of data result is obtained by filing one left the fields which it contains. One can choose the fields to be filed is by indicating the fields to preserve, that is to say by indicating the fields to be excluded.*

*If the structure of data has the same name as the initial structure, fields not safeguarded are destroyed.*

*To recover the disk space indeed, it is necessary to use option **RETASSAGE** of order **FINE** (cf [U4.11.02]).*

*Réentrant operator.*

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*Code\_Aster* ®

*Version*

*7.4*

*Titrate:*

*Operator EXTR\_RESU*

*Date:*

*31/01/05*

*Author (S):*

*J.P. LEFEBVRE, A.M. DONORE, G. Key NICOLAS*

*:*

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*2 Syntax*

*RESUOUT = EXTR\_RESU (*

*reuse = RESUOUT,*

*RESULT*

*: RESUIN,/*

*[evol\_elas]*

*/*

**[dyna\_trans]**

/

**[dyna\_harmo]**

/

**[acou\_harmo]**

/

**[mode\_meca]**

/

**[mode\_acou]**

/

**[mode\_stat\_depl]**

/

**[mode\_stat\_acce]**

/

**[mode\_stat\_forc]**

/

**[evol\_ther]**

/

**[evol\_noli]**

/

**[mult\_elas]**

/

**[fourier\_elas]**

**SENSITIVITY = (... to see [U4.50.02]...),**

**ARCHIVAGE=\_F**

(

**/LIST\_ARCH**

=

**LIARCH**

,

**[listis]**

**/PAS\_ARCH = NOT**

,

**[I]**

**# selection**

**fields**

**/CHAM\_EXCLU = CHAMEXCLU**

**, [l\_Kn]**

/

**NOM\_CHAM**

=

**NOMCHAM,**

**[l\_Kn]**  
#  
*selection sequence numbers*

**/NUME\_ORDRE = LORDRE**

,  
**[l\_I]**  
/  
**LIST\_ORDRE =**  
**LENTI**  
,  
**[listis]**

/  
**NUME\_MODE**  
=  
**LMODE**

,  
**[l\_I]**  
/  
**NOEUD\_CMP**  
=  
**LNOECMP,**  
**[l\_K16]**

/  
**NOM\_CAS =**  
**NCAS**

,  
**[l\_K16]**

/  
/  
**FREQ**  
=  
**LFREQ**

,  
**[l\_R]**

/  
**LIST\_FREQ**  
=  
**LREEL**  
,  
**[listr8]**  
/  
**INST**  
=  
**LINST**  
,  
**[l\_R]**  
/  
**LIST\_INST**  
=  
**LREEL**  
,  
**[listr8]**

/ **PRECISION**  
=  
/  
**PREC**  
,  
**[R]**  
/  
**1.0D-3,**  
**[DEFECT]**

/ **CRITERION =/**  
**“RELATIVE”, [DEFECT]**  
/  
**“ABSOLUTE”,**  
)  
**TITRATE**

=

*titrate*

*[l\_Kn]*

)

*Instruction manual*

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**Code\_Aster** ®

Version

7.4

Titrate:

Operator EXTR\_RESU

Date:

31/01/05

Author (S):

**J.P. LEFEBVRE**, A.M. DONORE, G. Key NICOLAS

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### **3 Operands**

#### **3.1 Operand**

**RESULT**

*Structure of data of result starting. If REUSIN is different from RESUOUT, then RESUIN is not modified.*

#### **3.2 Operand**

**SENSITIVITY**

*SENSITIVITY = sensitive parameter list*

*Activate the selection of derived from the result compared to significant parameters.  
The document [U4.50.02] specifies the operation of the key word.*

#### **3.3 Key word**

*factor*

**FILING**

*Defines the fields to be safeguarded. This perhaps more repeated key word once. If it misses the entirety of the results is safeguarded.*

##### **3.3.1 Operands**

**LIST\_ARCH and PAS\_ARCH**

*Define the sequence numbers to safeguard.*

**LIST\_ARCH = LIARCH**; list sequence numbers obtained by order **DEFI\_LIST\_ENTI** [U4.34.02],  
**PAS\_ARCH**  
= **NOT**; safeguard results starting from the first, all the “steps” sequence numbers.

### 3.3.2 Operands

**CHAM\_EXCLU** and **NOM\_CHAM**

Defines the types of results which one does not wish to safeguard (**SIEF\_ELNO\_ELGA**,...) in function

type of the structure of data **RESULT RESUIN** in entry. To specify the fields that one do not wish to safeguard, one can:

.  
that is to say to list the fields to be preserved with operand **NOM\_CHAM**,

.  
that is to say to list the fields to be excluded with operand **CHAM\_EXCLU**.

If one of the fields to be retained does not form part of the structure of data result the code stops in fatal error. To consult the document [U5.01.01] and the following.

### 3.4 Operand

**TITRATE**

Titrate given to the structure of data **RESUOUT** created (cf [U4.03.01]).

### 3.5 Operands

**NUME\_ORDRE/LIST\_ORDRE/INST/LIST\_INST/FREQ/  
LIST\_FREQ/NUME\_MODE/NOEUD\_CMP/NOM\_CAS/PRECISION/  
CRITERION**

Selection in a structure of data result (cf [U4.71.00]).

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**Code\_Aster** ®

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7.4

**Titrate:**

## ***Operator EXTR\_RESU***

***Date:***

***31/01/05***

***Author (S):***

***J.P. LEFEBVRE, A.M. DONORE, G. Key NICOLAS***

***:***

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### ***4 Examples***

***Recopy in the structure of data FREQ2 of a mode on 8 of the structure of data FREQ.***

***FREQ = MODE\_ITER\_INV (MATR\_A= MATASSR, MATR\_B= MATASSM  
CALC\_FREQ= \_F (OPTION= "ADJUSTS",  
FREQ= (5. , 10. , 15. , 20. , 24. , 27. , 30. , 32. ,)),  
CALC\_MODE=\_F ("DIRECT" OPTION=))***

***FREQ2 = EXTR\_RESU (RESULT = FREQ,  
FILING = \_F (PAS\_ARCH = 8)  
)***

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***Code\_Aster ®***

***Version***

***7.4***

***Titrate:***

***Procedure EXTR\_TABLE***

***Date:***

***09/02/05***

***Author (S):***

***COURTEOUS Mr., J. Key PELLET***

***:***

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***Organization (S): EDF-R & D /AMA***

***Instruction manual***

***U4.7- booklet: Operations on the results and the fields***

***Document: U4.71.05***

***Procedure EXTR\_TABLE***

***1 Goal***

***To extract from a table a concept of the matr\_asse\_gene\_R type (generalized assembled matrix). This count was obtained by operator RECU\_TABLE (NOM\_TABLE = "MATR\_GENE"... ) from one concept result of operator CALC\_FLUI\_STRU.***

***Instruction manual***

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***Code\_Aster ®***

***Version***

***7.4***

***Titrate:***  
***Procedure EXTR\_TABLE***

***Date:***  
***09/02/05***

***Author (S):***  
***COURTEOUS Mr., J. Key PELLET***

***:***  
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***2 Syntax***

***resu = EXTR\_TABLE (***

***COUNT***

***=***  
***matable,***  
***[tabl\_\*]***

***# 1. Definition of the type of the result:***

***TYPE\_RESU***  
***= "MATR\_ASSE\_GENE\_R",***

***# 2. Selection of the cell to be extracted:***

***# 2.1 Selection of the column containing the cell to be extracted:***

***NOM\_PARA***

***=***  
***para,***  
***[KN]***

## # 2.2 Selection of the line containing the cell to be extracted:

***FILTER = ( \_F (NOM\_PARA***

***=***

***para***

***,***

***[KN]***

***/***

***CRIT\_COMP***

***=***

***/"EQ"***

***,***

***[DEFECT]***

***/"***

***,***

***/"LT"***

***,***

***/"WP"***

***,***

***/"IT"***

***,***

***/"GE"***

***,***

***/"VACUUM",***

***/"NON\_VIDE",***

***/"MAXIMUM",***

***/"ABS\_MAXI",***

***/"MINI",***

***/"ABS\_MINI",***

**# If CRIT\_COMP among EQ, LT, WP, IT, GE**

**/VALE\_I**

=

**ival,**

**[I]**

/

**VALE\_K**

=

**kval,**

**[KN]**

/

/

**VALE**

=

**rval,**

**[R]**

/

**VALE\_C**

=

**cval,**

**[C]**

/

**PRECISION**

=

/

**prec,**

**[R8]**

/

**1.0D-3**

,

**[DEFECT]**

/

**CRITERION =**

**/"RELATIVE", [DEFECT]**

/

**"ABSOLUTE"**

,

),),

**TITRATE**

=

**titrate,**

**[KN]**

)

**If TYPE\_RESU: “MATR\_ASSE\_GENE\_R” then resu  
of matr\_asse\_gene\_r type  
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**7.4**

**Titrate:**

**Procedure EXTR\_TABLE**

**Date:**

**09/02/05**

**Author (S):**

**COURTEOUS Mr., J. Key PELLET**

**:**

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**3 Operands**

**3.1 Operand**

**COUNT**

**COUNT = matable**

**One gives the name of the table of which one wants to extract the value from a cell.**

**3.2 Operand**

**TYPE\_RESU**

**TYPE\_RESU:**

**Type of the result created. For the moment, only “MATR\_ASSE\_GENE\_R” is available.**

**3.3 Operand**

**NOM\_PARA**

***NOM\_PARA = para***

***One gives the name of the parameter identifying the column containing the cell to be extracted.***

### ***3.4***

***To extract a cell; key word FILTERS***

***This key word factor (répétable at will) is used to select the line containing the cell to be extracted. The use of this key word is described in order IMPR\_TABLE [U4.91.03].***

### ***3.5 Operand***

***TITRATE***

***TITRATE = title***

***Titrate that one wants to give to the result of the order [U4.02.01].***

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***7.4***

***Titrate:***

***Procedure EXTR\_TABLE***

***Date:***

***09/02/05***

***Author (S):***

***COURTEOUS Mr., J. Key PELLET***

***:***

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***4 Examples***

***Example resulting from the case test sdll118a***

***One wishes to extract from table TT the matrix of mass generalized for a speed of fluid data:***

```
MG = EXTR_TABLE (TYPE_RESU = "MATR_ASSE_GENE_R",  
COUNT  
=  
TT,  
NOM_PARA  
=  
"MATR_MASS",  
FILTER  
=  
_F (NOM_PARA = "NUME_VITE",  
VALE_I  
=  
2  
),
```

***);***

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***Code\_Aster ®***

***Version***

***7.4***

***Titrate:***

***Operator COMB\_MATR\_ASSE***

***Date:***

***25/01/05***

***Author (S):***

***J. Key PELLET***

***:***



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**Organization (S): EDF-R & D /AMA**

**Instruction manual**

**U4.7- booklet: Operations on the results and the fields**

**Document: U4.72.01**

**Operator COMB\_MATR\_ASSE**

**1 Goal**

**To combine linearly, with real or complex coefficients, of the concepts of the *matr\_asse\_\** type.**

**This operator also allows to only carry out linear combinations while considering real or imaginary part of a matrix with complex coefficients (extraction of the real part or complex of a matrix).**

**All the concepts of the *matr\_asse\_\** type to be combined, must share same classification and it even mode of storage of assembled matrix, i.e. the two matrices will have been assemblies by operator *ASSE\_MATRICE* with the same concept argument for the key word *NUME\_DDL* (cf [U4.61.11]).**

**Product a structure of data of the *matr\_asse\_\** type.**

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**Code\_Aster ®**

**Version**

**7.4**

**Titrate:**

**Operator *COMB\_MATR\_ASSE***

**Date:**

**25/01/05**

**Author (S):**

**J. Key PELLET**

**:**

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**2 Syntax**

***cmass [matr\_asse\_\*] = COMB\_MATR\_ASSE***

**(/COMB\_R**

**= (\_F (**

**PART =/"REAL",**

**/**

**"IMAG"**

**,**

***MATR\_ASSE = m,/[matr\_asse\_DEPL\_R]***

**/**

*[matr\_asse\_TEMP\_R]*  
/  
*[matr\_asse\_PRES\_R]*  
/  
*[matr\_asse\_DEPL\_C]*  
/  
*[matr\_asse\_TEMP\_C]*  
/  
*[matr\_asse\_PRES\_C]*  
/  
*[matr\_asse\_GENE\_R]*  
/  
*[matr\_asse\_GENE\_C]*

*COEF\_R*  
=  
*R,*  
*[R]*

),),  
/  
*COMB\_C*  
= (*\_F* (  
*MATR\_ASSE = m,**[matr\_asse\_DEPL\_R]*  
/  
*[matr\_asse\_TEMP\_R]*  
/  
*[matr\_asse\_DEPL\_C]*  
/  
*[matr\_asse\_TEMP\_C]*

/

**[matr\_asse\_PRES\_R]**

/

**[matr\_asse\_PRES\_C]**

/

**[matr\_asse\_GENE\_R]**

/

**[matr\_asse\_GENE\_C]**

**/COEF\_R = R**

,

**[R]**

/

**COEF\_C**

=

**C,**

**[C]**

),),

/

**CALC\_AMOR\_GENE**

=

**\_F (**

/

***AMOR\_REDUIT***

=

***lr8***

,

***[l\_R]***

/

***LIST\_AMOR***

=

***lisr8,***

***[listr8]***

***MASS\_GENE***

=

***masgen,***

***[matr\_asse\_GENE\_R]***

***RIGI\_GENE***

=

***riggen,***

***[matr\_asse\_GENE\_R]***

),

***SANS\_CMP =***

***“LAGR”,***

)

***if COMB\_R and MATR\_ASSE: [matr\_asse\_DEPL\_R]***

***then [\*]***

***- > DEPL\_R***

***[matr\_asse\_TEMP\_R]***

**[\*]**

**- > TEMP\_R**

**[matr\_asse\_PRES\_R]**

**[\*]**

**- > PRES\_R**

**[matr\_asse\_DEPL\_C]**

**[\*]**

**- > DEPL\_R**

**[matr\_asse\_TEMP\_C]**

**[\*]**

**- > TEMP\_R**

**[matr\_asse\_PRES\_C]**

**[\*]**

**- > PRES\_R**

**[matr\_asse\_GENE\_R]**

**[\*]**

**- > GENE\_R**

**if COMB\_C and MATR\_ASSE: [matr\_asse\_DEPL\_R]**

**then [\*]**

**- > DEPL\_C**

**[matr\_asse\_TEMP\_R]**

**[\*]**

**- > TEMP\_C**

**[matr\_asse\_DEPL\_C]**

**[\*]**

**- > DEPL\_C**

**[matr\_asse\_TEMP\_C]**

**[\*]**

**- > TEMP\_C**

**[matr\_asse\_PRES\_R]**

**[\*]**

**- > PRES\_C**

**[matr\_asse\_PRES\_C]**

**[\*]**

**- > PRES\_C**

**if CALC\_AMOR\_GENE**

**:**

**[matr\_asse\_GENE\_R]**

**then [\*]**

**- > GENE\_R**

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**Code\_Aster** ®

**Version**

**7.4**

**Titrate:**

**Operator COMB\_MATR\_ASSE**

**Date:**

**25/01/05**

**Author (S):**

**J. Key PELLETT**

**:**

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**3 Operands**

**3.1 Word**

**key**

**COMB\_R**

**/COMB\_R**

**Description of the terms of the linear combination producing a matrix with real coefficients.**

**3.1.1 Operand**

**PART**

**PART**

**=/"REAL"**

**,**

**/**

**"IMAG"**

**,**

**To carry out extractions or linear combinations of part (S) imaginary (S) or real (S) of complex matrices.**

**3.1.2 Operand**

## ***MATR\_ASSE***

***MATR\_ASSE = m***

***Name of the concept matr\_asse\_\* to be combined.***

### ***3.1.3 Operand***

***COEF\_R***

***COEF\_R = R***

***Real coefficient to apply to the concept argument of MATR\_ASSE.***

### ***3.2 Word***

***key***

***COMB\_C***

***/COMB\_C***

***=***

***Description of the terms of the linear combination producing a matrix with coefficients complexes.***

#### ***3.2.1 Recall on the syntax of the complex values***

***The complex values can be declared in two different ways:***

***.***

***in the form  $+ I B$  with syntax  $I H$  has has,  $B$  where has and  $B$  are real numbers,***

***.***

***in the form (module, phase) with  $MP MOD$ ,  $pH$  where  $MOD$  and  $pH$  are real numbers ( $pH$  in degrees).***

#### ***3.2.2 Operand***

***MATR\_ASSE***

***MATR\_ASSE = m***

***Name of the concept matr\_asse\_\* to be combined.***

#### ***3.2.3 Operands***

***COEF\_R/COEF\_C***



***/COEF\_R = R***

***Real coefficient to apply to the concept argument of MATR\_ASSE.***

***/  
COEF\_C  
=  
C***

***Coefficient complexes to apply to the concept argument of MATR\_ASSE.***

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***Code\_Aster ®***

***Version***

***7.4***

***Titrate:***

***Operator COMB\_MATR\_ASSE***

***Date:***

***25/01/05***

***Author (S):***

***J. Key PELLET***

***:***

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***3.3 Word***

***key***

***CALC\_AMOR\_GENE***

***This key word makes it possible to build an object of the matr\_asse\_gene\_R type corresponding to the matrix***

***of damping of Basile starting from a list of reduced depreciation.***

***MASS\_GENE = masgen, RIGI\_GENE = riggen,***

***masgen and riggen are the 2 generalized matrices of mass and rigidity.***

***3.4 Operand***

***SANS\_CMP = "LAGR"***

***This operand causes to put in the "zero" terms of the assembled matrix result corresponding to the lines and the columns of the degrees of freedom of Lagrange.***

## ***4 Examples of use***

### ***4.1***

#### ***Traditional linear combination***

***mat\_rs = COMB\_MATR\_ASSE***

***(COMB\_C = (\_F (MATR\_ASSE = mat\_1, COEF\_R = 1.),  
\_F (MATR\_ASSE=  
mat\_2,  
COEF\_C=  
"IH",  
0.,1.,),),)***

)

***The concept produced mat\_rs is of the matr\_asse\_\*\_C type (complex):***

***mat\_rs = mat\_1 + I mat\_2***

### ***4.2***

#### ***Recopy of a concept of the matr\_asse\_\*\_R type***

***mat\_sauv = COMB\_MATR\_ASSE (COMB\_R = \_F (MATR\_ASSE = mat\_1, COEF\_R = 1.))***

### ***4.3 Difference***

*enter*

*COMB\_C and COMB\_R:*

*mat\_R = COMB\_MATR\_ASSE (COMB\_R = \_F (MATR\_ASSE = mat\_1, COEF\_R = 1.))*

*#*

*#*

*mat\_R*

*is with real coefficients*

*mat\_R*

*= mat\_1*

*#*

*mat\_C = COMB\_MATR\_ASSE (COMB\_C = \_F (MATR\_ASSE = mat\_1, COEF\_R = 1.))*

*#*

*#*

*mat\_C*

*is with complex coefficients, but the imaginary part is null*

*#*

*mat\_C*

*= mat\_1*

*+*

*I.*

*[0].*

#### *4.4*

*Extraction of the real part of a matrix of the matr\_asse\*\_C type*

*mat\_R = COMB\_MATR\_ASSE*

*(COMB\_R = \_F (*

*PART = "REAL",*

*MATR\_ASSE*

*=*

*mat\_C,*

*COEF\_R*

*=*

*1.*

*,*

),

)

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**Code\_Aster** ®

*Version*

7.4

*Titrate:*

*Operator COMB\_CHAM\_NO*

*Date:*

04/01/05

*Author (S):*

**X. DESROCHES, L. VIVAN** *Key*

:

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*Organization (S): EDF-R & D /AMA, CS IF*

***Instruction manual***

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***Document: U4.72.02***

***Operator COMB\_CHAM\_NO***

## ***1 Goal***

***To carry out the linear combination of fields to the nodes.***

***All the concepts of the cham\_no\_\* type to be combined must be based on same classification (order NUME\_DDL [U4.61.11]).***

***This operator also allows to carry out the recombination of modes of Fourier in a direction data (for displacements or temperatures).***

***The produced concept (cham\_no\_\*) can be réentrant.***

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***Version***

***7.4***

***Titrate:***

***Operator COMB\_CHAM\_NO***

***Date:***

***04/01/05***

***Author (S):***

***X. DESROCHES, L. VIVAN Key***

***:***

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## ***2 Syntax***

***cchno [cham\_no\_\*] = COMB\_CHAM\_NO***

***(  
reuse = cchno,***

***/COMB\_R = \_F (***

***PART =/"IMAG",***

***/***

***"REAL"***

**CHAM\_NO**

=

**CH**

,

/

**[cham\_no\_DEPL\_R]**

/

**[cham\_no\_TEMP\_R]**

/

**[cham\_no\_PRES\_R]**

/

**[cham\_no\_DEPL\_C]**

/

**[cham\_no\_TEMP\_C]**

/

**[cham\_no\_PRES\_C]**

**COEF\_R**

=

**R,**

**[R]**

),

/

**COMB\_C**

=

**\_F (**

**CHAM\_NO**

=

**CH**

,

**[cham\_no\_DEPL\_R]**

/

**[cham\_no\_DEPL\_C]**

/

**[cham\_no\_TEMP\_R]**

/

**[cham\_no\_TEMP\_C]**

/

**[cham\_no\_PRES\_R]**

/

**[cham\_no\_PRES\_C]**

/

**COEF\_R**

=

**R,**

**[R]**

/

**COEF\_C**

=

**C,**

**[C]**

),

/



**COMB\_FOURIER = \_F (**  
**CHAM\_NO = CH,**  
**/**  
**[cham\_no\_DEPL\_R]**  
**/**  
**[cham\_no\_TEMP\_R]**

**NUME\_MODE**  
**=**  
**N,**  
**[I]**

**TYPE\_MODE =/"SYME",**  
**/"ANTI"**  
**,**

**COEF\_R =**  
**/R**  
**, [R]**  
**/**

***1,***  
***[DEFECT]***

***),***

***ENG =, (in degrees)***

***[R]***

***)***

***if COMB\_R and CHAM\_NO: [cham\_no\_DEPL\_R]***  
***then [\*]***

***->***

***DEPL\_R***

***[cham\_no\_TEMP\_R]***

***[\*]***

***->***

***TEMP\_R***

***[cham\_no\_PRES\_R]***

***[\*]***

***->***

***PRES\_R***

***[cham\_no\_DEPL\_C]***

***[\*]***

***->***

***DEPL\_R***

***[cham\_no\_TEMP\_C]***

***[\*]***

***->***

***TEMP\_R***

**[cham\_no\_PRES\_C]**

**[\*]**

**->**

**PRES\_R**

**if COMB\_C and CHAM\_NO: [cham\_no\_DEPL\_R]**

**then [\*]**

**->**

**DEPL\_C**

**[cham\_no\_DEPL\_C]**

**[\*]**

**->**

**DEPL\_C**

**[cham\_no\_TEMP\_R]**

**[\*]**

**->**

**TEMP\_C**

**[cham\_no\_TEMP\_C]**

**[\*]**

**->**

**TEMP\_C**

**[cham\_no\_PRES\_R]**

**[\*]**

**->**

**PRES\_C**

**[cham\_no\_PRES\_C]**

**[\*]**

**->**

**PRES\_C**

**if COMB\_FOURIER and CHAM\_NO [cham\_no\_DEPL\_R]**

**then [\*]**

**->**

**DEPL\_R**

**[cham\_no\_TEMP\_R]**

**[\*]**

**->**

**TEMP\_R**

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## 7.4

***Titrant:***

***Operator COMB\_CHAM\_NO***

***Date:***

***04/01/05***

***Author (S):***

***X. DESROCHES, L. VIVAN Key***

***:***

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### 3 Operands

#### 3.1

***Recall on the syntax of the complex values***

***The complex values can be declared in two different ways:***

***.***

***in the form***

***+ ib with syntax  $IH$  has has,  $B$***

***where***

***has and  $B$  are real numbers.***

***.***

***in the form***

***(module, phase) with  $MP$   $MOD$ ,  $pH$***

***where***

***$MOD$  and  $pH$  are real numbers ( $pH$  in degree).***

#### 3.2 Word

***key***

***COMB\_R***

***/COMB\_R = \_F***

***Description of the terms of the linear combination producing a  $cham\_no\_*$  with coefficients realities.***

##### 3.2.1 Operand

***PART***

*PART =/“REAL”,  
/  
“IMAG”  
,*

*To carry out extractions or linear combinations of part (S) imaginary (S) or of part (S) real (S) of cham\_no complex.*

### **3.2.2 Operand**

**CHAM\_NO**

*CHAM\_NO = CH,*

*Name of the concept of the cham\_no\_\* type to be combined.*

### **3.2.3 Operand**

**COEF\_R**

*COEF\_R = R,*

*Real coefficient to apply to the concept argument of CHAM\_NO.*

## **3.3 Word**

*key*

**COMB\_C**

*/COMB\_C = \_F*

*Description of the terms of the linear combination producing a cham\_no\_\* with coefficients complexes.*

### **3.3.1 Operand**

**CHAM\_NO**

*CHAM\_NO = CH,*

*Name of the concept of the cham\_no\_\* type to be combined.*

### **3.3.2 Operands**

**COEF\_R and COEF\_C**

*/COEF\_R = R,*

*Real coefficient to apply to the concept argument of CHAM\_NO.*

*/  
COEF\_C  
=  
C,*

*Coefficient complexes to apply to the concept argument of CHAM\_NO.*

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### **3.4 Word**

**key**

**COMB\_FOURIER**

*/  
COMB\_FOURIER = \_F*

*Harmonic description by harmonic of the terms of the Fourier series with to combine. With an occurrence of the key word factor COMB\_FOURIER corresponds description supplements of a harmonic and only one.*

*The description of a harmonic comprises:*

.  
*the field of displacements (or temperatures) resulting from a preliminary resolution on the harmonic considered,*

.  
*the number of mode or number of the harmonic of FOURIER,*

.  
*the type of the harmonic (symmetrical or antisymmetric).*

### **3.4.1 Operand**

**CHAM\_NO**

$CHAM\_NO = CH,$

*Field of displacements (or temperatures) corresponding to harmonic N*

### **3.4.2 Operand**

**NUME\_MODE**

$NUME\_MODE = N,$

*Entirety indicating the number of the harmonic.*

### **3.4.3 Operand**

**TYPE\_MODE**

$TYPE\_MODE = /$ “SYME”, *symmetrical harmonic*

/

“ANTI”

,  
*antisymmetric harmonic*

### **3.4.4 Operand**

**COEF\_R**

*COEF\_R*

*=/R,*

*Multiplying coefficient associated the harmonic*

*/1. , (1 per defect in the standard recombination)*

**Recall:** *The recombination of FOURIER on displacements is written:*

*cosn*

*sin N*

*0*

*NR*

*0*

**U** (*)* =

*cosn*

**one** +

*N*

*S*

*sin N*

**U**

*has*

*N = 0*

*0*



-  $\sin N$

0

$\cos n$

14444 2

4 4444 3

4

1444 2

4

3

4444

*Have*

*Aa*

*with one*

*N*

*N*

*N*

*N*

*S = (S*

*U R, S*

*U Z, S*

*U) (in the same way for **ua**).*

*A symmetrical harmonic is thus recombined with the matrix *Have*, a harmonic antisymmetric with the *Aa* matrix.*

### **3.5 Operand**

**ENG**

*ENG = angle in degree of the section where the recombination of FOURIER takes place.*

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*Titrate:*

*Operator COMB\_CHAM\_NO*

*Date:*

*04/01/05*

*Author (S):*

*X. DESROCHES, L. VIVAN Key*

*:*

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## **4**

### ***Phases of checking/execution***

#### ***Phase of checking***

*It is checked that the “produced concept” is not an operand of entry of the operator.*

*In the case of the recombination of FOURIER, one checks that all the cham\_no to be recombined are of even standard (cham\_no\_DEPL\_R or cham\_no\_TEMP\_R).*

#### ***Production run***

*.*

*With the execution the operator checks before carrying out the linear combination, that the type of values of the result is compatible with the type of the values of the concepts cham\_no\_\* with to combine.*

*.*

*It also carries out the checks of coherence: arguments of the cham\_no\_\* type must have same classification.*

## **5 Examples**

### **5.1**

#### ***Traditional linear combination***

***Utot = COMB\_CHAM\_NO (COMB\_C = (\_F (CHAM\_NO = U1, COEF\_R = 1.),***

***\_F***

***(CHAM\_NO=U2,***

**COEF\_C=RI**

0.,  
1.),),

)

*The concept produces Utot is of cham\_no\*\_C type (complex):  $U_{tot} = U_1 + I U_2$*

*The Utot concept can be used again as concept produced for a news combination with U3 cham\_no\*\_R (real):*

**Utot = COMB\_CHAM\_NO**

*(reuse = Utot,*

**COMB\_C = (\_F (CHAM\_NO = Utot, COEF\_R = 1.),**

**\_F (CHAM\_NO**

=

**U3,**

**COEF\_R**

=

2.),),

)

*What produces:  $U_{tot} = U_{tot} + 2. U_3$*

**5.2**

**Recopy concept of the cham\_no type**

*This operator is also used for the recopy of a concept of the `cham_no_*` type:*

```
CH_sauv = COMB_CHAM_NO (COMB_R = _F (CHAM_NO = CH, COEF_R = 1.)
)
```

### **5.3** *Recombination of FOURIER in thermics*

*One calculates the recombination of FOURIER in = 0 of 2 symmetrical modes: mode 1 and mode 2.*

```
to
=
COMB_CHAM_NO
(COMB_FOURIER
=(
_F (CHAM_NO =TEMP1, NUME_MODE =1, TYPE_MODE = ' SYME'),
_F (CHAM_NO
=temp2, NUME_MODE
=2, TYPE_MODE
= ' SYME'),),
ENG
=
0.)
```

*Each field of temperature (temp1 and temp2) comes from a resolution on the mode corresponding.*

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*Titrate:*

*Operator COMB\_CHAM\_NO*

*Date:*

*04/01/05*

*Author (S):*

*X. DESROCHES, L. VIVAN Key*

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## 5.4 *Recombination of FOURIER in elasticity*

*dep45*  
=  
*COMB\_CHAM\_NO*  
*(COMB\_FOURIER*  
=(  
*\_F (CHAM\_NO =DEPIS, NUME\_MODE =1, TYPE\_MODE = ' SYME'),*

*\_F (CHAM\_NO*  
*=dep0a, NUME\_MODE*  
*=0, TYPE\_MODE*  
*= ' ANTI'),),*

*ENG*  
=  
*45.)*

*One recombines in = 45°:*

·  
*a harmonic resulting (for example) from a loading in uniform pressure mode 1 symmetrical,*

·  
*a harmonic resulting from a loading in pure torsion (antisymmetric mode 0).*

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*Code\_Aster* ®  
*Version*  
*7.4*

*Titrate:*

***Operator COMB\_CHAM\_ELEM***

***Date:***

***04/01/05***

***Author (S):***

***X. DESROCHES, L. VIVAN Key***

***:***

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***Organization (S): EDF-R & D /AMA, CS IF***

***Instruction manual***

***U4.7- booklet: Operations on the results and the fields***

***Document: U4.72.03***

***Operator COMB\_CHAM\_ELEM***

***1 Goal***

***To carry out the linear combination of fields to the elements.***

*All the concepts of the `cham_elem_*` type to be combined must be of the same structure (same lists groups of elements, to come from the same option of calculation).*

*This operator is also used to carry out the recombination of modes of Fourier in a direction data (for the strains and stresses in mechanics, flows in thermics).*

*The produced concept (`cham_elem_*`) can be réentrant.*

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*Operator COMB\_CHAM\_ELEM*

*Date:*

*04/01/05*

*Author (S):*

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*:*

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## *2 Syntax*

*chml*

*[`cham_elem_*`] = COMB\_CHAM\_ELEM*

*(*

*reuse = chml,*

*/COMB\_R=\_F (CHAM\_ELEM= CH,/[`cham_elem_SIEF_R`]*

*/*

*[`cham_elem_FLUX_R`]*

*/*

*[`cham_elem_EPSI_R`]*

*/*

*[cham\_elem\_ENER\_R]*

/

*[cham\_elem\_CRIT\_R]*

/

*[cham\_elem\_DBEL\_R]*

/

*[cham\_elem\_PRES\_R]*

/

*[cham\_elem\_SIEF\_C]*

*COEF\_R=*

*R*

,

*[R]*

*“REAL” PARTIE=*

*, [K]*

/

*“IMAG”*

,

*),*

/

*COMB\_C*

*=\_F (*

*CHAM\_ELEM*

*=*

*CH,*



/

*[cham\_elem\_SIEF\_R]*

/

*[cham\_elem\_SIEF\_C]*

/

*COEF\_R=*

*R*

,

*[R]*

/

*COEF\_C=*

*C*

,

*[C]*

),

/

*COMB\_FOURIER*

*=\_F (CHAM\_ELEM = CH,*

*/[cham\_elem\_SIEF\_R]*

/

*[cham\_elem\_FLUX\_R]*

/

*[cham\_elem\_EPSI\_R]*

*NUME\_MODE=*

*nume,*  
*[I]*

*TYPE\_MODE=/"SYME", [K]*

*/"ANTI",*

*COEF\_R=/  
R  
,  
[R]*

/ 1.,

[DEFECT]

),

ENG

=

Eng

[R]

)

if COMB\_R and CHAM\_ELEM

:

[cham\_elem\_SIEF\_R]

then [\*]

- > SIEF\_R

[cham\_elem\_FLUX\_R]

[\*]

- > FLUX\_R

[cham\_elem\_EPSI\_R]

[\*]

- > *EPSI\_R*  
[*cham\_elem\_ENER\_R*]  
[\*]  
- > *ENER\_R*  
[*cham\_elem\_CRIT\_R*]  
[\*]  
- > *CRIT\_R*  
[*cham\_elem\_DBEL\_R*]  
[\*]  
- > *DBEL\_R*  
[*cham\_elem\_PRES\_R*]  
[\*]  
- > *PRES\_R*  
[*cham\_elem\_SIEF\_C*]  
[\*]  
- > *SIEF\_R*

*if COMB\_C and CHAM\_ELEM*

*:*  
[*cham\_elem\_SIEF\_R*]  
*then* [\*]  
- > *SIEF\_C*  
[*cham\_elem\_SIEF\_C*]  
[\*]  
- > *SIEF\_C*

*if COMB\_FOURIER and CHAM\_ELEM:*

[*cham\_elem\_SIEF\_R*] *then* [\*]  
- > *SIEF\_R*  
[*cham\_elem\_FLUX\_R*]  
[\*]  
- > *FLUX\_R*  
[*cham\_elem\_EPSI\_R*]  
[\*]  
- > *EPSI\_R*

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**Code\_Aster** ®

*Version*

7.4

*Titrate:*

*Operator COMB\_CHAM\_ELEM*

*Date:*

*04/01/05*

*Author (S):*

*X. DESROCHES, L. VIVAN Key*

*:*

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### *3 Operands*

#### *3.1*

*Recall on the syntax of the complex values*

*The complex values can be declared in two different ways:*

*.*

*in the form*

*+ ib with syntax IH has has, B*

*where*

*has and B are real numbers.*

*.*

*in the form*

*(module, phase) with MP modulates, phase*

*where*

*modulate and phase are real numbers (phase in degree).*

#### *3.2 Word*

*key*

*COMB\_R*

*/COMB\_R = \_F*

*Description of the terms of the linear combination producing a cham\_elem\_\* with coefficients realities.*

*CHAM\_ELEM = CH,*

*Name of the concept of the cham\_elem\_\* type to be combined.*

***COEF\_R = R,***

***Real coefficient to apply to the CH concept.***

***PART***

***=***

***In the case of complex CHAM\_ELEM, one takes the real or imaginary part.***

***3.3 Word***

***key***

***COMB\_C***

***/COMB\_C = \_F***

***Description of the terms of the linear combination producing a cham\_elem\_\* with values complexes.***

***CHAM\_ELEM = CH,***

***Name of the concept of the cham\_elem\_\* type to be combined.***

***/COEF\_R = R,***

***Real coefficient to apply to the CH concept.***

***/***

***COEF\_C***

***=***

***C,***

***Coefficient complexes to apply to the concept argument of CHAM\_ELEM.***

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7.4

Titrate:

Operator **COMB\_CHAM\_ELEM**

Date:

04/01/05

Author (S):

**X. DESROCHES, L. VIVAN** Key

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**3.4 Word**

**key**

**COMB\_FOURIER**

/

**COMB\_FOURIER = \_F**

*Recombination of FOURIER with harmonic description by harmonic of the terms of Fourier series.*

*In **elasticity**, recombination of FOURIER on the deformations (resp. constraints) is written:*

*L I4*

*04,2*

*sinl I4*

*04,2*

*() =*

*cos*

*S +*

*has*

*L*

$0$   
 $\sin L I$   
 $0$   
 $\cos l I$   
 $L$

$L L$   
 $-$

$2,4$   
 $2$

$2,4$   
 $2$

where  $L$  is the whole of the modes (symmetrical and/or antisymmetrical) which were calculated.

$I_n$  is the matrix identity of order  $N$ ,

$sl$ :  $L$  is the number of the harmonic ( $S$  for symmetrical),

$Al$ :  $L$  is the number of the harmonic ( $has$  for antisymmetrical),

$l$ : angle of the section where the deformations (resp are calculated. constraints).

In the formula above, all the coefficients  $R$  are worth 1. (standard case).

In **thermics**, the recombination of **FOURIER** on flows is written:

$L I_2$   
 $02,1$   
 $\sin l I_2$   
 $02,1$

$() =$

$\cos$

$S +$   
 $has$   
 $L$



$0$   
 $\sin L$   
 $0$   
 $\cos l$   
 $L$

$L L$

-

,

$1 2$

,

$1 2$

*with the same notations as above.*

### **3.4.1 Operand**

**CHAM\_ELEM**

$CHAM\_ELEM = CH,$

*Name of the concept of the  $cham\_elem\_*$  type to be recombined.*

### **3.4.2 Operand**

**COEF\_R**

$COEF\_R = R,$

*Real coefficient to apply to the harmonic considered (by defect 1.)*

### **3.4.3 Operand**

**NUME\_MODE**

*NUME\_MODE = nume,*

*Number of the harmonic.*

### **3.4.4 Operand**

**TYPE\_MODE**

*TYPE\_MODE = /“SYME”,*

*/*  
*“ANTI”,*

*Symmetrical or Antisymmetric harmonic.*

### **3.5 Operand**

**ENG**

*ENG = Eng,*

*Angle in degree where the recombination of FOURIER takes place.*

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Version

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Titrate:

Operator *COMB\_CHAM\_ELEM*

Date:

04/01/05

Author (S):

**X. DESROCHES, L. VIVAN** Key

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**4**

## ***Phases of checking/execution***

### ***Phase of checking***

*It is checked that the “produced concept” is not an operand of entry of the operator.*

### ***Production run***

.

*With the execution the operator checks before carrying out the linear combination, that the type of values of the result is compatible with the type of the values of the concepts *cham\_elem\_\** with to combine.*

.

*The checks of coherence are also carried out: arguments of the *cham\_elem\_\** type must have same the ligrels, i.e. to be calculated on the same lists of groups of elements.*

## ***5 Examples***

### ***5.1***

#### ***Traditional linear combination***

***Utot = COMB\_CHAM\_ELEM (COMB\_C = (\_F (CHAM\_ELEM= U1, COEF\_R =1.),  
\_F (CHAM\_ELEM  
=U2,***

**COEF\_C****=RI**

0.,

1.),),

)

***The concept produces Utot is of cham\_elem\_\*\_C type (complex):***

**$$U_{tot} = U1 + I U2$$**

***The Utot concept can be used again as concept produced for a new combination with U3 cham\_elem\_\*\_R (real):******Utot = COMB\_CHAM\_ELEM (reuse = Utot,******COMB\_C = (\_F******(CHAM\_ELEM = Utot, COEF\_R = 1.),******\_F******(CHAM\_ELEM******=******U3,*****COEF\_R****=****2.),),**

)

***What produces:***

**$$U_{tot} = U_{tot} + 2. U3$$**

## 5.2

### *Recopy concept of the cham\_lem type*

```
CH_sauv = COMB_CHAM_ELEM (COMB_R = _F (CHAM_ELEM = CH, COEF_R = 1.)  
)
```

## 5.3

### *Recombination of FOURIER in elasticity*

```
sig45 = COMB_CHAM_ELEM  
(COMB_FOURIER=  
(_F  
(CHAM_ELEM = sig1,  
NUME_MODE  
=  
1,  
TYPE_MODE  
=  
“SYME”  
),
```

```
_F  
(CHAM_ELEM = sig2,  
NUME_MODE  
=  
0,  
TYPE_MODE  
=  
“ANTI”  
),  
ANGLE  
=  
45.,
```

)

*One calculates the recombination of FOURIER of a stress field for the section = 45. of one harmonic resulting from a loading symmetrical mode 1 and a harmonic resulting from one loading in pure torsion (antisymmetric mode 0).*

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*5.4*

*Recombination of FOURIER in thermics*

*flux0 = COMB\_CHAM\_ELEM*

*(COMB\_FOURIER=*

*(\_F*

*(CHAM\_ELEM = flux1,*

*NUME\_MODE*

*=*

*1,*

*TYPE\_MODE*

*=*

*“SYME”*

,),

***\_F***  
***(CHAM\_ELEM = flux2,***  
***NUME\_MODE***  
***=***  
***2,***  
***TYPE\_MODE***  
***=***  
***“SYME”***  
***,),***  
***ANGLE***  
***=***  
***0.,***

)

***One calculates the recombination of FOURIER for the section = 0. of 2 symmetrical modes: mode 1 and mode 2.***

***Each field of flow (flux1 and flux2) comes from a resolution on the mode considered.***

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***J. Key PELLET***

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***Organization (S): EDF-R & D /AMA***

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***Document: U4.72.04***

***Operator CREA\_CHAMP***

***1 Goal***

***To create a field of the cham\_no type, chart or cham\_elem. One can create a field:***



.  
*by assignment of values on nodes or meshes,*

.  
*by assembling (and/or combining) pieces of existing fields,*

.  
*by evaluating the functions of a field of functions to make a field of realities of it,*

.  
*by modifying the geometrical representation of a field (passage nodes <-> points of Gauss for example),*

.  
*by extracting a field from a SD of the type SD\_RESULTAT (evol\_ther, evol\_noli, mode\_meca,...).*

*One can also be useful oneself of this order to combine several fields linearly (also possible functionality with orders COMB\_CHAM\_NO and COMB\_CHAM\_ELEM), but one can make “complicated” combinations more: multiplication of fields...*

*Product a SD of the cham\_no\_\* type or carte\_\* or cham\_elem\_\**

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## **2 Syntax**

**ch2 [\*] = CREA\_CHAMP**

(

**TYPE\_CHAM =**  
**/“NOEU\_xxx”,**  
**/“CART\_xxx”,**

**/“ELNO\_xxx”**  
**,**  
**/“ELGA\_xxx”,**  
**/“ELEM\_xxx”,**

**# to impose the classification of the ddls CHAM\_NO result:**

**/NUME\_DDL = naked, [nume\_ddl]**  
**/**  
**CHAM\_NO**  
**=**  
**cnonu**  
**, [cham\_no\_\*]**

**TITRATE**  
**= title**  
**,**  
**[l\_Kn]**  
**INFORMATION**  
**= /1**  
**,**  
**[DEFECT]**

**/2 ,**

**/OPERATION**  
**=**  
**“AFFE”**

,  
#

=====

/  
**GRID**  
=

*my*  
,  
*[grid]*

**/MODEL**  
=

*Mo*  
,  
*[model]*

**OPTION**  
=

*option*  
,  
*[KN]*

**PROL\_ZERO**  
=

/  
“NOT”  
, [DEFECT]  
/  
“YES”  
,

**AFFE=**  
**(\_F**  
**(**  
  
/  
**ALL**

=  
“YES”,  
/  
/  
**GROUP\_MA**  
=  
**grma**

,  
**[l\_grma]**  
/  
**NET**  
=  
**net**

,  
**[l\_maille]**  
/  
**GROUP\_NO**  
=  
**grno**

,  
**[l\_grno]**  
/  
**NODE**  
=  
**node**  
,

**[l\_noeud]**

**NOM\_CMP =**

**lcmp**

,  
**[l\_K8]**

/  
**VALE**

=  
**lvaler**

,  
**[l\_R]**

/  
**VALE\_I**

=  
**lvalei**

,  
**[l\_I]**

/  
**VALE\_C**

=  
**lvalec**

,  
**[l\_C]**

/  
**VALE\_F**

=  
**lvalef**

,

/  
[l\_fonction]  
/  
[l\_formule]  
,),

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/  
**OPERATION**  
=  
“ADZE”  
,

#####

/  
**GRID**  
=

**my**

,  
**[grid]**

**/MODEL**

=

**Mo**

,  
**[model]**

**OPTION**

=

**option**  
**[KN]**

**PROL\_ZERO**

=

/  
**“NOT”**

,  
**[DEFECT]**

/  
**“YES”**

,

**ASSE=**

**(\_F**  
**(**

/  
**(**

**ALL**

=

**“YES”,**

/

/

**GROUP\_MA**

=

**grma**

,

**[l\_grma]**

/

**NET**

=

**net**

,

**[l\_maille]**

/

**GROUP\_NO**

=

**grno**

,

**[l\_grno]**

/

**NODE**

=

**node**

,

**[l\_noeud]**

**CHAM\_GD**

= **ch1,**

**[champ\_\*]**



*NOM\_CMP =  
lcmp  
,*  
*[l\_K8]*

*NOM\_CMP\_RESU = lcmp\_resu,  
[l\_K8]*

*/OFFICE PLURALITY  
=*

*“NOT”  
,*  
*[DEFECT]*

*/OFFICE PLURALITY  
=*

*“YES”*

**COEF\_R**

=

/

**1.**

**, [DEFECT]**

/

**coef,**

**[R]**

**),)**

/

**OPERATION**

=

**“EVAL”**

**,**

**#**

=====

**CHAMP\_F =**

**ch\_fonc,**

**/**

**[cham\_no\_NEUT\_F]**

**/**

**[cham\_elem\_NEUT\_F]**

**CHAMP\_PARA=**

**will l\_ch\_para**

**,**

**[l\_champ\_\*]**

**/OPERATION =**

**“DISC”,**

**#**

=====

**# if the field result is a CHAM\_ELEM:**

**MODEL**

**=**

**Mo**

**,**

**[model]**

**OPTION**

=

*option*

*[KN]*

*PROL\_ZERO*

=

/

*“NOT”*

,

*[DEFECT]*

/

*“YES”*

,

*CHAM\_GD =*

*ch1*

,

*[champ\_\*]*

/

*OPERATION =*

*“EXTR”,*

*#*

=====

*# extraction of the field of geometry of a grid:*

/

*GRID*

= *my*  
,  
*[grid]*

*NOM\_CHAM* =  
“*GEOMETRY*”,

*# extraction in a table:*

/

*COUNT*  
=  
*tabl*  
,  
*[table]*

*# extraction of the “level set” of a SD fin\_xfem:*

/

*FISSURE*  
=  
*xfem*  
,  
*[fin\_xfem]*

*NOM\_CHAM* =  
/“*LTNO*”,

/  
"LNNO"  
,  
/  
"GRLTNO"  
,  
/  
"GRLNNO"

,  
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*# extraction of a field of a SD\_RESULTAT:*

/  
*RESULT =*  
*resu,*

*NOM\_CHAM =*

/“ACCE”,

/

...

(cf.

[\$7.1]),

***SENSITIVITY***

=

/

***theta,***

***[theta\_geom]***

/

***para***

,

***[para\_sensi]***

***/# Selection of a sequence number in the SD\_RESULTAT***

/

***NUME\_ORDRE =***

***nuordr***

,

***[I]***

/

***NUME\_MODE***

=

***numode***

,

***[I]***

/

***NOEUD\_CMP***

=

***(node, cmp),***

***[l\_K8]***

/

**NOM\_CAS =**

***nocas,***

**[KN]**

**/**

***ENG***

**=**

**,**

**[R]**

**/**

**/**

***INST***

**=**

***inst,***

**[R]**

**/**

***FREQ***

**=**

***freq,***

**[R]**

**/ PRECISION**

**= /**

***prec***

**, [R]**

**/**

***1.D-3,***

**[DEFECT]**

**/**



**CRITERION =**

/

**“RELATIVE”**

,

**[DEFECT]**

/

**“ABSOLUTE”**

,

/

**Interpol**

=

/

**“NOT”,**

**[DEFECT]**

/

**“FLAX”,**

***/# Calculation of a field containing the “extrema” of one  
SD\_RESULTAT***

**TYPE\_MAXI =/“MAXIMUM”,**

/

**“MINI”**

,

/

**“MAXI\_ABS”**

,

/

**“MINI\_ABS”**

,

/

**“NORM\_TRAN”**

***TYPE\_RESU***

=

/

***“VALE”***

,

***[DEFECT]***

/

***“INST”***

,

***/TOUT\_ORDRE***

=

***“YES”***

,

***[DEFECT]***

/

***LIST\_INST***

=

***linst***

,

***[listr8]***

/

***LIST\_FREQ***

=

***lfreq***

,

***[listr8]***

**/ PRECISION =/prec,  
[R]**

**/  
1.0E-3,  
[DEFECT]**

**/  
CRITERION =/"ABSOLUTE",**

**/  
"RELATIVE"  
, [DEFECT]**

**);**

**If  
TYPE\_CHAM  
=  
"NOEU\_TEMP\_R"**

***then [\*]***  
***= CHAM\_NO\_TEMP\_R***  
***“NOEU\_DEPL\_R”***  
***CHAM\_NO\_DEPL\_R***  
...

***“CART\_TEMP\_R”***  
***CARTE\_TEMP\_R***

***“CART\_DEPL\_R”***  
***CARTE\_DEPL\_R***  
...

***“ELNO\_DEPL\_R”***  
***CHAM\_ELEM\_DEPL\_R***  
...

***“ELGA\_DEPL\_R”***  
***CHAM\_ELEM\_DEPL\_R***  
...

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### **3 Operands**

#### **3.1**

#### **Operands Generals**

##### **3.1.1 Operand**

**TYPE\_CHAM, assignment of a type to the field result**

**This key word (obligatory) is initially used to typify (within the meaning of the supervisor of Aster) the field result of order. It is made of 2 “words” connected by a “underlined white” ( \_):**

**TYPE\_CHAM= “” where:**

**/“NOEU”**

**Field with the nodes**

**(CHAM\_NO\_\*)**

**/**

**“CART”**

**Constant field by mesh**

**(CARTE\_\*)**

/

**“ELNO”**

*Field by elements with the nodes*

**(CHAM\_ELEM\_\*)**

/

**“ELGA”**

*Field by elements at the points of Gauss (CHAM\_ELEM\_\*)*

/

**“ELEM”**

*Constant field by element*

**(CHAM\_ELEM\_\*)**

**GD=**

/

**“DEPL\_R”**

*displacement*

/

**“SIEF\_R”**

*constraint*

/

**“TEMP\_R”**

*temperature*

/

**“FLUX\_R”**

*flow*

/

...

*The type of the field result is entirely deduced from this information given by the user. By example:*

**TYPE\_CHAM=**

**“NOEU\_DEPL\_R”**

->

**CHAM\_NO\_DEPL\_R**

**TYPE\_CHAM=**

**“CART\_SIEF\_R”**

->

**CARTE\_SIEF\_R**

**TYPE\_CHAM=**

**“ELNO\_EPSI\_R”**

->

**CHAM\_ELEM\_EPSI\_R**

**TYPE\_CHAM=**

**“ELGA\_VARI\_R”**

->

**CHAM\_ELEM\_VARI\_R**

*This key word is also used to specify (for the order) which must be the nature of the field wanted in result. It is essential for the operations “AFFE”, “ADZE” and “DISC”.*

*Examples:*

**OPERATION= “AFFE” + TYPE\_CHAM= “CART\_DEPL\_R”**

**=> a CHART of DEPL\_R.**

**OPERATION= “ADZE” + TYPE\_CHAM= “NOEU\_EPSI\_R”**

**=> a CHAM\_NO of EPSI\_R.**

**OPERATION= “DISC” + TYPE\_CHAM= “NOEU\_SIEF\_R”**

**=> a CHAM\_NO of SIEF\_R.**

*There are only two operations for which this key word is an useless constraint (but obligatory!) for user (OPERATION=' EVAL' and OPERATION=' EXTR') bus for these two operations, nature of the field result is imposed by the choice of the operation.*

*The information of key word TYPE\_CHAM is (unfortunately) tiresome for*

*OPERATION=' EXTR'. It results from key word NOM\_CHAM. The correspondence is given in [§3.7.1].*

*Important remark*

*The possibility of creating cham\_elem of any size is conditioned by the state of development (data-processing) of the types of finite elements of the model. All is not yet possible; for example, to create a cham\_elem FLUX\_R on a model containing them elements DKT, it is necessary that this finite element envisaged to do it (what is not the case today).*

*One cannot give here the precise list of the sizes allowed for each type of finite element. One will be satisfied to say roughly:*

.

*for the isoparametric elements of mechanics, the sizes are allowed: GEOM\_R, INST\_R, NEUT\_R, NEUT\_F, EPSI\_R, SIEF\_R, VARI\_R, DOMMAG and HYDR\_R,*

•  
*for the isoparametric elements of thermics, the sizes are allowed: GEOM\_R, INST\_R, NEUT\_R and NEUT\_F.*

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### *3.1.2 Words*

*key*

*NUME\_DDL and CHAM\_NO*

*These two key words make it possible to impose a classification for the field result (if this one is one CHAM\_NO). One gives via these key words a “model” of classification for the field result.*

*If naked NUME\_DDL= is given, one will take as classification that of naked. This possibility is not valid that for the fields of displacements (“MECHANICAL” phenomenon) or for fields of temperature (“THERMAL” phenomenon) or of the fields of acoustic pressure (phenomenon “ACOUSTIC”).*

*If CHAM\_NO= chno is given, the numeration of chno will be taken.*

*Notice on the disk space used:*

*Sometimes these 2 key words make it possible to save much place on the “Total” basis.*

*When for example, one extracts from many cham\_no of a SD RESULT, if one does not use one of these key words, one duplicates the profile of the field for each one of them. If one uses one of these 2 key words, all these fields will be based on the profile contained in chno (or naked).*



### 3.1.3 Operand

**TITRATE = titr**

*Titrate that one wants to give to the field result [U4.03.01].*

### 3.1.4 Operand

**INFORMATION = /1 /2**

**INFORMATION = 1**

*No impression.*

**INFORMATION = 2**

*Impression on the file "MESSAGE" of the field result.*

### 3.2 Operand

**OPERATION = /"AFFE"/"ADZE"/"EVAL"/"DISC"  
/"EXTR"**

*This operand is used to choose the "mode" of manufacture of the field result. One can create a field:*

- .  
*by assignment of values on nodes or meshes (OPERATION=' AFFE'),*
- .  
*by assembling pieces of fields defined on pieces of grids (OPERATION=' ASSE'),*
- .  
*by modifying the geometrical representation (discretization) of a field (passage nodes <-> points of Gauss for example) (OPERATION=' DISC'),*
- .  
*by extracting a field from a SD of the type SD\_RESULTAT (evol\_ther, evol\_noli, mode\_meca,...) (OPERATION=' EXTR').*
- .  
*by combining linearly fields (OPERATION=' ASSE'),*
- .  
*in "combining" (multiplication, exponential,...) fields (OPERATION=' EVAL'),*
- .  
*by evaluating the functions of a field of functions to make a field of realities of it (OPERATION=' EVAL'),*

### 3.3 Operands

*for*

**OPERATION = "AFFE"**

*This operation makes it possible to affect values (real, whole, complex or function) on entities geometrical (nodes or meshes) of a grid.*

*The size associated with the field is implicitly given by key word TYPE\_CHAM (above).*

### **3.3.1 Operand GRID = netted**

*When one creates a CHAM\_NO or a CHART, it is necessary to specify on which grid this field will be based.*

*For that, one uses the key word GRID.*

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### **3.3.2 Operands MODELS = model OPTION = option PROL\_ZERO =/"YES" /"NOT"**

*When a CHAM\_ELEM is created, it is necessary to specify on which finite elements the field will be defined. For that, one uses the MODEL key word.*

*To describe the structure of a CHAM\_ELEM, it is not enough to give (via the MODEL) a type of element*

*for each mesh, because a type of element can know several "forms" of CHAM\_ELEM for one size given. To create the desired field, the user can use the key word OPTION. If by example, it writes: X= CREA\_CHAMP (... MODELE=mo, OPTION=' SIEF\_ELGA\_DEPL',...), it field created by CREA\_CHAMP will have the same form that if it had been calculated by CALC\_ELEM/*

*OPTION=' SIEF\_ELGA\_DEPL'. If the user does not employ the key word OPTION, CREA\_CHAMP will choose*

*(if it can it) a form by defect.*

*In a CHAM\_ELEM, all the elements of the same type (even standard of mesh and even modeling) must obligatorily have the same components. If the field result is incompletely described (if there are not affected all the meshes), it is necessary to authorize (possibly) the order CREA\_CHAMP “to prolong” the field by “zero” where it was not described. It is the object of the key word PROL\_ZERO.*

*If PROL\_ZERO = “NOT” (defect)  
If elements are incomplete, one stops in fatal error.*

*If PROL\_ZERO = “YES”  
One prolongs the field incompletely described by “0.”*

### **3.3.3 Key word factor AFFE**

*The other operands are gathered under the key word factor AFFE. This key word is répétable. principle of overload is applied between the various occurrences of key word AFFE: if an entity geometrical is affected several times, the last assignment carries it.*

### **3.3.4 Operands**

**TOUT=' OUI', GROUP\_MA, GROUP\_NO, MESH and NODE**

*The geometrical entities that one wants to affect are given by operands TOUT=' OUI', GROUP\_MA, GROUP\_NO, MESH and NODE.*

*If TYPE\_CHAM=' NOEU\_xxx', one affects nodes; the use of operands GROUP\_MA and MESH is possible and means that one affects all the nodes of the specified meshes.*

*If TYPE\_CHAM: “EL. \_xxx” (or “CART\_xxx”), one affects meshes; the use of the operands GROUP\_NO and NODE are then prohibited.*

### **3.3.5 Operand**

**NOM\_CMP**

*The names of the components which one wants to affect are given by operand NOM\_CMP.*

### **3.3.6 Operands**

**VALE, VALE\_I, VALE\_C or VALE\_F**

*The values to be affected are given by operands VALE, VALE\_I, VALE\_C or VALE\_F according to nature (reality, entirety, complex, function (or formulates)) components of size (DEPL\_R: reality, DEPL\_C: complex, TEMP\_F: function/formula,....).*

### **3.3.7 Examples**

*Creation of a field to the nodes of displacement. One wants to impose the classification of the field (that of cnomod):*

*DEPL1 = CREA\_CHAMP (OPERATION= "AFFE",*

*TYPE\_CHAM=' NOEU\_DEPL\_R', GRID = MA*

*, CHAM\_NO= CNOMOD,*

*AFFE=*

*(\_F (TOUT=' OUI',*

*NOM\_CMP= ("DX", "DY", "DZ"),*

*VALE= (0.0.0.),),*

*\_F (GROUP\_MA= (GM1, GM2), NOM\_CMP= "DX", VALE= 3.5d-2),*

*\_F (NOEUD= (n5, n7, n9), NOM\_CMP= "DY", VALE= 1.6d-2),*

)

)

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**Creation of a chart of temperature (functions):**

**TEMPF = CREA\_CHAMP (OPERATION= “AFFE”,**

**TYPE\_CHAM=' CART\_TEMP\_F', GRID = MA,**  
**AFFE= (**  
**\_F (**  
**TOUT=' OUI',**  
**NOM\_CMP= (“TEMP”), VALE\_F=**  
**F1),**  
**\_F (**  
**GROUP\_MA= (GM1, GM2), NOM\_CMP= (“TEMP”**  
**), VALE\_F=**  
**F2),)**  
**)**

### **3.4 Operands**

**for**  
**OPERATION = “ADZE”**

#### **3.4.1 General**

**This operator “assembles” “pieces of fields” to manufacture new. Each occurrence of the key word ADZE defines a piece of field. One calls a piece of field, restriction of an existing field (chart/cham\_no or cham\_elem) on a whole of entities geometrical (meshs or nodes) and on a whole of components.**

**There is a principle of overload of the occurrences of the key word ADZE if the pieces overlap them ones others.**

**Currently, one can manufacture:**

**.**  
**a cham\_no by assembling pieces of cham\_no.**

**.**  
**a cham\_elem by assembling pieces of cham\_elem and/or charts.**

**The operation “ADZE” also makes it possible to change the size associated with a field; for example**

*to transform a field of deformation (EPSI\_R) into stress field (SIEF\_R). For that it is necessary to use key words NOM\_CMP and NOM\_CMP\_RESU.*

*The assembly of the pieces of fields can be done by cumulating the pieces (key words OFFICE PLURALITY and COEF\_R). That makes it possible to use this order to make linear combinations of CHAM\_NO or of CHAM\_ELEM.*

### **3.4.2 Operands**

**GRID, MODEL and PROL\_ZERO**

*Even use that for OPERATION= "AFFE" [§3.3.1] and [§3.3.2].*

### **3.4.3 Operands for the key word factor ADZE**

*Each occurrence of the key word factor ADZE makes it possible to define a piece of field that one assemble in the field result.*

#### **3.4.3.1 Operand**

**CHAM\_GD = ch1**

*ch1 is the field (existing) with which one wants to manufacture a piece of field.*

#### **3.4.3.2 Operands**

**TOUT=' OUI', GROUP\_MA, GROUP\_NO, MESH and NODE**

*These operands are used to define the geometrical restriction of the field ch1. If ch1 is a CHAM\_NO, one can use all these operands. If ch1 is a CHAM\_ELEM (or a CHART), one cannot use the operands GROUP\_NO and NODE.*

#### **3.4.3.3 Operands**

**NOM\_CMP and NOM\_CMP\_RESU**

*Operand NOM\_CMP is used to define the components on which one wants to restrict the field ch1. If NOM\_CMP misses, all the components of ch1 are taken.*

*Operand NOM\_CMP\_RESU is used to re-elect (if it is wished) the components of ch1. If NOM\_CMP\_RESU is provided, NOM\_CMP must be it also and the two lists in correspondence must be of the same length.*

*Example 1: to transform a field of EPSI\_R into field of VARI\_R*

*CHVARI=CREA\_CHAMP (OPERATION=' ASSE', TYPE\_CHAM=' ELGA\_VARI\_R',  
MODELE=MO,*

*ASSE=\_F (CHAMP=CHEPSI, TOUT=' OUI',*

*NOM\_CMP = ("EPXX", "EPYY"),*

*NOM\_CMP\_RESU= ("V3", "V1"),),)*

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*Example 2: to permute cmps SIXX and SIYY of a field of SIEF\_R*

*CHS2=CREA\_CHAMP (OPERATION='ASSE', TYPE='NOEU\_SIEF\_R',*

*MAILLAGE= MA,*

*ASSE=\_F (CHAMP=CHS1, TOUT='OUI',*

*NOM\_CMP = ("SIXX", "SIYY"),*

*NOM\_CMP\_RESU= ("SIYY", "SIXX",),))*

### **3.4.3.4 Operands**

#### **OFFICE PLURALITY and COEF\_R**

*Operand CUMUL='OUI' wants to say that the values of the occurrence concerned will be added with the possible already existing values.*

*If CUMUL='NON', the affected value replaces the value possibly already present (CUMUL='OUI' is invalid for the fields of "text" (k8/k16,...) of course).*

*The operand COEF\_R = coefr allows the multiplication of the piece of field by the real coefficient coefr before assembling it with the field result.*

*Example:*

*To manufacture the cham\_elem:  $ch3 = 2. * ch1 + 3. * ch2$*

*CH3= CREA\_CHAMP (OPERATION= "ADZE",*

*MODEL = MO, TYPE\_CHAM = 'ELGA\_EPSI\_R',*

*ADZE = (\_F (CHAM\_GD = CH1, ALL = 'OUI',*

*CUMUL='OUI', COEF\_R = 2.),*

*\_F (CHAM\_GD = CH2, ALL = 'OUI',*



CUMUL=' OUI', COEF\_R = 3.),)  
)

### 3.4.4 Examples

#### Example 1

*To manufacture a cham\_no temperature by extracting a field already calculated (in a evol\_ther) and by redefining it (with 25. degrees) on the group of meshes soudur1.*

```
CH1= CREA_CHAMP (OPERATION= "EXTR", TYPE_CHAM=' NOEU_TEMP_R',
RESULTAT= EVOTH, NOM_CHAM= "TEMP", INST = 12.)
CH2= CREA_CHAMP (OPERATION = "AFFE", TYPE_CHAM=' NOEU_TEMP_R',
GRID
=MA,
AFFE=_F (ALL = ' OUI', NOM_CMP = ' TEMP', VALE = 25.) )
```

```
CH3= CREA_CHAMP (OPERATION = "ADZE",
GRID = MA, TYPE_CHAM = ' NOEU_TEMP_R',
ADZE = (_F (CHAM_GD = CH1, ALL = ' OUI'),)
_F (CHAM_GD = CH2, GROUP_MA = SOUDUR1,)
)
```

#### Example 2:

*To manufacture a cham\_elem VARI\_R (to use it as an initial state for stat\_non\_line) in recovering the variables intern (6 and 8) of a law of behavior to make variables 1 and 2 of them (new) law of behavior which will be used in the stat\_non\_line to come.*

```
CH1= CREA_CHAMP (OPERATION= "EXTR", TYPE_CHAM=' ELGA_VARI_R',
RESULTAT= STNL, NOM_CHAM= "VARI_ELGA", INST = 4.)
```

```
CH2= CREA_CHAMP (OPERATION= "ADZE",
MODEL = MO, TYPE_CHAM = ' ELGA_VARI_R',
ADZE = _F (CHAM_GD = CH1, ALL = ' OUI',
```

```
NOM_CMP = ("V6", "V8"),
```

```
NOM_CMP_RESU
```

```
=(
"V1",
```

“V2”),

))

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### *3.5 Operands*

*for*

*OPERATION = “EVAL”,*

*This operation is used to transform a field of functions into fields of realities by evaluating them functions of the field of functions.*

*The field of functions is obligatorily a field of size “NEUT\_F” and the field result will be always a field of “NEUT\_R”. This field could be transformed into field of another unspecified size by calling one second time upon order CREA\_CHAMP/  
OPERATION='ASSE'.*

*An example of the use of operation “EVAL” is given in the document [U2.01.09] “Definition analytical of a stress field... “*

#### *3.5.1 Operand*

*CHAM\_F = chf*

*chf is the name of the field of functions to be evaluated (CHAM\_NO, CHART or CHAM\_ELEM).*

#### *3.5.2 Operand*

**CHAM\_PARA= will l\_chpara**

*will l\_chpara is the list of the fields “parameters” for the evaluation of the functions. All fields of will l\_chpara must be discretized in the same way that chf. For example, if chf is one CHAM\_ELEM/ELGA, it is necessary that all the fields of will l\_chpara are also CHAM\_ELEM/ELGA.*

*It is necessary that the list of the fields parameters is sufficient to allow the evaluation of all them functions referred in chf.*

### 3.5.3 Examples

#### 3.5.3.1 Example

1

*One wants to create a cham\_elem (SIEF\_R) at the points of Gauss whose components are analytical functions of the geometry and time. For this example, one supposes that one has already manufactured two fields at the points of Gauss CHGEOMG: field of geometry and CHINSTG: field moments.*

**RHO=1000.**

**G=10.**

**KP=3.**

**SIZZ = FORMULA (NOM\_PARA = “Z”, VALE = “RHO\*G\*Z”)**

**SIXX = FORMULA (NOM\_PARA = (“Z”, “INST”), VALE = “KP\*SIZZ (Z) +3.\*INST”)**

**# Assignment of the functions:**

**# -----**

**SIG1=CREA\_CHAMP (OPERATION=' AFFE', TYPE\_CHAM=' ELGA\_NEUT\_F',  
MODELE=MO, PROL\_ZERO=' OUI',  
AFFE=\_F (TOUT=' OUI', NOM\_CMP= (“X1”, “X2”),  
VALE\_F= (“SIXX”, “SIZZ”)))**

**# Evaluation of the functions:**

**# -----**

**SIG2= CREA\_CHAMP (OPERATION=' EVAL', TYPE\_CHAM=' ELGA\_NEUT\_R',  
MODELE=MO, CHAM\_F=SIG1, CHAM\_PARA= (CHGEOMG, CHINSTG))**

**# transformation of the field of NEUT\_R into SIEF\_R:**

**# -----**

**SIG3=CREA\_CHAMP (OPERATION=' ASSE', TYPE\_CHAM=' ELGA\_SIEF\_R',  
MODELE=MO, PROL\_ZERO=' OUI',  
ASSE=\_F (TOUT=' OUI', CHAM\_GD=SIG2,  
NOM\_CMP= (“X1”, “X2”),  
NOM\_CMP\_RESU= (“SIXX”, “SIZZ”),**

))

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**3.5.3.2 Example**

**2**

**One wants to calculate a field of temperature to nodes (CH3) containing the product of 2 other fields with the nodes of temperature (CH1 and CH2)**

**# 1) transformation of cham\_no\_TEMP\_R (CH1 and CH2) into cham\_no\_NEUT\_R:**

**# -----**

**CH1N=CREA\_CHAMP (OPERATION='ASSE', TYPE\_CHAM='NOEU\_NEUT\_R',  
MAILLAGE=MA,  
ASSE=\_F (ALL = "YES", CHAM\_GD = CH1,  
NOM\_CMP = ("TEMP"), NOM\_CMP\_RESU = ("X1")),)**

**CH2N=CREA\_CHAMP (OPERATION='ASSE', TYPE\_CHAM='NOEU\_NEUT\_R',  
MAILLAGE=MA,  
ASSE=\_F (ALL = "YES", CHAM\_GD = CH2,  
NOM\_CMP = ("TEMP"), NOM\_CMP\_RESU = ("X2")),)**

**# 2) multiplication CH3N = CH1N \* CH2N:**

**# -----**

**FMULT = FORMULA (NOM\_PARA = ("X1", "X2"), VALE = "X1\*X2")**

**CHFMU=CREA\_CHAMP (OPERATION='AFFE', TYPE\_CHAM='NOEU\_NEUT\_F',  
MAILLAGE=MA,  
AFFE=\_F (ALL = "YES", NOM\_CMP = "X3", VALE\_F = FMULT))**

**CH3N=CREA\_CHAMP (OPERATION='EVAL', TYPE\_CHAM='NOEU\_NEUT\_R',  
CHAM\_F=CHFMU, CHAM\_PARA= (CH1N, CH2N,))**

**# 3) transformation of cham\_no\_NEUT\_R (CH3N) into cham\_no\_TEMP\_R:**

**# -----**

**CH3=CREA\_CHAMP (OPERATION='ASSE', TYPE\_CHAM='NOEU\_TEMP\_R',  
MAILLAGE=MA,  
ASSE=\_F (ALL = "YES", CHAM\_GD = CH3N,  
NOM\_CMP = ("X3"), NOM\_CMP\_RESU = ("TEMP",)),)**

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**3.6 Operands**

**for**

**OPERATION = "DISC"**

**This operation is used to modify the "discretization" of an existing field. For example, to transform one field with the nodes in fields at the points of Gauss. The two fields (given and result) are obviously associated the same size.**

*The discretization wanted by the user for his field result is indicated by the key word **TYPE\_CHAM**.*

*Only 7 cases of figure are currently treated by the order:*

*1) passage: **CHART***

*- > **CHAM\_ELEM/ELNO***

*2) passage: **CHART***

*- > **CHAM\_ELEM/ELGA***

*3) passage: **CHART***

*- > **CHAM\_ELEM/ELEM***

*4) passage: **CHART***

*- > **CHAM\_NO***

*5) passage: **CHAM\_NO***

*- > **CHAM\_ELEM/ELNO***

*6) passage: **CHAM\_NO***

*- > **CHAM\_ELEM/ELGA***

*7) passage: **CHAM\_ELEM/ELNO***

*- > **CHAM\_NO***

*In the case of figure 1, 2 and 3, one duplicates the value assigned to the mesh (**CHART**) on all the points*

*of Gauss (or nodes) of this mesh.*

*In the case of figure 5, the passage of the values of the nodes at the points of Gauss is done by using them*

*functions of form of the finite elements of the model.*

*In the case of figure 6, the passage to the values of the nodes of the grid is done by average arithmetic of the values carried by the nodes of the convergent elements.*

### **3.6.1 Operand**

**CHAM\_GD= ch1**

*ch1 is the field which one wants to modify the “discretization”.*

### **3.6.2 words**

*key*

**MODEL and PROL\_ZERO**

*Even use that for OPERATION = “AFFE” [3.3.2]*

### **3.6.3 Example**

**% CHXG = FIELD OF GEOMETRY AT THE POINTS OF GAUSS:**

% -----

**CHXN =CREA\_CHAMP (OPERATION=' EXTR', TYPE\_CHAM=' NOEU\_GEOM\_R',  
NOM\_CHAM=' GEOMETRIE', MAILLAGE=MA)**

**CHXG= CREA\_CHAMP (OPERATION=' DISC', TYPE\_CHAM=' ELGA\_GEOM\_R',  
MODELE=MO, CHAM\_GD= CHXN)**

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### **3.7 Operands**

**for**

**OPERATION = "EXTR"**

*This operation is in general used to extract a field from a SD as resultat\_sdaster type.*

*There are 3 exceptions:*

- one can extract the field from geometry of the nodes of a grid. The words should then be used keys: GRID = my, NOM\_CHAM = "GEOMETRY" and TYPE\_CHAM = "NOEU\_GEOM\_R".*
- one can create a field by extracting from a table the values corresponding to parameters pre-established names: DO NOT NET, NODE, SOUS\_POINT, names of the components.*
- one can extract the "level set" associated with a crack XFEM. It is then necessary to use them*

*key words:*

**FISSURE = fiss\_xfem, NOM\_CHAM =/"LTNO"**

**/"LNNO"**

**/**

**"GRLTNO"/**

**“GRLNNO”**

**and TYPE\_CHAM = “NOEU\_NEUT\_R”**

**“LTNO”**

**level set tangent**

**“LNNO”**

**level set normal**

**“GRLTNO” gradient of the level set tangent**

**“GRLNNO” gradient of the level set normal**

### **3.7.1 Typing of the field result, key word TYPE\_CHAM**

**Key word TYPE\_CHAM (obligatory) [§3.2] must be well informed. Put aside the case of the extraction in**

**a SD of the type DYNA\_HARMO, key word TYPE\_CHAM results from the reference symbol of the extracted field**

**(NOM\_CHAM). The table below gives the correspondence between these two key words.**

**NOM\_CHAM TYPE\_CHAM**

**NOM\_CHAM TYPE\_CHAM**

**“ACCE” “NOEU\_DEPL\_R”**

**“INTE\_ELNO\_ACTI”**

**“ELNO\_INTE\_R”**

**“ACCE\_ABSOLU” “NOEU\_DEPL\_R”**

**“INTE\_ELNO\_REAC”**

**“ELNO\_INTE\_R”**

**“DCHA\_ELGA\_SIGM” “ELGA\_VARI\_R”**

**“INTE\_NOEU\_ACTI” “NOEU\_INTE\_R”**

**“DCHA\_ELNO\_SIGM” “ELNO\_VARI\_R”**

**“INTE\_NOEU\_REAC” “NOEU\_INTE\_R”**

**“DEGE\_ELNO\_DEPL” “ELNO\_EPSI\_R”**

**“IRRA”**

**“NOEU\_IRRA\_R”**

**“DEPL” “NOEU\_DEPL\_R”**

**“META\_ELGA\_TEMP”**

**“ELGA\_VARI\_R”**

**“DEPL\_ABSOLU” “NOEU\_DEPL\_R”**

**“META\_ELNO\_TEMP”**

**“ELNO\_VARI\_R”**

**“ECIN\_ELEM\_DEPL” “ELEM\_ENER\_R”**

**“META\_NOEU\_TEMP” “NOEU\_VAR2\_R”**

**“EFGE\_ELNO\_CART” “ELNO\_SIEF\_R”**

**“PRES\_ELNO\_DBEL” “ELNO\_DBEL\_R”**

**“EFGE\_ELNO\_DEPL” “ELNO\_SIEF\_R”**



**“PRES\_ELNO\_IMAG” “ELNO\_PRES\_R”**  
**“EFGE\_NOEU\_CART” “NOEU\_SIEF\_R”**  
**“PRES\_ELNO\_REEL” “ELNO\_PRES\_R”**  
**“EFGE\_NOEU\_DEPL” “NOEU\_SIEF\_R”**  
**“PRES\_NOEU\_DBEL” “NOEU\_DBEL\_R”**  
**“ENDO\_ELNO\_SIGA” “ELNO\_SIEF\_R”**  
**“PRES\_NOEU\_IMAG” “NOEU\_PRES\_R”**  
**“ENDO\_ELNO\_SIGM” “ELNO\_SIEF\_R”**  
**“PRES\_NOEU\_REEL” “NOEU\_PRES\_R”**  
**“ENDO\_ELNO\_SINO” “ELNO\_SIEF\_R”**  
**“RADI\_ELGA\_SIGM” “ELGA\_VARI\_R”**  
**“EPME\_ELGA\_DEPL” “ELGA\_EPSI\_R”**  
**“RADI\_ELNO\_SIGM” “ELNO\_VARI\_R”**  
**“EPME\_ELNO\_DEPL” “ELNO\_EPSI\_R”**  
**“REAC\_NODA”**  
**“NOEU\_DEPL\_R”**  
**“EPME\_ELNO\_DPGE” “ELNO\_EPSI\_R”**  
**“SIEF\_ELGA”**  
**“ELGA\_SIEF\_R”**  
**“EPMG\_ELGA\_DEPL” “ELGA\_EPSI\_R”**  
**“SIEF\_ELGA\_DEPL” “ELGA\_SIEF\_R”**  
**“EPMG\_ELNO\_DEPL” “ELNO\_EPSI\_R”**  
**“SIEF\_ELNO”**  
**“ELNO\_SIEF\_R”**  
**“EPOT\_ELEM\_DEPL” “ELEM\_ENER\_R”**  
**“SIEF\_ELNO\_ELGA” “ELNO\_SIEF\_R”**  
**“EPSA\_ELNO” “ELNO\_EPSI\_R”**  
**“SIGM\_ELNO\_CART”**  
**“ELNO\_SIEF\_R”**  
**“EPSG\_ELGA\_DEPL” “ELGA\_EPSI\_R”**  
**“SIGM\_ELNO\_DEPL” “ELNO\_SIEF\_R”**  
**“EPSG\_ELNO\_DEPL” “ELNO\_EPSI\_R”**  
**“SIGM\_ELNO\_SIEF” “ELNO\_SIEF\_R”**  
**“EPSI\_ELGA\_DEPL” “ELGA\_EPSI\_R”**  
**“SIGM\_ELNO\_VARI” “ELNO\_SIEF\_R”**  
**“EPSI\_ELNO\_DEPL” “ELNO\_EPSI\_R”**  
**“SIGM\_NOEU\_CART” “NOEU\_SIEF\_R”**  
**“EPSI\_NOEU\_DEPL” “NOEU\_SIEF\_R”**  
**“SIGM\_NOEU\_DEPL” “NOEU\_SIEF\_R”**  
**“EPSP\_ELGA” “ELGA\_EPSI\_R”**  
**“SIGM\_NOEU\_SIEF”**  
**“NOEU\_SIEF\_R”**  
**“EPSP\_ELNO” “ELNO\_EPSI\_R”**

**“SIGM\_NOEU\_VARI”**  
**“NOEU\_SIEF\_R”**  
**“EQUI\_ELGA\_EPSI” “ELGA\_SIEF\_R”**  
**“SIGM\_NOZ1\_ELGA” “NOEU\_SIEF\_R”**  
**“EQUI\_ELGA\_SIGM” “ELGA\_SIEF\_R”**  
**“SIGM\_NOZ2\_ELGA” “NOEU\_SIEF\_R”**  
**“EQUI\_ELNO\_EPSI” “ELNO\_SIEF\_R”**  
**“SIPO\_ELNO\_DEPL” “ELNO\_SIEF\_R”**  
**“EQUI\_ELNO\_SIGM” “ELNO\_SIEF\_R”**  
**“SIPO\_ELNO\_SIEF” “ELNO\_SIEF\_R”**  
**“EQUI\_NOEU\_EPSI” “NOEU\_SIEF\_R”**  
**“SIPO\_NOEU\_SIEF” “NOEU\_SIEF\_R”**  
**“EQUI\_NOEU\_SIGM” “NOEU\_SIEF\_R”**  
**“SIRE\_ELNO\_DEPL” “ELNO\_SIEF\_R”**  
**“ERRE\_ELEM\_NOZ1” “ELEM\_ERREUR”**  
**“SOUR\_ELGA\_ELEC” “ELGA\_SOUR\_R”**  
**“ERRE\_ELEM\_NOZ2” “ELEM\_ERREUR”**  
**“TEMP”**  
**“NOEU\_TEMP\_R”**  
**“ERRE\_ELGA\_NORE” “ELGA\_ERREUR”**  
**“THETA”**  
**“NOEU\_DEPL\_R”**

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***:***

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**“ERRE\_ELNO\_ELGA” “ELNO\_ERREUR”**

**“VALE\_NCOU\_MAXI” “ELEM\_SPMA\_R”**

**“FLUX\_ELGA\_TEMP” “ELGA\_FLUX\_R”**  
**“VARI\_ELGA”**  
**“ELGA\_VARI\_R”**  
**“FLUX\_ELNO\_TEMP” “ELNO\_FLUX\_R”**  
**“VARI\_ELNO”**  
**“ELNO\_VARI\_R”**  
**“FLUX\_NOEU\_TEMP” “NOEU\_FLUX\_R”**  
**“VARI\_ELNO\_ELGA” “ELNO\_VARI\_R”**  
**“FORC\_NODA” “NOEU\_DEPL\_R”**  
**“VARI\_NOEU\_ELGA”**  
**“NOEU\_VAR2\_R”**  
**“GEOMETRY” “NOEU\_GEOM\_R”**  
**“QUICKLY”**  
**“NOEU\_DEPL\_R”**  
**“GRAD\_ELGA\_THETA” “ELGA\_G\_DEPL\_R” “VITE\_ABSOLU”**  
**“NOEU\_DEPL\_R”**  
**“GRAD\_ELNO\_ELGA” “ELNO\_G\_DEPL\_R” “VNOR\_ELEM\_DEPL” “ELEM\_VNOR\_C”**  
**“GRAD\_NOEU\_THETA” “NOEU\_VAR2\_R”**

**“HYDR\_ELGA” “ELGA\_HYDR\_R”**

*For the DYNA\_HARMO, NOM\_CHAM can take three values: “DEPL”, “QUICKLY” and “ACCE”.  
In  
three cases, the type of the field result are a CHAM\_NO\_DEPL\_C and it is thus necessary to inform:  
TYPE\_CHAM=' NOEU\_DEPL\_C'.*

### **3.7.2 Operand COUNT**

**COUNT = tabl**

*Name of concept counts containing the values to be stored in the field. Names of  
parameters of the table must comply with certain rules.*

*If the field to be produced is a field with nodes “”, one must find like names  
parameters of the table:*

*NODE + of the names of CMPS among the names of the CMPS of size.*

*The parameter NODE contains the name of the node.*

*If the field to be produced is a field with elements “”, one must find like names  
parameters of the table:*

*NET, NOT + names of CMPS among the names of the CMPS of size.*

*The parameter MESH contains the name of the mesh.*

*The parameter NOT contains the number of the node in the connectivity of the mesh.*

*If the field to be produced is a field with nodes “”, one must find like names parameters of the table:*

*NET, NOT, SOUS\_POINT + names of CMPS among the names of the CMPS of the size*

*The parameter MESH contains the name of the mesh.*

*The parameter NOT contains the number of the point of Gauss in the mesh.*

*Parameter SOUS\_POINT (necessary only for the fields to “under-points”) contains it number of the under-point of Gauss in the point of Gauss.*

*If the field to be produced is a field with nodes “”, one must find like names parameters of the table:*

*NET + names of CMPS among the names of the CMPS of size.*

### **3.7.3 Operand**

**RESULT**

**RESULT = resu**

*Name of concept result in which one wants to recover a field.*

### **3.7.4 Operand**

**NOM\_CHAM**

**NOM\_CHAM**

*This key word specifies the reference symbol of the field to be extracted [U4.71.00].*

### **3.7.5 Operand**

**SENSITIVITY = para**

*This key word means that one does not wish to extract the true field from the SD\_RESULTAT, but its derived compared to the significant parameter para.*

*The document [U4.50.02] specifies the operation of this key word.*

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***Operator CREA\_CHAMP***

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### ***3.7.6 Operands***

***NUME\_ORDRE/NUME\_MODE/NOM\_MODE/.../INTERPOL***

***These key words are used to specify which is the sequence number of the SD\_RESULTAT which one wants to extract.***

***The choice of the key words to use depends on the type of SD\_RESULTAT [U4.71.00].***

***Note:***

- 1) When one uses Interpol = "FLAX", the extracted field will be an interpolation enters two fields of the SD\_RESULTAT. This interpolation always does not have a direction "physical"; for example on clean modes.***
- 2) When one uses an access of the "real" type (INST or FREQ), one seeks a field in a given interval. If several fields in the interval are found, the program stop in fatal error.***

### ***3.7.7 Calculation of a field containing the "extrema" of a SD\_RESULTAT***

***The idea is to create a field containing in each point of space the extreme value recorded with run of a transient (or the moment to which this value was recorded).***

***Today this paragraph relates to only the results of the evol\_ther type, evol\_elas, evol\_noli and dyna\_trans. The fields are always of "real" type.***

***One must specify:***

- ***sequence numbers defining the transient: TOUT\_ORDRE, LIST\_INST,***  
***·***
- the selected type of extremality: TYPE\_MAXI = "MAXIMUM",..., "MINI\_ABS", "NORM\_TRAN",***  
***·***

*what one wants: the extreme value or the moment when this value is reached (TYPE\_RESU).*

### **3.7.7.1 Operand**

#### **TYPE\_MAXI**

*/“MAXIMUM”*

*one considers the maximum reached by the components during transient,*

*/“MAXI\_ABS”*

*one considers the maximum reached by the absolute value of components during the transient,*

*/“MINI”/“MINI\_ABS”*

*idem for the minima,*

*/“NORM\_TRAN”*

*one considers the maximum reached by the quantity:*

*$DX ** 2 + DY ** 2 + DZ ** 2.$*

.

*for the 4 values: “MAXIMUM”,..., “MINI\_ABS”, the components of the field are treated independently from/to each other: the extreme values can not be reached with even urgent,*

.

*the fifth possible value: “NORM\_TRAN” is not possible that for the fields of *depl\_R*. In a given point, one seeks the moment when the standard of the vector translation is maximum and one recopy in the field result all the components of the field at the found moment.*

### **3.7.7.2 Operand**

#### **TYPE\_RESU**

*/“VALE”,*

*the field result contains the extreme values recorded during the transient,*

*Note:*

*Even if the extremum were obtained with an absolute value (“MAXI\_ABS” or “MINI\_ABS”), the stored value is algebraic.*

*/“INST”,*

*the field result contains the values of the moments when the extreme values were met.*

*Caution: if for example:*

**NOM\_CHAM = "FLUX\_ELNO\_TEMP",  
TYPE\_RESU  
=  
"INST",**

*the field result is a cham\_no\_FLUX\_R which contains values of moments!*

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### **3.7.7.3 Operands**

**TOUT\_ORDRE/LIST\_INST/LIST\_FREQ/PRECISION/CRITERION**

*These key words make it possible to specify the extent of the transient to be examined.*

*If TOUT\_ORDRE = "YES" one reviews all the sequence numbers.*

*If LIST\_INST = linst one considers only the specified moments.*

### **3.7.8 Examples**

#### **3.7.8.1 Extraction of a field of temperature of a concept result of the evol\_ther type**

**temp10 = CREA\_CHAMP**

**(OPERATION=' EXTR',**

**NOM\_CHAM = "TEMP", TYPE\_CHAM = "NOEU\_TEMP\_R",**

**RESULT = evoth, INST = 10. )**

*temp10 is the field of temperature extracted the evoth result (of evol\_ther type) at moment 10.*

### *3.7.8.2 Extraction of a field of displacement of a concept result of the mode\_meca type*

```
mode4 =
CREA_CHAMP
(OPERATION=' EXTR',
NOM_CHAM = "DEPL", TYPE_CHAM = "NOEU_DEPL_R",
RESULT = modes
, NUME_MODE = 4)
```

*mode4 is the 4th clean mode of the modes result (of mode\_meca type).*

### *3.7.8.3 Extraction of the field of "temperature" containing the moments when the maximum temperature was attack during a transient*

```
instmax =
CREA_CHAMP (OPERATION=' EXTR',
NOM_CHAM = "TEMP", TYPE_CHAM = "NOEU_TEMP_R",
RESULT = evoth
,
TYPE_MAXI
=
"MAXIMUM"
,
TYPE_RESU
=
"INST"
)
```

### *3.7.8.4 Extraction of a stress field in a table*

*That is to say the file (fort.81) containing the image of the following table:*

```
#DEBUT_TABLE
#TITRE CONSTRAINT "ELNO"
DO NOT NET SIXX SIYY SIZZ
K8 I R R R
M1 1 -1.632E+03 -2.553E+02 6.788E-01
M1 2 -5.302E+03 -9.663E+01 6.018E+01
M1 3 -3.638E+03 -1.058E+02 5.669E+01
M2 1 5.632E+01 1.553E+02 3.788E-01
...
```



## **#FIN\_TABLE**

*One can extract a field from “constraints” to the nodes of this table while making:*

*# reading of the table:*

**TA=LIRE\_TABLE (UNITE=81, TYPE\_TABLE=' TABLE', SEPARATEUR=' ')**

*# extraction of the field in the table:*

**CH=CREA\_CHAMP (OPERATION=' EXTR', TYPE\_CHAM=' ELNO\_SIEF\_R', TABLE=' TA',  
MODELE=MO, PROL\_ZERO=' OUI', OPTION=' SIEF\_ELNO\_DEPL')**

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***Document: U4.72.05***

***Operator PROJ\_CHAMP***

***1 Goal***

***To project the fields with the nodes of a structure of data result on another grid. This order can be used for example to transfer on a “mechanical” grid, the result of a calculation thermics carried out on a “thermal” grid different. One can also continue a calculation thermics (or mechanics) on another grid (more or less refined).***

***The order makes it possible to define “zones” (geometrical) which one projects the ones on the others what makes it possible to solve the problem of a desired discontinuity of the field projected (for example it length of the lips of a crack).***

***In a more anecdotic way, the order also makes it possible to project the fields by elements “ELNO” and “ELEM” (see [§3.7]) but this possibility is of less interest. In the same way, methods (disadvised) “NUAGE\_DEG\_0/1” make it possible to create “insulated” cham\_no\_\****

***Product a structure of data SD\_RESULTAT (or exceptionally cham\_no\_\*)***

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## *2 Syntax*

*resu = PROJ\_CHAMP*

*(*

*# Use of the functions of form of the 1st model (method strongly advised):*

*/*

*METHODE=*

*“ELEM”*

*,*

*[DEFECT]*

*RESULT*

*= evol*

*,*

*/*

*[evol\_ther]*

*/[evol\_elas]*

*/[evol\_noli]*

*/[evol\_char]*

*[/mode\_meca]*

*[/mode\_stat\_depl]*

*[/base\_modale]*

**MODELE\_1**

**= mol**

,

**[model]**

**MODELE\_2**

**= mo2**

**,  
[model]**

**CAS\_FIGURE =**

**/  
"3D",**

**/  
"2D",**

**/  
"2.5D",  
/"1.5D",**

**# Selection of the names of the fields**

**/  
TOUT\_CHAM**

**=  
"YES"**

**,  
[DEFECT]**

**/  
NOM\_CHAM**

**=  
l\_noch**

**,  
[l\_Kn]**

**# Selection of the sequence numbers**

**/**

**TOUT\_ORDRE =**  
**“YES”**

,

**[DEFECT]**

/

**NUME\_ORDRE =**  
**l\_nuor**

,

**[l\_I]**

/

**/INST =**  
**l\_inst**

,

**[l\_R]**

/

**FREQ**  
**=**  
**l\_freq**

,

**[l\_R]**

**/LIST\_INST**  
**=**  
**l\_inst**

,

**[listr8]**

**/LIST\_FREQ**  
**=**  
**l\_freq**

,

**[listr8]**

**/ PRECISION**

**=/prec,**

**/**

**1.0E-3**

**,**

**[DEFECT]**

**/ CRITERION =/"RELATIVE"**

**, [DEFECT]**

**/**

**"ABSOLUTE"**

**,**

**DISTANCE\_MAX**

**=**

**d\_max,**

**[R]**

**ALARM**

**=**

**/**

**"YES",**

**[DEFECT]**

**/**

**'NOT,**



***PROL\_ZERO***

=

/

***“NOT”***,

***[DEFECT]***

***TYPE\_CHAM***

=

***“NOEU”***

***# if the projected SD is of type “mode”:***

***RIGI\_MECA***

=

***kass***

***[matr\_asse]***

***MASS\_MECA***

=

***mass***

***[matr\_asse]***

***AMOR\_MECA***

=

*aass*

*[matr\_asse]*

*# “Smoothing” of a group of dots (strongly disadvised method!)*

*/METHODE=/"NUAGE\_DEG\_1"*

,

/

*"NUAGE\_DEG\_0"*

,

*CHAM\_NO =*

*chno1*

,

*[cham\_no\_\*]*

*CHAM\_NO\_REFE*

=

*chno2*

,

*[cham\_no\_\*]*

*VIS\_A\_VIS*

*= (\_F (*

*/TOUT\_1*

=

**“YES”**

,

**/ GROUP\_MA\_1 = lgma1, [l\_gr\_maille]**

**/ MAILLE\_1**

=

**lmail1**

,

**[l\_maille]**

**/ GROUP\_NO\_1 = lgno1, [l\_gr\_noeud]**

**/ NOEUD\_1 =**

**lnoe1**

,

**[l\_noeud]**

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*/ TOUT\_2*

=

“YES”

,

*/ GROUP\_MA\_2 = lgamma2, [l\_gr\_maille]*

*/ MAILLE\_2*

=

*lmail2*

,

*[l\_maille]*

*/ GROUP\_NO\_2 = lgrno2, [l\_gr\_noeud]*

*/ NOEUD\_2 =  
lnoe2  
,  
[l\_noeud]*

*CAS\_FIGURE =  
/  
"3D",*

*/  
"2D",  
/  
"2.5D",  
/"1.5D",*

*),),*

*SENSITIVITY  
=*

*will listpara  
,*

[l\_para\_sensi]

**TITRATE**

= *titr*

,

[l\_Kn]

);

*Type of the result of the operator:*

*if one uses key word CHAM\_NO, resu is a CHAM\_NO of the same size as chno1,*

*if one uses the key word RESULT, resu is a standard SD\_RESULTAT in the same way than evol.*

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**3 Operands**

**3.1 Operand**

**METHOD**

*Two families of method of projection of the nodes of a grid on another grid are available.*

*First family (ELEM) is traditional: to calculate the value on a node of the new grid, one seeks in which element of the old grid this node is, then one interpolates the value with assistance of the functions of form of this element. When the node is not in one of the elements of the old grid (apart from the fields geometrical modelled), the method connects the node and the point of the element nearest and interpolates the value using the functions of form of the element. There is thus (by defect) a “prolongation” of the field outside the initial grid. Operand DISTANCE\_MAX makes it possible to modify this behavior.*

*Second family (NUAGE\_DEG\_1/0) (strongly disadvised) uses the concept of clouds of points, by forgetting the finite elements present in the models. It is more general than the family (ELEM) because it makes it possible to project a field with the nodes without these nodes being carried by finite elements (for example a whole of sensors). On the other hand, this family often disturbs them users familiar of the finite element method because it is purely geometrical and does not see material borders nor holes: the computed value on a node of the new grid depends on all the nodes which are close for him. In the zones of strong gradient, the values can be obtained with a strong extrapolation, which is seldom very “physical”.*

### *3.1.1 Limitations*

*Method ELEM treats the fields with the nodes of the SD\_RESULTAT.*

*Method NUAGE\_DEG\_1/0 can treat only the insulated fields (and not SD\_RESULTAT).*

### *3.2 Operands*

*CHAM\_NO and CHAM\_NO\_REFE*

*The order projects the values of the cham\_no chno1 on the nodes of the grid subjacent with “model of field”: chno2.*

*It created then the cham\_no result on the same model as chno2 (same components carried by the same nodes) but with values obtained by “interpolation” of the values of chno1.*

*One can project a cham\_no a priori does not matter that it real or complex size, in 2D or in 3D. The field to be projected and the model field must be of the same type (DEPL\_R, TEMP\_R,...).*

*The field result will be then of the same type.*

### *3.3 Word*

*key*

*VIS\_A\_VIS*

*This key word optional factor makes it possible to project the field “per pieces”. By defect, it is the unit field which is projected.*

*This key word makes it possible to project discontinuous fields or to solve the problem of the projection of complex models (see [§3.3.3]).*

*If it is used this key word allows the user to project a field a priori discontinuous (on a line or a surface) and to preserve this discontinuity for the projected field:*

Z1  
O  
With  
B  
Z2

*Appear 3.3-a*

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*For example, that is to say the fissured structure of [Figure 3.3-a]. The field of displacement is discontinuous on the crack: the upper lips and lower although geometrically confused have each one their own field of displacement.*

*Let us suppose that one has 2 grids ( $M$  and  $M_e$ ) different from this structure and that for each one*



*of these grids, the Z1 zones and Z2 are represented by two named GROUP\_MA Z1 and Z2.*

*One will be able to write:*

```

VIS_A_VIS = (
  _F (
    (GROUP_MA_1 = "Z1", GROUP_MA_2 = "Z1"
  ),
  _F
    (GROUP_MA_1
  =
    "Z2"
  ,
  GROUP_MA_2
  =
    "Z2"),

```

*The values of the field projected on the upper lip (pertaining to Z1) will only hold account values of the initial field on Z1. In the same way the values obtained on the lower lip do not depend that initial field on Z2.*

**Note:**

*On line OB, the nodes are not duplicated their values will be calculated twice (for the 2 occurrences of VIS\_A\_VIS). It is the last occurrence which will impose its value.*

### **3.3.1 Operands**

**TOUT\_1/GROUP\_MA\_1/MAILLE\_1/GROUP\_NO\_1/NOEUD\_1**

*These operands are used to define the whole of the meshes ("ELEM") or of the nodes ("CLOUD...") in to take into account in the initial grid.*

### **3.3.2 Operands**

**TOUT\_2/GROUP\_MA\_2/MAILLE\_2/GROUP\_NO\_2/NOEUD\_2**

*These operands are used to define the whole of the nodes where the field is evaluated.*

### **3.3.3 Use of key word VIS\_A\_VIS to project the complex models**

**Key word VIS\_A\_VIS makes it possible for example to solve the problem of the projection of a field of temperature calculated on a model containing of the elements 3D and the elements of hull (a solid**

*whose skin interns would be covered with a “liner” with a grid in elements of hull).*

*The problem is as follows: the elements 3D carry on their nodes the only degree of freedom TEMP, whereas the elements of hull (thermal) carry the 3 degree of freedom: TEMP, TEMP\_INF and TEMP\_SUP. If one does not take precautions and that one projects all the model of only one blow, them*

*degree of freedom TEMP\_INF and TEMP\_SUP “will be lost” during projection. Indeed, like initial grid contains elements voluminal, it is the procedure “3D” which is applied: for each node of grid 2, one seeks a voluminal mesh which contains this node (or which in is near). Once this found mesh, one interpolates the degrees of freedom carried by all the nodes of this mesh. Practically, no mesh 3D can carry on all its nodes the degrees of freedom TEMP\_INF and TEMP\_SUP; those are thus lost.*

*To solve this problem it is necessary to do something like:*

```
evo2= PROJ_CHAMP (RESULTAT=evo1,...  
VIS_A_VIS= (_F (GROUP_MA_1: “VOLU”, GROUP_MA_2=' VOLU'),,
```

```
_F (GROUP_MA_1:  
“LINER”  
,  
GROUP_MA_2=' LINER'),),)
```

*In this manner, the meshes of “LINER” of grid 2 will be affected by the values carried by the meshes of “LINER” of the grid 1 and they will carry the same degrees of freedom.*

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### **3.4 Operand**

#### **RESULT**

**RESULT = evo1,**

*Name of the concept result which one wants to project.*

*Note:*

*For a evol\_noli, the concept result will not contain (by defect [§3.7]) only the fields of displacements. To calculate the internal variable and stress fields correspondents, it is necessary to use order STAT\_NON\_LINE by using the key word PREDICTION: "DEPL\_CALCULE".*

### **3.5 Operand**

#### **MODELE\_1**

**MODELE\_1 = mo1,**

*Name of the model associated with the initial concept (evo1)*

### **3.6 Operand**

#### **MODELE\_2**

**MODELE\_2 = mo2,**

*Name of the model associated with the concept result (resu). This model must be created as a preliminary.*

### **3.7 Operand**

#### **CAS\_FIGURE**

*This key word (optional) is used to direct the program towards one of the 4 following cases:*

- "3D" the only elements of the grid "1" which will be used for projection are the elements voluminal: hexahedrons, pentahedrons, tetrahedrons and pyramids. The nodes have 3 cordonnées (X, Y, Z).*
- "2D" the only elements of the grid "1" which will be used for projection are the elements surface: quadrangles and triangles. The grid is supposed to be plane. The nodes have 2 cordonnées (X, Y).*
- "2.5D" the only elements of the grid "1" which will be used for projection is the elements surface: quadrangles and triangles. The grid is 3D. The nodes have 3 cordonnées (X, Y, Z). It is the case of the "hulls" plunged in 3D.*
- "1.5D" the only elements of the grid "1" which will be used for projection is the elements*

***linear: segments. The grid can be 2D or 3D. The nodes have 2 or 3 cordonnées (X, Y, (Z)).***

***This key word can also be used under key word VIS\_A\_VIS. It can change value according to occurrences.***

***If the user does not inform this key word, the program adopts following logic:  
One traverses the list of the meshes of model 1 candidates to to be projected (this list can be filtered thanks to key word VIS\_A\_VIS)***

***· if there exists at least 1 mesh 3D in this list***

***=> CAS=' 3D'***

***· if not:***

***if there exists at least 1 mesh 2D in this list***

***if the geometry is “2D”***

***=> CAS=' 2D'***

***if the geometry is “3D”***

***=> CAS='2.5D'***

***if not***

***:***

***if there exists at least 1 mesh 1D in this list => CAS='1.5D'***

### **3.8**

#### ***Selection of the names of the fields***

***The key words TOUT\_CHAMP = “YES” or NOM\_CHAM = l\_noch make it possible to choose which are them***

***fields of the SD RESULT which one wants to project (by defect all fields with the nodes). One can also to project the fields by elements “ELNO” and “ELEM” (but not “ELGA”); for that, it is necessary***

***explicitly to give their names via key word NOM\_CHAM.***

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***Titrate:***

***Operator PROJ\_CHAMP***

***Date:***

31/01/06

Author (S):

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### **3.8.1 Remarks on the projection of the fields by elements**

*This possibility was introduced initially to make it possible to project the fields of pressure calculated by the Code Saturn (constant by elements) on the skin of a mechanical grid Aster. Its development being general, it is available for all the fields "ELEM" and "ELNO" but sound use can sometimes surprise the user.*

*As for the fields with the nodes, the fields by projected elements of the concept evo1 in concept resu will bear the same names (for example: "SIGM\_ELNO\_DEPL").*

*The projected fields (resu) will be by "natural" defect in the same way as the fields "origin" (evo1): "ELEM" or "ELNO".*

*One can however modify this behavior by defect by using key word TYPE\_CHAM=' NOEU' to force the fields projected to be fields with the nodes.*

*What does one make numerically?*

- Champs of the type ELNO: for each mesh of grid 2, one traverses the nodes of this net and the value of each node is calculated as one would do it for a field with the nodes. The result of this projection is thus (by construction), a field ELNO which is continuous between the elements.*
- Champs of the type ELEM (constant by mesh): the value carried by a mesh of grid 2 is obtained by arithmetic mean of the values carried by its nodes (calculated like for a field ELNO).*

*When TYPE\_CHAM=' NOEU' is not used, the projection of fields by elements only has direction if the elements projected the ones on the others are in the same way "standard" (hull, beam, Iso parametric). Indeed, if one projected for example a field 3D of "SIGM\_ELNO\_DEPL" on one formed linear model of elements of bar, one could not store the values of constraints SIXX, ... on these elements (which know only the generalized efforts: NR, MX,...)*

### **3.8.2 Operand**

**TYPE\_CHAM= "NOEU"**

*This key word is used to force the fields projected to be fields "with the nodes". This key word is used systematically (for example) by order MACR\_LIGN\_COUPE because one cannot create fields by elements on the "fictitious" model of beam created by this macro-order of*

*visualization.*

### **3.9 Operand**

#### ***DISTANCE\_MAX***

*To project grid MA1 on grid MA2, method (ELEM) seeks in which element of grid MA1 is each node of MA2, then interpolates the value using the functions of form element. When that a node of MA2 is not in any element of grid MA1, the method puts in relation the node etle not (of the edge) of the element nearest. It interpolates the value using functions of form of the element and that even if the node is "far" from this element.*

*If it is wished that a node which is not in any the elements of grid MA1, not be concerned by projection, one uses operand DISTANCE\_MAX. This operand makes it possible to give the distance*

*maximum that one authorizes between the node and the element nearest.*

*If the node does not answer the criterion of proximity the field will not be projected on this node (i.e it node will not carry any component). By defect, an alarm will be emitted (see the key word ALARME=OUI/NON)*

### **3.10 Operand**

#### ***ALARME= "YES"/"NOT"***

*When a node of the grid "2" is found "far" from the elements of the grid "1" (see key word DISTANCE\_MAX above), the code transmits by defect a message of alarm. One can avoid these alarms*

*by using ALARME='NON'.*

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### **3.11 Operand**

***PROL\_ZERO= “NOT”/“YES”***

*When the user wants to impose a classification on the fields of the SD\_RESULTAT, it must use one of key words RIGI\_MECA, MASS\_MECA or AMOR\_MECA.*

*If desired classification imposes that a given node carries components and that the criterion of DISTANCE\_MAX makes that this node is not concerned with projection, one is unable to affect values on this node. There will be, by defect, a fatal error in this case of figure. To avoid this fatal error, the user must use word key PROL\_ZERO=' OUI' in order to affect value 0. on it node.*

### **3.12 Operands**

***RIGI\_MECA, MASS\_MECA and AMOR\_MECA***

*These 3 key words make it possible to associate (for a structure of data of the type “mode”) theirs matr\_asse with the structure of data produced. They are necessary if one wishes to use the result order in later calculations (orders REST\_BASE\_PHYS, MACRO\_PROJ\_BASE, ...).*

### **3.13 Selection of the sequence numbers**

*cf [U4.71.00].*

### **3.14 Operand**

***SENSITIVITY***

***SENSITIVITY = will listpara,***

*This key word is followed of a sensitive parameter list. It specifies that one is not interested in result in itself, but with derived from the result compared to the significant parameters.*

### **3.15 Operand**

***TITRATE***

***TITRATE = titr,***

***Titrate that one wants to give to the concept result.***

## **4 Example**

***Calculations thermics and mechanics on two different grids.***

**Note:**

**The mechanical model can contain (for example) elements of cable nonpresent in the thermal model.**

**ma1=LIRE\_MAILLAGE (...)**

**;**

**mo1=AFFE\_MODELE (MAILLAGE=ma1,  
AFFE=\_F (TOUT=' OUI', PHENOMENE=' THERMIQUE',...));**

**...**

**evo1**

**= THER\_LINEAIRE (MODEL = mo1,...);**

**ma2 = LIRE\_MAILLAGE (...);**

**# grid more refined**

**mo2 = AFFE\_MODELE (MAILLAGE= ma2,... "THERMAL",...);**

**evo2**

**= PROJ\_CHAMP (METHODE= "ELEM", RESULTAT= evo1, NOM\_CHAM= "TEMP",**

**MODELE\_1= mo1, MODELE\_2= mo2,**

**);**

**ch2 = AFFE\_CHAR\_MECA (TEMP\_CALCULEE= evo2,...**

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**Operator PROD\_MATR\_CHAM**

**Date:**

**27/01/05**

**Author (S):**

**J. Key PELLET**



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**Organization (S): EDF-R & D /AMA**

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**Operator PROD\_MATR\_CHAM**

### **1 Goal**

**To carry out the product of a matrix by a vector.**

**The matrix is a structure of data of the type *matr\_asse*: it is with actual values or complex, symmetrical or not symmetrical, with a storage “line of sky per blocks” or Morse. The vector is a structure of data of the *cham\_no* type. It is with actual values or complex. One imposes that stamp and vector are both to actual values or both with complex values (if not to use before orders *COMB\_MATR\_ASSE* [U4.72.01] or *COMB\_CHAM\_NO* [U4.72.02]) and that they share same classification (see order *NUME\_DDL* [U4.61.11]).**

**Product a concept of the *cham\_no*\* type.**

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**2 Syntax**

**uass**

**[cham\_no\_\*] = PROD\_MATR\_CHAM (**

**MATR\_ASSE**

**= m,/[matr\_asse\_DEPL\_R]**

**/**

**[matr\_asse\_TEMP\_R]**

**/**

**[matr\_asse\_DEPL\_C]**

**/**

**[matr\_asse\_PRES\_C]**

**CHAM\_NO**

=

**U**

,

/

**[cham\_no\_DEPL\_R]**

/

**[cham\_no\_TEMP\_R]**

/

**[cham\_no\_DEPL\_C]**

/

**[cham\_no\_PRES\_C]**

**TITRATE**

= *titr*

,

**[l\_Kn]**

)

*The type of the concept of uass is:*

**MATR\_ASSE**

**CHAM\_NO**

**CHAM\_NO**

**[matr\_asse\_DEPL\_R]**

*and [cham\_no\_DEPL\_R]*

*[cham\_no\_DEPL\_R]  
[matr\_asse\_DEPL\_C]  
and [cham\_no\_DEPL\_C]*

*[cham\_no\_DEPL\_C]  
[matr\_asse\_TEMP\_R]  
and [cham\_no\_TEMP\_R]*

*[cham\_no\_TEMP\_R]  
[matr\_asse\_PRES\_C]  
and [cham\_no\_PRES\_C]*

*[cham\_no\_PRES\_C]*

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*3 Operands*

*3.1 Word*

*key*

*MATR\_ASSE*

*MATR\_ASSE = m*

*Name of the matrix (concept `matr_asse_*`) to combine.*

### **3.2 Word**

*key*

**CHAM\_NO**

*CHAM\_NO = U*

*Name of the vector (concept `cham_no_*`) to combine.*

### **3.3 Key word**

**TITRATE**

*TITRATE = titr*

*Titrate that one wants to give to the result*

## **4 Examples**

### **4.1**

*Phase of checking*

- *Vérification which the produced concept is not an operand of entry of the operator.*

### **4.2 Phase**

*of execution*

- *Vérification that the matrix and the vector to be multiplied are both with actual values or all them two with complex values.*

- *Vérification of coherence: the operands of the `matr_asse_*` type and `cham_no_*` type must to share same classification.*

- *Vérification that the matrix was not already factorized.*

## **5 Example**

*of use*

*Product stamps vector:*

***u\_mv\_1 = PROD\_MATR\_CHAM  
(MATR\_ASSE = mat\_1,  
CHAM\_NO  
=  
u\_1,***

)

***For example, one can use this order to create a vector second member resulting from the product matrix of mass and a vector acceleration obtained by order DYNA\_LINE\_TRAN. It vector second member can be used as loading for a static calculation.***

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***Operator PROJ\_MESU\_MODAL***

***1 Goal***

***To extrapolate experimental measurements on a digital model in dynamics.***



*The experimental data can be displacements, speeds, accelerations, deformations or of the constraints. They are defined as a function of time or the frequency, or in the form of list.*

*It is a question of identifying the generalized co-ordinates of measurement relating to a base of projection defined on the digital model. This base of projection (deformed, forced or deformations) is calculated as a preliminary according to a concept of the mode\_meca type or base\_modale. Vectors of base are then restricted with the measured degrees of freedom. Space association enters the points of measure and the nodes of the numerical grid can be carried out manually ou/et automatically. The identification of the generalized co-ordinates is carried out by resolution of a problem of minimization of the least type squares, possibly regularized according to the method of Tikhonov.*

*Is applicable to any type of model (1D, 2D and 3D).*

*Product a structure of data of the tran\_gene type, harm\_gene or mode\_gene.*

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*2 Syntax*

*repgene [\*\_gene] = PROJ\_MESU\_MODAL*

*(MODELE\_CALCUL*

*=*

**\_F (**

**BASE**

**=**

**base**

**/**

**[base\_modale]**

**/**

**[mode\_meca]**

**MODEL**

**=**

**mocalc**

**[model]**

**),**

**MODELE\_MESURE =**

**\_F (**

**MEASURE**

**=**

**measure**

**/**

**[dyna\_trans]**

**/**

**[dyna\_harmo]**

**/**

**[base\_modale]**

**MODEL**

**=**

**mostru**  
**[model]**

**NOM\_CHAM**  
=  
/  
**“DEPL”**  
**[DEFECT]**  
/  
**“QUICKLY”**  
/  
**“ACCE”**  
/  
**“SIEF\_NOEU”**  
/  
**“EPSI\_NOEU\_DEPL”**

),

**CORR\_MANU**  
=  
**\_F (**

**NOEU\_MESURE**  
=  
**no1**  
**[node]**

**NOEU\_CALCUL**  
=  
**no2**  
**[node]**  
),

**RESOLUTION =**  
**\_F (**  
**METHOD =/“LU” [DEFECT]**

/  
“SVD”  
*If METHOD = “SVD” then:*  
*EPS*  
=  
/  
*0.*  
*[DEFECT]*  
/  
*eps*  
*[R]*

*REGUL*  
=  
/  
“NOT”  
*[DEFECT]*  
/  
“NORM\_MIN”  
/  
“TIK\_REL”  
*If REGUL! = “NOT” then:*  
*/COEF\_PONDER =/0. [DEFECT]*  
/  
*W*  
*[l\_R]*  
/  
*COEF\_PONDER\_F*  
=*w\_f*  
*[l\_fonction]*

),

)

*If measurement = [dyna\_trans]  
then repgene = [tran\_gene]  
If measurement = [dyna\_harmo]  
then repgene = [harm\_gene]  
If measurement = [mode\_meca]  
  
then repgene = [mode\_gene]  
If measurement = [base\_modale]  
then repgene = [mode\_gene]*

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### ***3 Operands***

#### ***3.1 Key word***

***factor***

***MODELE\_CALCUL***

***This key word factor gathers the characteristics of the digital model on which one wants to extrapolate measure. It should appear only once.***

#### ***3.1.1 Operand***

***MODEL***

**MODEL = mocalc**

*Name of the digital model on which the base of projection is built.*

### **3.1.2 Operand**

**BASE**

**BASE = bases**

*Name of the base of projection. This base of projection is of mode\_meca type or base\_modale. This concept was possibly enriched, via order CALC\_ELEM followed of CALC\_NO, by the fields of strains and/or modal stresses calculated with the nodes.*

### **3.2 Key word**

**factor**

**MODELE\_MESURE**

*This key word factor gathers information on the measured field (observed) that one wishes to extrapolate on the digital model. It should appear only once.*

#### **3.2.1 Operand**

**MODEL**

**MODEL = mostru**

*Name of the model associated with the observation.*

#### **3.2.2 Operand**

**MEASURE**

**MEASURE = measurement**

*Name of the measured field.*

*This key word determines the type of concept produced by operator PROJ\_MESU\_MODAL. If measurement is of type dyna\_trans, the produced concept is of tran\_gene type. If measurement is of type dyna\_harmo, the produced concept is of harm\_gene type. If measurement is of mode\_meca type or base\_modale, the produced concept is of mode\_gene type.*

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### ***3.2.3 Operand***

***NOM\_CHAM***

***NOM\_CHAM =***

***/“DEPL”***

***/“QUICKLY”***

***/“ACCE”***

***/“SIEF\_NOEU”***

***/“EPSI\_NOEU\_DEPL”***

***This key word makes it possible to choose the name of the field measured to extrapolate in a list of names***

***symbolic systems predefined. Only one field is authorized. Components of the field considered are those which were measured (observed) and were read in measurement.***

### ***3.3 Key word***

***factor***

***CORR\_MANU***

***This key word factor makes it possible the user to manually define (to overload) the correspondence enters***

***the node of observation and the similar node of the digital model. This key word factor is optional, but it can as many appear time as necessary. On the other hand, operands under this key word factor go per pair: a NOEU\_MESURE must have its corresponding NOEU\_CALCUL.***

***If this key word factor misses, space association between the points of measurement and the nodes of numerical grid is carried out automatically by using the function of form of the element of digital model to determine the value of the field on the point of measurement.***

#### ***3.3.1 Operand***

## ***NOEU\_MESURE***

***NOEU\_MESURE = no1***

***This key word informs the name of the node of observation which one wishes to associate the node digital model no2. In certain cases, the file of grid associated with measurement is with universal format (Ideas format), one cannot thus know the name Aster associated a priori with node. It is thus necessary, in this case, of reading the grid resulting from PRE\_IDEAS, by LIRE\_MAILLAGE in order to be able to name of the node.***

### ***3.3.2 Operand***

***NOEU\_CALCUL***

***NOEU\_CALCUL = no2***

***This key word informs the name of the node of the digital model which one wishes to associate the node of observation no1.***

### ***3.4 Key word***

***factor***

***RESOLUTION***

***One defines here the method of resolution to be used and the parameters associated with this method.***

### ***3.4.1 Operand***

***METHOD***

***METHOD =/“LU”***

***/***

***“SVD”***

***One proposes the method LU (decomposition out of LU Lower-Upper) and method SVD (decomposition in singular values) for the calculation of the opposite matrix. For method SVD, the number of singular values to take into account depends on the value of eps that the user inform under operand EPS. By defect, one adopts the method LU.***

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### ***3.4.2 Operand***

***EPS***

***This key word is used if method SVD is chosen.***

***EPS***

***= /***

***0.***

***/***

***eps***

***This key word gives the value from which a singular value is regarded as null.***

***It determines the number of singular values thus to exploit at the time of the resolution. A eps equal to***

***zero mean that all the singular values are to be taken into account. eps equal to 1 means that one considers only the greatest singular value. By defect, one chooses EPS = 0.***

### ***3.4.3 Operand***

***REGUL***

***REGUL =/***

***“NOT”***

***/“NORME\_MIN”***

***/***

***“TIK\_RELA”***

***REGUL makes it possible to specify the method of regularization which one wants to use. By defect, one***

***do not add a regularization (not additional constraint on the solution: REGUL = “NOT”).***

*Currently, two types of regularization are available (minimal standard: REGUL = "NORM\_MIN" or Tikhonov of order 0 and "relative" Tikhonov: REGUL = "TIK\_RELA"). One seeks to minimize, for each sequence number of the measured field, the functional calculus following compared to:*

*2  
2  
Q  
- + -*

*exp  
num  
priori*

*with:*

*.  
: generalized co-ordinates relating to the base of projection.  
num*

*.  
Q: measured field following the degrees of freedom of observation.  
exp*

*.  
: base projection restricted with the degrees of freedom of observation.  
num*

*.  
: coefficients weighting making it possible to specify the affected weight with information has priori on the solution.*

*According to the method used, the parameters of the preceding functional calculus are declined like follows:*

*Without regularization: = 0*

*Minimal standard (NORM\_MIN): prior = 0*

*"Relative" Tikhonov (TIK\_RELA): prior: solution found with the preceding sequence number*

*It is disadvised using this key word when key word NOM\_PARA IS DEFORMED.*

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### **3.4.4 Operands**

**COEF\_PONDER and COEF\_PONDER\_F**

*This key word corresponds to the affected weight with information a priori, it is used if one is applied regularization with the solution.*

**/COEF\_PONDER =**

**coef**

*List weighting coefficients on the solution a priori (method of regularization of Tikhonov) [bib3].*

**/**  
**COEF\_PONDER\_F**

**= coef\_f**

*List weight functions on the solution a priori (method of regularization of Tikhonov). The variables of these functions depend on key word NOM\_PARA. If NOM\_PARA is INST, the variable are time. If NOM\_PARA is FREQ, the variable is the frequency. If NOM\_PARA IS DEFORMED, the variable is the sequence number of the deformation.*

*If the number of coefficients or weight functions given is lower than the number of basic vectors used in the base of projection, the coefficients or functions of weighting of the additional vectors are taken equal to the last coefficient or to last function of the list.*

## **4**

### **Phase of checking and execution**

#### **4.1 Calculation of the base of projection restricted with the degrees of freedom measured**

*Initially, the grid of measurement is projected on the grid of the digital model. One determine then the participation of the nodes of the digital model for each node of measurement via the function of form of the element which contains the node of measurement. Correspondence obtained between nodes is provided in the file MESSAGE of the Aster study.*

*The second treatment consists in calculating the component of the field (projection bases) to the node of measure according to the measured degrees of freedom.*

## *4.2 Calculation of the generalized co-ordinates*

*The solution of the equation of minimization is given by:*

$$\begin{pmatrix} -1 \\ 0 \end{pmatrix} = [T \quad TQ \quad \text{num} \quad \text{num}] \begin{pmatrix} \text{num exp} \end{pmatrix}$$

$$\begin{pmatrix} I \end{pmatrix} = [T + (I) \quad TQ \quad I \quad I \quad \text{num} \quad \text{num} \quad ]^{-1} \begin{pmatrix} \text{num exp} \quad \text{prior} \end{pmatrix}$$

*With:*

*(I): co-ordinates generalized for the sequence number I (Ti or fi),*

***Q (I): measure with the sequence number I,  
exp***

***: base projection restricted with the degrees of freedom of measurement,  
num***

***(I): coefficients allowing to specify the affected weight with information a priori with the number of order I. These variables or functions are defined by the user in the operands COEF\_PONDER or COEF\_PONDER\_F of the key word factor RESOLUTION. They are introduced in the form of a list of realities or functions and correspond, term in the long term, with each vector of the base of projection selected.***

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***According to the method used, the preceding parameters are declined as follows:***

***Without regularization: = 0***

***Minimal standard (NORM\_MIN): prior = 0***

***“Relative” Tikhonov (TIK\_RELA): prior = i-1***

***Notice 1:***

***If a weighting coefficient is negative, the treatment stops in fatal error.***

***Notice 2:***

***If all the weighting coefficients are null for a given sequence number and that it a many measurements are strictly lower than the number of basic vectors, a message***

*of alarm is emitted to prevent risk of singular matrix indeed (, in this case, it does not have there not unicity of the solution).*

*At the end of calculation, the identified generalized co-ordinates are derived in order to calculate them speeds and corresponding accelerations.*

*The result of the inversion is a concept of the tran\_gene type, harm\_gene or mode\_gene.*

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*Example of use of PROJ\_MESU\_MODAL*

*For the examples of use, it is highly advised to refer to the cases tests SDLD104 and SDLV122.*

*One presents in this paragraph the various stages for the expansion of measurement on the model numerical.*

*.*

*Reading of the grid made up of the points of measurement:*

*This operation aims to read the position of the points of measure to a file of the type grid. The format of this file must be readable by Code\_Aster (format GIBI, universal (I-deas) or soon MED). Meshs connecting the nodes of measurement can have been defined.*

*They do not have obviously any physical significance but will possibly allow to display the results at the time of the phase of postprocessing.*

*In the majority of the cases, the grid results from a code of experimental measurement which provides one file with the universal format (I-deas format). To transform it into format Aster, one uses operator PRE\_IDEAS.*

*PRE\_IDEAS (UNITE\_IDEAS = 19, UNITE\_MALLAGE = 21,  
mailmesu = LIRE\_MALLAGE (UNIT = 21),*

.

*Assignment of a mechanical model to the grid:*

*This operation aims to define the model of the support of the nodes of the grid made up points of measurement. Two cases can be considered: assignment of a modeling DIS\_T (discrete in translation => 3 degrees of freedom per node: DX, DY and DZ) or assignment of one modeling DIS\_TR (discrete in translation - rotation => 6 degrees of freedom per node: DX, DY, DZ, DRX, DRY and DRZ) if measurements of rotation are carried out.*

*modlmesu = AFFE\_MODELE (GRID = mailmesu,  
AFFE*

=

*\_F (  
GROUP\_NO*

=

*“noeumesu”,  
MODELING*

=

*“DIS\_T”,  
PHENOMENON*

=

*“MECHANICAL”),  
)*

.

*Reading of measurement:*

*Measurement can be read via operator LIRE\_RESU. This operator allows to read a file with universal format (dataset 58). He recovers the component of the field observed and assigns it to the model corresponding.*

*measure = LIRE\_RESU (FORMAT = “IDEAS”,  
UNIT = 33,  
DATASET\_58 = “YES”,  
GRID = mailmesu,*

**TYPE\_RESU = "DYNA\_TRANS",  
NOM\_CHAM = "SIEF\_NOEU",)**

.

**Definition of the base of projection:**

**The base of projection must be of the mode\_meca type or base\_modale. This concept can result MODE\_ITER\_SIMULT or DEFI\_BASE\_MODAL.**

**If one wants to extrapolate a field of strain or stress, the base must be enriched, via order CALC\_ELEM followed by CALC\_NO, by the fields of strain or stress calculated with the nodes.**

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.

**Calculation of the generalized co-ordinates:**

**The calculation of the generalized co-ordinates relating to the base of projection is ensured by operator PROJ\_MESU\_MODAL.**

**repgene = PROJ\_MESU\_MODAL (  
MODELE\_CALCUL**

**=**

**\_F (  
MODEL = modlcalc,  
BASE = bases,)  
MODELE\_MESURE**

**=**



```
_F (  
MODEL = modlmesu,  
MEASURE = measurement,  
NOM_CHAM = "SIEF_NOEU"),  
CORR_MANU  
=  
_F (  
NOEU_MESURE = "no1",  
NOEU_CALCUL = "no2"),  
RESOLUTION =  
_F (  
METHOD = "SVD",  
EPS = 1.E-4),  
)
```

***Expansion on the digital model:***

***This expansion consists in calculating on all the nodes of the digital model, the field compatible with the field observed on the measured degrees of freedom. This expansion is realized by order REST\_BASE\_PHYS.***

***answer = REST\_BASE\_PHYS (RESU\_GENE = repgene,***  
***TOUT\_CHAM = "YES"),***

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*Organization (S): EDF-R & D /AMA*

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***Macro-order MACR\_RECAL***

***1 Goal***

***To readjust computation results on experimental results or other computation results.***

*Let us consider on the one hand one or more test results and on the other hand one or more Aster calculations modelling these tests. MACR\_RECAL makes it possible to determine the parameters of these calculations (which can be parameters of law of behavior, loading, etc...) describing them as well as possible tests.*

*For more precise details on the algorithmy implemented, to refer to [R4.03.06].*

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*2 Syntax*

*Lr*

*=*

*MACR\_RECAL [listr8]*

*(UNITE\_ESCL*

*= plain*

*[I]*

***RESU\_EXP***

=

***resu\_exp***  
***[assd]***

***WEIGHT***

=

***weight***  
***[assd]***

***RESU\_CALC***

=

***resu\_calc***  
***[assd]***

***LIST\_PARA***

=

***will list\_para***  
***[assd]***

***UNITE\_RESU = /91***

***[defect]***

***· uni\_r***

**ITER\_MAXI**

=  
/10  
[defect]  
· it

**RESI\_GLOB\_RELA = /1.E-3**

[defect]  
/  
resi

**PARA\_DIFF\_FINI = /1.E-3**

[defect]  
/  
coef

**GRAPH**

**UNIT**

=  
/  
90  
[defect]  
/  
uni\_g

***INTERACTIVE =/"NOT"***

***[defect]***

***/***

***"YES"***

***FORMAT =/"XMGRACE"***

***[defect]***

***/***

***"GNUPLOT"***

***);***

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### ***3 Presentation general***

#### ***3.1 Principle of retiming***

***Let us consider the model problem of identification of the elastoplastic characteristics  $E$ ,  $y$ , AND (respectively Young modulus, elastic limit and module of work hardening) of a material on one uniaxial tensile test.***

***One has on the one hand the experimental traction diagram giving the evolution of the constraint according to time and which is a data:***

***T***

***There is in addition a function of the 3 parameters which for each value of the triplet  $E$ ,  $y$ , AND returns a calculated traction diagram:***

***( $E$ ,  $y$ , AND)***

***T***



*The objective of retiming is then to answer the question:*

*Which are the values of (E, y, AND) describing my experiment as well as possible?*

### **3.2**

#### **Organization of retiming**

*To conclude a retiming, it is necessary to have the whole of information following:*

- .*
- the NR experimental curves (with each one of these curves can be allotted a weight arbitrary),*
- .*
- the P parameters to readjust like, for each one, an estimate of its initial value, its minimal value and its maximum value,*
- .*
- the command file modelling the NR tests which one wants to readjust,*
- .*
- names of the NR sizes to be extracted from the command file above and which will be readjusted on the NR experimental curves. These sizes must be contained in one count resulting from POST\_RELEVE\_T.*

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*The setting in data of this information requires the following organization then:*

·  
*a command file says main containing the NR experimental curves, the P parameters, names of the sizes to be readjusted as well as other information suitable for retiming, the whole indicated in MACR\_RECAL. The various formats used are specified in what follows,*

·  
*a command file says slave modelling the experimental tests.*

*Indeed, retiming is an iterative process: the master file carries out the file slave, it recovers the NR curves calculated with the current prices of the P parameters, it compares the values of curves calculated with those of the experimental curves, it deduces some from new values for P parameters and revival the file slave. This process continues until obtaining convergence.*

*NR experimental curves*

*Master file*

*MACR\_RECAL*

*(file .com m of the profile*

*of study)*

*P parameters*

*Loops of retiming*

*NR calculated curves*

*File slave*

*In the following part the operands of MACR\_RECAL are described. One refers there to some notions of the language Python. It is however by no means necessary to know Python to use this macro order. The part “Example of use” is there to light the user.*

*The structure of data produced is a list of real containing the values of the parameters with convergence in the event of convergence or with the last iteration in the contrary case.*

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*4 Operands*

*4.1 Operand*

*UNITE\_ESCL*

*UNITE\_ESCL*

*Logical number of unit of the file slave, allotted in interface ASTK (column UL).*

*The extension of this file can be unspecified.*

*4.2 Operand*

*RESU\_EXP*

*RESU\_EXP*

*Name of the list Python of NR tables Numeric Python containing the NR experimental curves.*

*The list is beforehand defined in the form:*

*resu\_exp= [Numeric.array ([  
[X, y],  
0  
0*

*[X, y],  
1  
1  
...*

*[X, y]),  
N  
N*

*.....  
Numeric.array ([  
[U, v],  
0  
0*

*[U, v],  
1  
1*

...

*[U, v]]*  
*N*  
*N*  
*]*

#### ***4.3 Operand WEIGHT***

***WEIGHT***

*Name of table Numeric Python containing the NR weight to be assigned to the NR experimental curves.*

*So nonwell informed, then the table is made up of 1. The list is beforehand defined under form:*

*POIDS= Numeric.array (p0, p1,...)*

#### ***4.4 Operand RESU\_CALC***

***RESU\_CALC***

*Name of the list Python of NR lists Python containing the definition of the numerical answers corresponding to experimental measurements on which one will carry out retiming.*

#### ***4.5 Operand LIST\_PARA***

***LIST\_PARA***

*Name of the list Python of P lists Python containing the names of the variables, their values initial, their minimal values and their maximum values. This list is beforehand defined in the form:*

*List\_para= [[“PARA1\_\_”, INI\_1, MIN\_1, MAX\_1],  
 [“PARA2\_\_”, INI\_2, MIN\_2, MAX\_2],*

....  
[“PARAP\_\_”, INI\_P, MIN\_P, MAX\_P]

**Caution:**

*It is asked that the names of the variables end in two white underlined (by example: YOUN\_\_).*

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**4.6 Operand**

***ITER\_MAXI***

***ITER\_MAXI***

*Iteration count maximum of retiming.*

**4.7 Operand**

***RESI\_GLOB\_RELA***

***RESI\_GLOB\_RELA***

*Relative total residue of retiming.*

*This value is disjointed of that well informed for nonlinear solveurs STAT\_NON\_LINE and DYNA\_NON\_LINE.*

**4.8 Operand**

## ***UNITE\_RESU***

## ***UNITE\_RESU***

***Logical number of unit of the file of result of retiming (evolution of the parameters during iterations, criteria of convergence).***

### ***4.9 Operand***

#### ***PARA\_DIFF\_FINIES***

#### ***PARA\_DIFF\_FINI***

***Retiming requires the calculation of derived from the answers compared to the parameters. This calculation is realized by finished differences. PARA\_DIFF\_FINIES corresponds to in the following formula:***

$$F(X + X) - F(X)$$

)

X

X

### ***4.10 Operand***

#### ***GRAPH***

#### ***UNIT***

***Logical number of unit of the graphs produced during retiming. With each iteration, MACR\_RECAL produce NR graphic POSTSCRIPT representing the NR experimental curves and calculated.***

#### ***INTERACTIVE***

***Posting of the graphs in an interactive way.***

***Caution:***

***This is not possible that when retiming turns in interactive and not in batch.***

#### ***FORMAT***

***Choice of the software of posting in interactive mode: xmgrace or gnuplot.***

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***5 Precautions  
of employment***

***Here a whole of councils essential to correct use of retiming.***

***The experimental curves are defined like tables with two columns: for  
X-coordinates and for the ordinates.***

***The experimental curves must be functions: to a X-coordinate does not have to correspond  
that an ordinate.***

***PROHIBITED AUTHORIZES***



•  
*One must readjust NR curves calculated on NR experimental curves.*

•  
*The first calculated curve will be readjusted on the first experimental curve, the second calculated curve will be readjusted on the second experimental curve, and so on in the order indicated for operands RESU\_EXP and RESU\_CALC.*

•  
*The sizes calculated well informed under operand RESU\_CALC must result from POST\_RELEVE\_T.*

•  
*The parameters of retiming must be declared in block at the beginning of the command file slave. For example:*

*BEGINNING ();*

*DSDE\_\_ = 200. ;*

*YOUN\_\_ = 8.E4;*

*SIGY\_\_ = 10. ;*

*.....*

•  
*The initial values of the parameters of retiming are those well informed for the operand LIST\_PARA and not those present in the file slave of the user.*

•  
*With each iteration of retiming, the calculations defined in the file slave must converge. Within the framework of retiming of nonlinear calculations, it is thus strongly recommended to use the automatic cutting of the step of time.*

•  
*Within the framework of retiming of nonlinear calculations with automatic cutting of the step of time, it is essential to define a list of filing under operand LIST\_ARCH.*

•  
*Retiming is a powerful means to obtain values of parameters with started from tests. It is however not miraculous: the experimental curves must contain sufficiently information to identify the parameters. It is for example impossible to identify elastoplastic parameters with a test remaining in the elastic range. Tests experimental must thus excite the parameters to be identified.*

•  
*In same logic, it is desirable that the experimental curves contain points in a number sufficient for describing the action of the parameters well to be identified.*

•  
*Lastly, in the case of the use of several experimental curves, the fact that they have it an even many points balance the information which they bring.*

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## **6 Example of use**

### **6.1 Identification of the parameters of a law of behavior elastoplastic on a tensile test**

*This example is treated by test ZZZZ159A [V1.01.159].*

#### **6.1.1 Position of the problem**

*One has the results of a tensile test. It is about the evolution of constraint SIYY to the course time as well as evolution of the plastic deformation cumulated in the course of time.*

**Constraint SIYY**

**Cumulated plastic deformation**

*One wishes to readjust on these tests the Young modulus, the elastic limit and the slope of work hardening of an elastoplastic law of behaviour to linear isotropic work hardening.*

#### **6.1.2 Setting in data**

##### **6.1.2.1 Experiment**

*One starts first of all by defining our test results. They consist of two curves that one defines as follows.*

```
experience= [Numeric.array ([[0.00000E+00, 0.00000E+00],  
[5.00000E-02, 5.00000E+01],  
.....  
[9.50000E-01, 2.07500E+02],  
[1.00000E+00, 2.08000E+02]]),  
Numeric.array ([[0.00000E+00, 0.00000E+00],  
[5.00000E-02, 0.00000E+00],  
.....  
[9.50000E-01, 3.71250E-03],  
[1.00000E+00, 3.96000E-03]])]
```

*experiment is thus the name of a Python list (definite between hooks) of 2 Numeric tables Python.*

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### *6.1.2.2 Calculation*

*One writes then the command file Aster slave modelling this tensile test where go to appear our 3 parameters as well as the two curves to be readjusted.*

*BEGINNING ();*

*# ASSIGNMENT OF THE VALUES OF THE PARAMETERS TO BE READJUSTED*

*# THE VALUES INDICATED HERE ARE OF NO IMPORTANCE*

*# ALONE COUNT THE VALUES INDICATED IN FILE MAITRE*

**DSDE\_\_ = 200. ;**

**YOUN\_\_ = 8.E4;**

**SIGY\_\_ = 1. ;**

.....

**ACIER=DEFI\_MATERIAU (ECRO\_LINE=\_F (D\_SIGM\_EPSI=DSDE\_\_,  
SY=SIGY\_\_),  
ELAS=\_F (NU=0.3,  
E=YOUN\_\_),);**

.....

**EVOL=STAT\_NON\_LINE (CHAM\_MATER=CHMAT,  
MODELE=MO,  
ARCHIVAGE=\_F (LIST\_INST=INSTANTS,  
ARCH\_ETAT\_INIT=' OUI'),  
CONVERGENCE=\_F (ITER\_GLOB\_MAXI=10,  
RESI\_GLOB\_RELA=1.E-05),  
COMP\_INCR=\_F (RELATION=' VMIS\_ISOT\_LINE'),  
INCREMENT=\_F (LIST\_INST=INSTANTS,  
SUBD\_PAS=4,  
COEF\_SUBD\_PAS\_1=1.0,  
SUBD\_PAS\_MINI=1.E-05),  
NEWTON=\_F (REAC\_ITER=1,  
REAC\_INCR=1),  
EXCIT=\_F (CHARGE=TRACTION,  
FONC\_MULT=RAMPE,));**

.....

**# EXTRACTION OF ANSWER SIGMAYY (T)  
REPONSE1=POST\_RELEVE\_T (ACTION=\_F (OPERATION=' EXTRACTION',  
INTITULE=' SIGYY',  
=EVOL RESULT,  
NOM\_CHAM = ' SIEF\_ELNO\_ELGA',  
NOM\_CMP = "SIYY",  
GROUP\_NO = "A"),);**

**# EXTRACTION OF ANSWER EPSP (T)  
REPONSE2=POST\_RELEVE\_T (ACTION=\_F (OPERATION=' EXTRACTION',  
INTITULE=' V1',  
=EVOL RESULT,  
NOM\_CHAM = ' VARI\_ELNO\_ELGA',**

***NOM\_CMP = "V1",  
GROUP\_NO = "A",),,);***

***END ();***

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***It is necessary for us now to define in the master file the initial values and the beaches of variations of our parameters. One wishes:***

***1.E5***

***<***

***Initial Young modulus = 1.E5***

***< 5.E5***

***5.***

***<***

***Initial elastic limit = 30.***

***<***

***500.***

***1.E3***

***<***

***Modulate initial work hardening = 1.E3 < 1.E4***

***What one writes under the forme=***

***Parameters***

= [[“YOUN\_\_”, 100000. , 50000. , 500000.], [“DSDE\_\_”, 1000. , 500. , 10000.],  
[“SIGY\_\_”, 30. , 5. , 500.]]

*Finally it remains us to define in the master file the sizes to be extracted from the command file slave above. We wish on the one hand to extract column INST and column SIYY from the table REPONSE1 and in addition column INST and the V1 column of table REPONSE2. We write it:*

*calculation = [[“REPONSE1”, “INST”, “SIYY”], [“REPONSE2”, “INST”, “V1”]]*

### **6.1.2.3 MACR\_RECAL**

*We now inform this information in the body of MACR\_RECAL:*

*RESU=MACR\_RECAL (  
UNITE\_ESCL =3,  
RESU\_EXP =experience,  
LIST\_PARA =parametres,  
RESU\_CALC =calcul,);*

### **6.1.2.4 ASTK**

*One defines finally the profile of study according to:*

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### 6.1.3 Results

Once the study carried out, the file of result of ZZZZ159\_opti.resu retiming contains information following:

Calculation of the sensitivity compared to = YOUN\_\_ DSDE\_\_ SIGY\_\_

=====  
Iteration 0 =

=> Fonctionnelle = 1.0

=> Résidu = 1.0

=> Paramètres =

YOUN\_\_ = 100000.0

DSDE\_\_ = 1000.0

SIGY\_\_ = 30.0

=====  
Calculation of the sensitivity compared to = YOUN\_\_ DSDE\_\_ SIGY\_\_

=====  
Iteration 1 =

=> Fonctionnelle = 0.259742161795

=> Résidu = 0.30865397471

=> Paramètres =

YOUN\_\_ = 300857.888503

DSDE\_\_ = 9135.12770111

SIGY\_\_ = 152.548047532

=====  
*Calculation of the sensitivity compared to = YOUN\_\_ DSDE\_\_ SIGY\_\_*  
=====

*Iteration 2 =*

*=> Fonctionnelle = 0.0757636994765*

*=> Résidu = 0.473053125246*

*=> Paramètres =*

*YOUN\_\_ = 157723.378846*

*DSDE\_\_ = 2022.7431335*

*SIGY\_\_ = 213.155325073*  
=====

=====  
*Calculation of the sensitivity compared to = YOUN\_\_ DSDE\_\_ SIGY\_\_*  
=====

*Iteration 3 =*

*=> Fonctionnelle = 0.00190706595529*

*=> Résidu = 0.0520849911718*

*=> Paramètres =*

*YOUN\_\_ = 192302.166747*

*DSDE\_\_ = 895.845518907*

*SIGY\_\_ = 203.753909707*  
=====

=====  
*Calculation of the sensitivity compared to = YOUN\_\_ DSDE\_\_ SIGY\_\_*  
=====

*Iteration 4 =*

*=> Fonctionnelle = 2.70165453323e-06*

*=> Résidu = 0.00172172540305*

*=> Paramètres =*

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Version

8.2

Titrate:



*Macro-order MACR\_RECAL*

*Date:*

*31/01/06*

*Author (S):*

*O. NICOLAS, A. ASSIRE, NR. TARDIEU Key*

*:*

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*YOUN\_\_ = 199801.572817*

*DSDE\_\_ = 1928.08902726*

*SIGY\_\_ = 200.274590793*

=====

*Calculation of the sensitivity compared to = YOUN\_\_ DSDE\_\_ SIGY\_\_*

=====

*Iteration 5 =*

*=> Fonctionnelle = 2.65431115925e-12*

*=> Résidu = 1.83121468206e-06*

*=> Paramètres =*

*YOUN\_\_ = 199999.975047*

*DSDE\_\_ = 1999.86955101*

*SIGY\_\_ = 200.000462987*

=====

=====

*CONVERGENCE REACHED*

=====

*Eigenvalues of Hessien:*

*[7.17223479e+00 3.67264061e-01 6.25194340e-04]*

*Associated clean vectors:*

*[[ 0.98093218 -0.00549396 -0.19427266]*

*[-0.19418112 -0.06940835 -0.97850712]*

*[ 0.00810827 -0.9975732 0.0691517 ]]*

*-----*

*One can deduce from it that:*

*The following combinations of parameters are dominating for your*

*calculation:*

*1)  $+9.8E-01 * YOUN\_ -1.9E-01 * DSDE\_$   
associated the eigenvalue  $7.2E+00$*

*The following combinations of parameters are insensitive for your  
calculation:*

*1)  $-1.9E-01 * YOUN\_ -9.8E-01 * DSDE\_$   
associated the eigenvalue  $6.3E-04$*

*And file POSTSCRIPT ZZZZ159.ps contains:*

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*Version*

*8.2*

*Titrate:*

*Operator MODI\_REPERE*

*Date:*

*22/02/06*

*Author (S):*

***X. DESROCHES, J.M. PROIX, R. FERNANDES** Key*

*:*

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*Organization (S): EDF-R & D /AMA*

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***Operator MODI\_REPERE***

***1 Goal***

***This operator allows to make postprocessings in cylindrical reference mark or in a reference mark defined by the user.***

***The call to MODI\_REPERE is necessarily done starting from a new argument:***

***resuou = MODI\_REPERE***  
***(RESULT = resuin...)***

***The concept result is in the same way standard than the concept given.***

***A concept produced by MODI\_REPERE should not be used any more then to make calculations.***

***It is of more necessary to take care to respect strictly the rules of the paragraph [§4].***

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*Operator MODI\_REPERE*

*Date:*

*22/02/06*

*Author (S):*

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*:*

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## *2 Syntax*

*resuout [\*] = MODI\_REPERE (*

***RESULT***

***= resuin***

***,***

***/***

***[evol\_elas]***

***/***

***[evol\_noli]***

***/***

***[evol\_ther]***

***/***

***[mode\_flamb]***

***/***

***[dyna\_trans]***

***/***

***[dyna\_harmo]***

***/***

***[mode\_meca]***

***/***

***[mult\_elas]***

***/***

***[base\_modale]***

**# Selection of the sequence number:**

**/**  
**TOUT\_ORDRE**  
**=**  
**“YES”**  
**,**  
**[DEFECT]**

**/**  
**NUME\_ORDRE**  
**=**  
**l\_nuor**

**,**  
**[l\_I]**  
**/**  
**LIST\_ORDRE**  
**=**  
**l\_nuor**  
**,**  
**[listis]**

**/**  
**NUME\_MODE**  
**=**  
**l\_numo**  
**,**  
**[l\_I]**

**/NOEUD\_CMP =**  
**l\_nomo,**

**[l\_K16]**

/

**NOM\_CAS**

=

**nocas**

,

**[K16]**

/

/

**INST**

=

**l\_inst**

,

**[l\_R]**

/

**FREQ**

=

**l\_freq**

,

**[l\_R]**

/

**LIST\_INST**

=

**l\_inst**

,

**[listr8]**

/

**LIST\_FREQ**

=

**l\_freq**

,

**[listr8]**

**/ PRECISION =/prec,**

**/**  
**1.0E-3**

**,**  
**[DEFECT]**  
**/**  
**CRITERION**

**=**  
**/**  
**“RELATIVE”,**  
**[DEFECT]**  
**/**  
**“ABSOLUTE”**  
**,**

**MODI\_CHAM**  
**= (\_F (**

**GROUP\_MA**  
**=**  
**l\_grma, [l\_gr\_maille]**

**GROUP\_NO**  
**=**

***l\_grno, [l\_gr\_noeud]***

***NET***

=

***l\_maille,  
[l\_maille]***

***NODE***

=

***l\_noeud,  
[l\_noeud]]***

***NOM\_CHAM***

=

***nomch,  
[K16]***

***NOM\_CMP =***

***l\_cmp,  
[l\_K8]***

***TYPE\_CHAM***

***=/"VECT\_2D"***

,

/



**“VECT\_3D”**

,

/

**“TORS\_3D”**

,

/

**“TENS\_2D”**

,

/

**“TENS\_3D”**

,

), )

**DEFI\_REPERE=\_F (REPERE=/"USER”**

,

**ANGL\_NAUT = () [L\_R]**

/

**“CYLINDRICAL”**

,

**ORIGIN = (X, y, Z) [l\_R]**

**AXE\_Z= (oz1 oz2 oz3) [l\_R]**

)

**INFORMATION**

=

/

1

,  
**[DEFECT]**

/

2

,

**TITRATE**

= *title*,

**[l\_Kn]**

)

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**Operator MODI\_REPERE**

**Date:**

**22/02/06**

**Author (S):**

**X. DESROCHES, J.M. PROIX, R. FERNANDES Key**

**:**

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**3 Operands**

**3.1 Operand**

**RESULT**

**RESULT**

**= resuin**

***Name of the structure of data result to calculate in cylindrical reference mark. This argument must imperatively to be different from that used for the concept produced by the operator.***

**3.2**

***Selection of the sequence numbers***

***Cf [U4.02.05].***

**3.3 Key word**

***factor***

**MODI\_CHAM**

***This key word factor makes it possible to define the fields and the components to be calculated. It can moreover be repeated several times.***

**3.3.1 Operands**

**GROUP\_MA, GROUP\_NO, NODE, MESH**

***Allow to restrict the change of reference mark to certain meshes or certain nodes.***

**Attention, for the fields by elements, NODE and GROUP\_NO are prohibited.**

### **3.3.2 Operand NOM\_CHAM**

*Reference symbol of the field to be treated (see booklet [U5.01]).*

### **3.3.3 Operand NOM\_CMP**

*Names of the components which one wants to treat (see [U2.01.04]). See also the paragraph [§4].*

### **3.3.4 Operand TYPE\_CHAM**

*This **obligatory** operand makes it possible to specify the type of field to be treated. The various types are them following:*

- /“VECT\_2D” means that one treats a field of vectors with 2 components,*
- /“VECT\_3D” means that one treats a field of vectors with 3 components,*
- /“TORS\_3D” means that one treats a field of torques with 6 components,*
- /“TENS\_2D” means that one treats a field of symmetrical tensors of order 2,*
- /“TENS\_3D” means that one treats a field of symmetrical tensors of order 3.*

*See also the paragraph [§4].*

### **3.4 Key word factor DEFI\_REPERE**

*This key word factor allows the choice of a reference mark among:*

*.  
locate “USER”: defined by the data of 3 nautical angles (in degrees):*

*ANGL\_NAUT = (  
)*

*.  
locate `CYLINDRICAL `: defined by the data of the origin of the reference mark and axis OZ:*

*ORIGIN = (X, y, Z)  
co-ordinates of the origin O of the reference mark  
AXE\_Z*

= (oz1, oz2, oz3) coordinated of a vector defining axis OZ (axis of the cylinder).

*This key word can as for him be used only only once.*

### **3.5 Operand INFORMATION**

*This operand makes it possible to post the structure of the concept result (resuout).*

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Titrate:

Operator *MODI\_REPERE*

Date:

22/02/06

Author (S):

**X. DESROCHES, J.M. PROIX, R. FERNANDES** Key

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### **3.6 Operand TITRATE**

*See [U4.03.01].*

## **4 Notes of use**

### **4.1**

#### ***Definitions and precautions of uses***

*A concept produced by MODI\_REPERE should not be used any more then to make calculations, Aster not memorizing the reference mark in which the fields appear. Only impressions or layouts are licit.*

According to each type of field it is necessary to specify after *NOM\_CMP* the exact number well of components and in the following order:

.  
in the case of vectors with 2 (or 3) component): *X, Y, (Z)*,

.  
in the case of a torque with 6 components: 3 translations *X, Y, Z*, and 3 rotations *X-ray, RY, RZ*,

.  
in the case of a tensor of order 2 (4 components): *XX, YY, ZZ, XY*,

.  
in the case of a tensor of order 3 (6 components): *XX, YY, ZZ, XY, XZ, YZ*.

**Note:**

.  
When a node *NR* of the grid is on axis *OZ* (cylindrical reference mark), it is sought average node of the geometrical centers of the meshes containing the node *NR* for the calculation of the matrix of passage in cylindrical reference mark. If this average node is also on the axis *OZ*, calculation stop in fatal error.

.  
When all the components of a node are not present in the field to treat, one writes nothing in the field transformed for this node. This meets for example with elements of the modeling *COQUE\_3D* for which nodes located in the middle of faces do not have a degree of freedom of translation. The field of displacement resulting from *MODI\_REPERE* is thus not calculated for these nodes mediums of faces.

## **4.2 Correspondences cylindrical**

For the expression of the constraints in cylindrical reference mark one makes the following correspondences (by simplification one notes  $T =$ ):

Constraints in Cartesian reference mark

Constraints in cylindrical reference mark

vector *X*

*R*

*Y*

*Z*

*Z*

*T*

tensor *XX*

*RR*

YY  
ZZ  
ZZ  
TT  
XY  
RZ  
XZ  
RT  
YZ  
ZT

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**X. DESROCHES, J.M. PROIX, R. FERNANDES** *Key*

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## **5 Examples**

### **5.1**

***Calculation of displacements in cylindrical reference mark***

```
RESU1=MODI_REPERE (  
RESULT = RESU,  
NUME_ORDRE = 1,  
MODI_CHAM = (_F (NOM_CHAM = "SIEF_ELNO_ELGA",  
NOM_CMP = ("SIXX", "SIYY", "SIZZ", "SIXY"),  
TYPE_CHAM = "TENS_2D"),),  
DEFI_REPERE = _F (  
LOCATE = "CYLINDRICAL",
```

**ORIGIN = (0.0, 0.0, 0.0),**  
**AXE\_Z = (0.0, 0.0, 1.0),**  
**),**  
**)**

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***Operator MODI\_REPERE***

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***Author (S):***

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*Operator CALC\_ELEM*

*Date:*

*02/03/06*

*Author (S):*

*A. ASSIRE, J. Key Mr. PROIX*

*:*

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*Organization (S): EDF-R & D /AMA*

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*Document: U4.81.01*

## **Operator CALC\_ELEM**

### **1 Goal**

**To create or supplement a computation result fields by elements (forced, deformations,...).**

**Each desired elementary field is characterized by the key word OPTION (“SIGM\_ELNO\_DEPL”, “FLUX\_ELGA\_TEMP”, “VARI\_ELNO\_ELGA”,...).**

**The concept produced result either is created, or modified, i.e. the call to CALC\_ELEM is done the following way:**

**resu**

**=**

**CALC\_ELEM**

**(RESULT = resu..., reuse = resu,...)**

**or**

**resu1 = CALC\_ELEM (RESULT = resu,...)**

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**Titrate:**

**Operator CALC\_ELEM**

**Date:**

**02/03/06**

**Author (S):**

**A. ASSIRE, J. Key Mr. PROIX**

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## ***2 Syntax***

***resu***  
***[\*] = CALC\_ELEM***

(  
***reuse = resu,***

***MODEL***  
=  
***Mo,***  
***[model]***

***CHAM\_MATER***  
=  
***chmater,***  
***[cham\_mater]***

***CARA\_ELEM***  
=  
***carac,***  
***[cara\_elem]***

***# Selection of the meshes concerned with calculation***

/  
**ALL**  
=  
**“YES”,**  
**[DEFECT]**

/  
**/ GROUP\_MA**  
**= l\_grma**  
,  
**[l\_gr\_maille]**

**/ NET**  
  
**= l\_mail**  
,  
**[l\_maille]**

**# Selection of the sequence number:**

/  
**TOUT\_ORDRE**  
=  
**“YES”,**

/  
**NUME\_ORDRE**  
=  
**l\_nuor**

,  
**[l\_I]**

/  
**LIST\_ORDRE**

=  
**l\_nuor**

,  
**[listis]**

/  
**NUME\_MODE**

=  
**l\_numo**

,  
**[l\_I]**

/  
**NOEUD\_CMP**

=  
**l\_nomo**

,  
**[l\_K16]**

/  
**NOM\_CAS**

=  
**nocas**

,  
**[K16]**

/  
**INST**

=  
**l\_inst**

,  
[l\_R]  
/  
**FREQ**  
=  
*l\_freq*  
,  
[l\_R]  
/  
**LIST\_INST**  
=  
*l\_inst*  
,  
[listr8]  
/  
**LIST\_FREQ**  
=  
*l\_freq*  
,  
[listr8]

| **PRECISION** =/prec,  
/  
1.0E-3,  
[DEFECT]  
/  
**CRITERION**  
=  
/  
"RELATIVE",  
[DEFECT]  
/  
"ABSOLUTE"  
,

*# options for linear mechanical results*

*RESULT*

= *resu*,

/

[*evol\_elas*]

/

[*mode\_meca*]

/

[*dyna\_trans*]

/

[*mode\_stat*]

/

[*base\_modale*]

/

[*dyna\_harmo*]

/

[*mode\_flamb*]

/

[*mult\_elas*]

/

[*fourier\_elas*]

/

*TYPE\_OPTION*

=

“*ALL*”

[*DEFECT*]

*OPTION*

=

*all*

*options*

*below*,

*# options of calculation of the constraints (elements of medium*

*continuous 2D and 3D) (cf [§3.5.1])*

*/TYPE\_OPTION = "SIGM\_MASSIF",  
OPTION*

*=*

*/ "SIEF\_ELNO\_ELGA"*

*/ "SIGM\_ELNO\_DEPL"*

*/ "SIEF\_ELGA\_DEPL"*

*#*

*options of calculation of the constraints (elements of structure:  
beams, pipes, hulls)  
(cf [§3.5.1])*

*/TYPE\_OPTION = "SIGM\_STRUCT",*



*OPTION =*  
*/ "SIEF\_ELNO\_ELGA"*

*/ "SIGM\_ELNO\_DEPL"*

*/ "SIEF\_ELGA\_DEPL"*

*/ "SIGM\_ELNO\_TUYO"*

*/ "SIPO\_ELNO\_DEPL"*

| *“EFGE\_ELNO\_DEPL”*

| *“EFGE\_ELNO\_CART”*

| *“SIGM\_ELNO\_CART”*

| *“SIGM\_ELNO\_SIEF”*

/ “*SIPO\_ELNO\_SIEF*”

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Author (S):

**A. ASSIRE**, J. Key Mr. *PROIX*

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*# options of calculation of the deformations  
(cf [§3.5.2])*

*/TYPE\_OPTION = "EPSI",*

*OPTION =*

*/ "EPSI\_ELNO\_DEPL"*

/ “*EPSI\_ELGA\_DEPL*”

/ “*EPME\_ELNO\_DEPL*”

/ “*EPME\_ELGA\_DEPL*”

/ “*DEGE\_ELNO\_DEPL*”

/ “EPSI\_ELNO\_TUYO”

*# options of calculation of energies (cf [§3.5.4])*

*/TYPE\_OPTION = “ENER”,*

*OPTION = / “EPOT\_ELEM\_DEPL”*

*/ “ECIN\_ELEM\_DEPL”*

*/ “ENEL\_ELGA”*

/ “ENEL\_ELNO\_ELGA”

/ “ETOT\_ELGA”

/ “ETOT\_ELNO\_ELGA”

/ “ETOT\_ELEM”

# options of calculation of criteria (cf [§3.5.5])

/TYPE\_OPTION = "CRIT",

OPTION =  
/ "EQUI\_ELNO\_SIGM"

/ "EQUI\_ELGA\_SIGM"

/ "EQUI\_ELNO\_EPSI"

/ "EQUI\_ELGA\_EPSI"



| *“EQUI\_ELNO\_EPME”*

| *“EQUI\_ELGA\_EPME”*

| *“ENDO\_ELNO\_SIGA”*

| *“ENDO\_ELNO\_SINO”*

/ “*ENDO\_ELGA*”

/ “*ENDO\_ELNO\_ELGA*”

/ “*SIEQ\_ELNO\_TUYO*”

/ “*EPEQ\_ELNO\_TUYO*”

/ “*CRIT\_ELNO\_RUPT*”

*# options of calculation of indicators of error  
(cf [§3.5.6])*

*/TYPE\_OPTION = “INDI\_ERRE”,*

*OPTION =  
/ “SIGM\_NOZI\_ELGA”*

/ “*ERRE\_ELEM\_NOZI*”

/ “SIGM\_NOZ2\_ELGA”

/ “ERRE\_ELEM\_NOZ2”

/ “SIRE\_ELNO\_DEPL”

/ “ERRE\_ELGA\_NORE”

/ “ERRE\_ELNO\_ELGA”

*# different options (cf [§3.5.7])*

*/TYPE\_OPTION = "OTHERS",*

*OPTION = / "VALE\_NCOU\_MAXI"*

*/ "PRES\_DBEL\_DEPL"*

*/ "VNOR\_ELEM\_DEPL"*

*# options of calculation of derived (related to*

*sensitivity*) (cf [§3.2])

*/TYPE\_OPTION = "DERIVED",*

*OPTION =*  
*/ "DEUL\_ELGA\_DEPL"*

*/ "DEDE\_ELNO\_DLDE"*

*/ "DESI\_ELNO\_DLSI"*

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Author (S):

**A. ASSIRE**, J. Key Mr. *PROIX*

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*# options for the nonlinear results (produced*

*by STAT\_NON\_LINE or DYNA\_NON\_LINE or DYNA\_TRAN\_EXPLI):*

**RESULT**

= *resu*,

/

[*evol\_noli*]

/  
*TYPE\_OPTION*  
=

“ALL”  
[DEFECT]

*OPTION = all options below,*

*# options of calculation of the constraints (elements of*

*continuous mediums 2D and 3D) (cf [§3.5.1])*

*/TYPE\_OPTION = `SIGM\_MASSIF,*

*OPTION =*  
*| “SIEF\_ELNO\_ELGA”*



*# options of calculation of the constraints (elements of*

*structure: beams, pipes, hulls)*

*(cf [§3.5.1])*

*/TYPE\_OPTION = "SIGM\_STRUCT",*

*OPTION =  
/ "SIEF\_ELNO\_ELGA"*

*/ "EFGE\_ELNO\_CART"*

| “*SIGM\_ELNO\_TUYO*”

| “*SIGM\_ELNO\_COQU*”

| “*SIGM\_ELNO\_SIEF*”

| “*SIPO\_ELNO\_SIEF*”

*# options of calculation of the deformations  
(cf [§3.5.2])*

*/TYPE\_OPTION = "EPSI",*

*OPTION =  
/ "EPSI\_ELNO\_DEPL"*

*/ "EPSI\_ELGA\_DEPL"*

*/ "EPSG\_ELNO\_DEPL"*

/ “EPMSG\_ELGA\_DEPL”

/ “EPME\_ELNO\_DEPL”

/ “EPME\_ELGA\_DEPL”

/ “EPMG\_ELNO\_DEPL”

/ “EPMG\_ELGA\_DEPL”

/ “EPSP\_ELNO”

/ “EPSP\_ELGA”

/ “EPGR\_ELNO”

/ “EPGR\_ELGA”

| “*EPSI\_ELNO\_TUYO*”

| “*DEGE\_ELNO\_DEPL*”

*# options of interpolation and extraction of*

*internal variables*

*/TYPE\_OPTION = “VARI”,*

*OPTION =*

/ “VARI\_ELNO\_ELGA”

/ “VARI\_ELNO\_TUYO”

/ “VARI\_ELNO\_COQU”

/ “EXTR\_ELGA\_VARI”

/ “EXTR\_ELNO\_VARI”

*# options of calculation of energies (cf [§3.5.4])*

*/TYPE\_OPTION = "ENER",*

*OPTION =  
/ "ETOT\_ELGA"*

*/ "ETOT\_ELNO\_ELGA"*

*/ "ETOT\_ELEM"*



/ “ENEL\_ELGA”

/ “ENEL\_ELNO\_ELGA”

*# options of calculation of criteria (cf [§3.5.5])*

*/TYPE\_OPTION = `CRIT,*

*OPTION =  
/ “EQUI\_ELNO\_SIGM”*

*/ “EQUI\_ELGA\_SIGM”*

| “EQUI\_ELNO\_EPSI”

| “EQUI\_ELGA\_EPSI”

| “EQUI\_ELNO\_EPME”

| “EQUI\_ELGA\_EPME”

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/ “ENDO\_ELNO\_SIGA”

/ “ENDO\_ELNO\_SINO”

/ “ENDO\_ELGA”

/ “ENDO\_ELNO\_ELGA”

/ “INDI\_LOCA\_ELGA”

/ “SIEQ\_ELNO\_TUYO”

/ “EPEQ\_ELNO\_TUYO”

| *“CRIT\_ELNO\_RUPT”*

| *“PMPB\_ELNO\_SIEF”*

| *“PMPB\_ELGA\_SIEF”*

*# options of calculation of indicators of error*

(cf [§3.5.6]))

*/TYPE\_OPTION = “INDI\_ERRE”,*

*OPTION =  
/ “ERRE\_ELGA\_NORE”*

*/ “ERRE\_ELNO\_ELGA”*

*/ “DCHA\_ELNO\_SIGM”*

/ “*DCHA\_ELGA\_SIGM*”

/ “*RADI\_ELNO\_SIGM*”

/ “*RADI\_ELGA\_SIGM*”

# *different options (cf [§3.5.7])*

*/TYPE\_OPTION = “OTHERS”,*

*OPTION =*  
*/ “VALE\_NCOU\_MAXI”*

*# options of sensitivity*

*/TYPE\_OPTION = "DERIVED",*

*OPTION =*  
*/ "DEDE\_ELNO\_DLDE"*

*/ "DESI\_ELNO\_DLSI"*

*/ "DEUL\_ELGA\_DEPL"*

*SENSITIVITY = l\_parasensi,*  
*/*  
*theta,*



*[theta\_geom]*  
/  
will listpara,  
*[para\_sensi]*  
)

*NOM\_CHAM*  
=  
*CH,*  
*[cham\_elem\_\*]*

*NOM\_CMP*  
=  
*cmp,*  
*[TXM]*

*EXCIT*  
=*\_F*  
(

*CHARGE = l\_charge, [l\_char\_meca]*

*/COEF\_MULT = cm, [R]*

*/*

*COEF\_MULT\_C=*

*cmc,*

*[C]*

*/*

*FONC\_MULT*

*=*

*Fm,*

*[function]*

*[tablecloth]*

*[formula]*

*/*

*FONC\_MULT\_C=*

*FMC,*

*[fonction\_C]*

*PHAS\_DEG = Pd,*

*[R]*

*PUIS\_PULS = N, [I]*

*TYPE\_CHARGE = "FIXES",*

)

*NORMALIZES*

*= /*

*"VMIS", [DEFECT]*

*/*

*"TOTAL",*

*/*

*"VMIS\_CINE"*

*,*

*/*

*"TOTAL\_CINE",*

*ANGLE*

= /

*delta,*

*[I]*

/

*0.,*

*[DEFECT]*

*PLAN*

=

/

*“EMAIL”, [DEFECT]*

/

*“MOY”,*

/

“INF”,

/

“SUP”,

/ NUME\_COUCHE

=

/

nume,

[I]

/

1,

[DEFECT]

/

NIVE\_COUCHE

=

/

“INF”,

/

“SUP”,

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*/*

*“MOY”*

*[DEFECT]*

*/*

*#*

*options*

*thermics*

*OPTION*

*=*

*/*

*“FLUX\_ELNO\_TEMP”,*

*/*

*“FLUX\_ELGA\_TEMP”,*

/  
“DEUL\_ELGA\_TEMP”,

/ “DETE\_ELNO\_DLTE”,

/ “ERTH\_ELEM\_TEMP”,

/ “*ERTH\_ELNO\_ELEM*”,

/  
“*SOUR\_ELGA\_ELEC*”,

/  
“*DURT\_ELGA\_META*”,

/  
“*DURT\_ELNO\_META*”,



/  
"HYDR\_ELNO\_ELGA",

*RESULT*

= *resu*,

/  
[*evol\_ther*]

*SENSITIVITY* = *l\_parasensi*,

/  
*theta*,  
[*theta\_geom*]

/  
will listpara,  
[*para\_sensi*]

/  
#  
*options*  
*acoustics*

*OPTION*

= / "PRES\_ELNO\_DBEL",

/ “*PRES\_ELNO\_REEL*”,

/ “*PRES\_ELNO\_IMAG*”,

/ “*PRES\_DBEL\_DEPL*”,

/ “*INTE\_ELNO\_ACTI*”,

/ "INTE\_ELNO\_REAC",

## *RESULT*

=

*resu,*

/

*[acou\_harmo]*

/

*[mode\_acou]*

*TITRATE = title*

,

*[l\_Kn]*

## *INFORMATION*

= /

*l,*

*[DEFECT]*

/ 2,

);

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### **3 Operands**

#### **3.1 Operands**

**RESULT/MODEL/CHAM\_MATER/CARA\_ELEM**

**RESULT**

: *resu*

*Name of the structure of data result to enrich. This argument can be the same one as that used for the concept enriched by the operator, or a different name, which will create a news structure of data result (see for example test SSL504 [V3.03.504]).*

**MODEL: Mo**

*Name of the model on which the efforts are calculated, the constraints, deformations,.... It is optional bus can be extracted from the result.*

**CHAM\_MATER: chmater**

*Material field associated with the model Mo. Also optional.*

**CARA\_ELEM: carac**

*Elementary characteristics associated the model Mo, if it contains elements of structure or if the isoparametric elements are affected by a local reference mark of anisotropy.*

#### **3.2 Operand**

***SENSITIVITY******SENSITIVITY***

:

/

***theta******[theta\_geom]***

/

***will listpara******[para\_sensi]***

***This key word is followed of a sensitive parameter list. It specifies that one is not interested with the result in itself, but with derived from the result compared to a parameter. Thus one sequence of the type:***

***RESULTAT=resu,  
SENSIBILITE= (PS),  
OPTION=' SIEF\_ELGA\_DEPL',***

***Mean that one wants to calculate at the points of Gauss the derivative of the constraints compared to parameter PS. See [U4 .50.02] for the details on the parameters associated with the key words.***

***/“DEUL\_ELGA\_DEPL”***

***/“DEDE\_ELNO\_DLDE”***

***Derived Eulérienne from the field of displacements at the points of Gauss or the nodes [R4.03.01].***

***Require the knowledge of the Lagrangienne derivative of displacements, therefore to have activated the option SENSITIVITY in MECA\_STATIQUE, and to use the key word SENSITIVITY in CALC\_ELEM.***

***/“DESI\_ELNO\_DLSI”***

***Derived Eulérienne from the stress field to the nodes [R4.03.01].***

***Require the knowledge of the Lagrangienne derivative of the constraints in linear elasticity, thus to have activated the option SENSITIVITY in MECA\_STATIQUE, and to use the key word SENSITIVITY in CALC\_ELEM.***

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**3.3**

***Selection of the meshes concerned with calculation***

***The key words ALL, GROUP\_MA and MESH make it possible the user to choose the meshes on which it wishes to make its elementary calculations of postprocessing.***

***/ALL: "YES"***

***All the meshes (carrying finite elements) will be treated. It is the default value.***

***// GROUP\_MA***

***: l\_grma***

***/NET***

***: l\_maille***

***Only the meshes included in l\_grma and/or l\_maille will be treated.***

**3.4**

***Selection of the sequence numbers***

***Cf [U4.71.00].***

**3.5**

***Operands for the mechanical options***

***3.5.1 Option of calculation of the constraints***

/ “SIEF\_ELGA\_DEPL”

*Calculation of the state of stress per element at the points of integration of the element (points of GAUSS or points of integrations for each layer of the elements of hull and each sector of the elements pipes) starting from displacements (linear elasticity), to see [U2.01.05].*

/ “SIEF\_ELNO\_ELGA”

*Calculation of the state of stress to the nodes (by element) starting from the state of stress with points of Gauss.*

/ “SIGM\_ELNO\_DEPL”

*Calculation of the constraints by element to the nodes starting from displacements (linear elasticity), to see [U1.04.00].*

/ “SIGM\_ELNO\_COQU”

/ “NUME\_COUCHE”

=

nume,

1,

[DEFECT]

/  
“NIV\_COUCHE” =/“INF”,

/

“SUP”,

/

“MOY”,

[DEFECT]

*Calculation of the constraints **in a layer** of elements of hull (key words NUME\_COUCHE and NIVE\_COUCHE) starting from the constraints at the points of integration of each layer (SIEF\_ELGA) calculated during a nonlinear calculation. These constraints are calculated in locate local hull defined by the user in order AFFE\_CARA\_ELEM. In case of the hulls in great displacements and great rotations (COQUE\_3D with DEFORMATION=' GREEN\_GR'), this option also integrates the calculation of the constraints of Cauchy starting from the constraints of Piola-Kirchhoff. Constraints resulting from this option are thus constraints of Cauchy in a layer.*

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| “SIGM\_ELNO\_TUYO”

*Calculation of the constraints in a layer and for an angular sector of elements pipe  
(key words NUME\_COUCHE, NIVE\_COUCHE and ANGLE).*

**ANGLE**

= /

*delta,*

[I]

/

0.,

[DEFECT]

/ NUME\_COUCHE

=

/

*nume,*

[I]

/

1,

[DEFECT]



```

/
NIVE_COUCHE
=
/
“INF”,
/
“SUP”,
/
“MOY”,
[DEFECT]

```

*with:*

- *delta: angle in degrees (whole value) counted starting from the position of generator of the element pipe,*
- *nume: number of layer (number 1 corresponds to the internal layer). Must to be lower or equal to the total number of layers given in STAT\_NON\_LINE (key word TUYAU\_NCOU),*
- *NIVE\_COUCHE indicates the position of the point of integration in layer (INF corresponds to the internal point).*

```

/ “SIGM_ELNO_CART”
“EFGE_ELNO_CART”

```

*Change of reference mark of the constraints (or the generalized efforts) by element with the nodes local reference mark with the **total** reference mark of description of the grid; this option consists in converting a stress field (or efforts generalized) for a model with elements of structure, attached to the reference mark of reference of a whole of plates or hulls or locate inertia the main thing of an element of beam, to express them in the total reference mark. The generalized efforts can be obtained in a reference mark specified by the user with the assistance key word EFGE\_REPERE*

```

/ “EFGE_ELNO_DEPL”

```

*PLAN*

*:*

/  
“EMAIL”  
[DEFECT]

/“MOY”

/  
“INF”

/“SUP”

*Calculation of the efforts generalized by element with the nodes starting from displacements (elasticity linear); this option has direction only for one model with elements of structure (beam, hull).*

*In the case of modelings of plates with offsetting (DKT, DST, Q4G, GRID),*

*PLAN makes it possible to define the plan of calculation:*

.  
*“EMAIL”*: plan of the grid,

.  
*“MOY”*: average plan,

.  
*“INF”*: higher plan (in the direction of the normal),

.  
*“SUP”*: lower plan (in the direction of the normal).

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/ *“SIPO\_ELNO\_DEPL”*

*“Forced” in the section of beam broken up into contributions of each effort  
generalized:*

*NR*

*SN*

*xx =*

*with*

*had*

*normal*

*effort*

*With*

*MY Z*

*SMFY*

=

*moment*

*with*

*had*

*inflection*

*of*

*MY*

*xx*

*I y*

*MZ y*

*SMFZ*

=

*moment*

*with*

*had*

*MZ*

*xx*

*I Z*

*Vyay*

*SVY*

=

*with*

*had*

*edge*

*effort*

*Vy*

, coefficient has  
cisailleme

of  
T

direction

in

NT

y

xy

With

y

Vzaz

SVZ

=

with

had

edge

effort

Vz

, coefficient has  
cisailleme

of  
T

direction

in

NT

Z

xz

With

Z

*MX Rt*  
*SMT*  
*=*  
*moment*  
  
*with*  
  
*had*  
  
*torsion*  
  
*of*  
  
*MX*  
*yz*  
*J X*

*All this in local reference mark, principal reference mark of inertia of the cross-section [R3.08.01].*

*The values of  $xx$  due to the two bending moments are the values maximum of those calculated in  $Y_{min}$ ,  $Y_{max}$  on the one hand, and in  $Z_{min}$ ,  $Z_{max}$  on the other hand (for a section general) (cf *AFFE\_CARA\_ELEM [U4.42.01]*).*

*For a rectangular section:*

*.*  
*one calculates the value of  $SMFY$  in  $Z = HZ/2$ ,*  
*.*  
*one calculates the value of  $SMFZ$  in  $y = HY/2$ .*

*.*  
*For a circular section, one calculates the values of  $SMFY$  and  $SMFZ$  for  $y$  and  $Z$  being worth  $R$ .*

*/ “SIGM\_ELNO\_SIEF”*

*/ “SIPO\_ELNO\_SIEF”*

*Calculation of the constraints linearized by element with the nodes starting from the generalized efforts (contents in field *SIEF\_ELNO\_ELGA*).*

*The expressions are the same ones as for options *SIGM\_ELNO\_DEPL* or *SIPO\_ELNO\_DEPL*, usable only in linear elasticity. Here, options *SIGM\_ELNO\_SIEF* and *SIPO\_ELNO\_SIEF* carry out same calculations as*

*NR*  
*M y. R M y. R*

*SIGM\_ELNO\_DEPL or SIPO\_ELNO\_DEPL (for example xx =*

*+*

*+*

*) with*

*S*

*Iz*

*Iy*

*to leave the field SIEF\_ELNO\_ELGA, which can be calculated for behaviors not linear. These local constraints are not the real constraints, but an estimate of constraints due to the efforts generalized under the assumption of a linear distribution in section of the beam.*

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### ***3.5.2 Options of calculation of the deformations***

*/ “DEGE\_ELNO\_DEPL”*

*Calculation of the deformations generalized by element with the nodes starting from displacements (linear elasticity); this option has direction only for one model with elements of structure.*

*/ “EPGR\_ELNO”*

*“EPGR\_ELGA”*

*Calculation (with the nodes or the points of Gauss) of the deformations of creep associated with model of creep of GRANGER (for the concretes).*

/ "EPME\_ELNO\_DEPL"  
"EPME\_ELGA\_DEPL"

*Calculation (with the nodes or the points of Gauss) of mechanical deformations `the "" from displacements. This calculation is made in theory of the `small " displacements. Deformations calculated are equal to the total deflections minus the thermal deformations.*

*m*  
*1*  
*HT*  
*ij (U) =*  
*(iu J +uji) -*  
*2*  
,

/ "EPMG\_ELNO\_DEPL"  
"EPMG\_ELGA\_DEPL"

*Calculation (with the nodes or the points of Gauss) of mechanical deformations `the "" from displacements. This calculation is made in theory of the `great " displacements. Deformations calculated are equal to the total deflections minus the thermal deformations.*

*1*  
*E m*  
*HT*  
*ij (U) =*  
*(U +u +u U*  
*I J*  
*JI*  
*K I K J) -*  
*2*  
,



| “EPSG\_ELGA\_DEPL”

*Deformations of Green Lagrange at the points of Gauss.*

1  
E (U) = (U + U + U U  
ij  
I J  
J I  
K I K J)

2

,  
,  
,  
,

| “EPSG\_ELNO\_DEPL”

*Deformations of Green Lagrange to the nodes.*

| “EPSI\_ELNO\_DEPL”  
“EPSI\_ELGA\_DEPL”

*Calculation of the deformations by element to the nodes (or the points of Gauss) from displacements.*

(  
1  
U)  
ij  
= (iu J + uj I)

2  
,  
,

| “EPSI\_ELNO\_TUYO”

*Calculation of the deformations **in a layer** and for an angular sector of elements pipe (key words NUME\_COUCHE, NIVE\_COUCHE and ANGLE).*

ANGLE  
= /  
delta,

[I]

/  
0.,  
[DEFECT]  
/ NUME\_COUCHE

=  
/  
nume,

[I]  
/  
1,  
[DEFECT]  
/  
NIVE\_COUCHE

=  
/  
"INF",  
/  
"SUP",  
/  
"MOY",

[DEFECT]  
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with:

- *delta*: angle in degrees (whole value) counted starting from the position of generator of the element pipe,
- *nume*: number of layer (number 1 corresponds to the internal layer). Must to be lower or equal to the total number of layers given in *STAT\_NON\_LINE* (key word *TUYAU\_NCOU*),
- *NIVE\_COUCHE* indicates the position of the point of integration in layer (*INF* corresponds to the internal point).

/ “EPSP\_ELGA”

Anelastic deformations at the points of Gauss. From the field of displacements (*U*), of constraints (*ε*), of temperatures *T* (it is thus necessary to provide the load containing “TEMP\_CALCULEE”), of possible anelastic deformations *ε<sub>a</sub>*, and of internal variables, one calculates at every moment: *p*

$= (U)$

-1

*HT*

- *A* - (*T*)

has

*fl*

- - where *fl*

is

clean deformation of creep of Granger.

/ “EPSP\_ELNO”

Anelastic deformations obtained by extrapolation with the nodes of the values at the points of Gauss (cf *EPSP\_ELGA*).

### 3.5.3 Options of interpolation and extraction of the internal variables

/ “VARI\_ELNO\_ELGA”

Calculation of the variables intern with the nodes of the elements starting from the points of Gauss.

The number and the type of these internal variables are specific to each model of behavior (cf *Doc. U4* of *STAT\_NON\_LINE* for example).

/ “VARI\_ELNO\_TUYO”

*Calculation of the variables intern **in a layer** and for an angular sector of elements pipe (key words NUME\_COUCHE, NIVE\_COUCHE and ANGLE).*

ANGLE

= /

delta,

[I]

/

0.,

[DEFECT]

/ NUME\_COUCHE

=

/

nume,

[I]

/

1,

[DEFECT]

/

NIVE\_COUCHE

=

/

“INF”,

/

“SUP”,

/

“MOY”,

[DEFECT]

with:

- delta: angle in degrees counted starting from the position of the generator of the element pipe,
- nume: number of layer (number 1 corresponds to the internal layer). Must to be lower or equal to the total number of layers given in STAT\_NON\_LINE (key word TUYAU\_NCOU),
- NIVE\_COUCHE indicates the position of the point of integration in layer (INF corresponds to the internal point).

| “VARI\_ELNO\_COQU”

*Calculation of the variables intern in a layer of elements hull defined by NUME\_COUCHE and NIVE\_COUCHE.*

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**Note:**

*For options **RADI\_ELNO\_SIGM** and **RADI\_ELGA\_SIGM**, it should be known that calculation require to compare the stress fields with the moments  $T_i$  and  $t_{i+1}$ . The result is arranged with the sequence number associated with the moment  $T_i$ .*

( -

+1

):

*The indicator of loss of radiality is calculated by: **IP***

**I**

**I**

**I**

= 1-

.

**I** -

+1

**I. I**

*By defect, calculation is done for the sequence numbers 1 with n1.*

*If one specifies the list of moment (with “holes” possibly), calculation will only concern the required moments but it the moment  $T_i$  with the moment  $t_{i+1}$  in the list will always compare of moments having been used to make non-linear calculation.*

/ “**EXTR\_ELNO\_VARI**”,

“EXTR\_ELGA\_VARI”

*Extraction of the **variables only intern in THM** (respectively with the nodes by elements and at the points of Gauss).*

*To be able post to treat the variables intern in THM in a more convivial way, of the fields were created. The principle of these fields is to extract from field VARI\_ELGA (or VARI\_ELNO\_ELGA for the cham\_elem with the nodes) the variable interns which interests us via a key word more speaking that V1, V2,...*

*NOM\_VARI*

*= /*

*nom\_vari,*

*[TXM]*

*The name of the new fields is EXTR\_ELGA\_VARI and EXTR\_ELNO\_VARI for cham\_elem and EXTR\_NOEU\_VARI for the cham\_no.*

*As a post treatment these fields are calculated by CALC\_ELEM and CALC\_NO. syntax to be used is as follows:*

*· for a cham\_elem*

*GAMP=CALC\_ELEM (RESULTAT=U1,*

*OPTION=' EXTR\_ELNO\_VARI',*

*NOM\_VARI=' GAMP'); -----> new key word to indicate which*

*variable one wishes to extract via one name*

*coded*

*· for a cham\_no*

```
GAMP=CALC_NO (reuse=GAMP,  
RESULTAT=GAMP,  
OPTION=' EXTR_NOEU_VARI');
```

*Since it is just a question of extracting one (and only one!!) internal variable, cham\_elem correspondents must be calculated as a preliminary.*

*The list of the various reference symbols of the internal variables is:*

*“DPORO”*

*: variation of the porosity of material*

*“DRHOLQ”*

*: variation of the density of material*

*“DPVP”*

*: variation of the steam pressure*

*“SATLIQ”*

*: saturation of the liquid*

*“EVP”*

*: cumulated voluminal plastic deformation*

*“IND\_ETA”*

*: Mechanical indicator of state*

*“D”*

*: Value of the damage*

*“IND\_END”*

*: Indicator*

*of damage*

*“TEMP\_MAX”*

*: Temperature*

*maximum*

*“GAMP”*

*: Plastic deformation déviatoire cumulated*

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## Operator CALC\_ELEM

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**“PCR”**

: *Pressure*

*critical*

**“SEUIL\_HYD”**

: *Threshold*

*hydrous*

**“IND\_HYD”**

: *Hydrous indicator of irreversibility*

**“PCOHE”**

: *Pressure of cohesion*

**“COMP\_ROC”**

: *Behavior of the rock*

**“SEUIL\_ISO”**

: *Threshold*

*isotropic*

**“ANG\_DEV”**

: *Angle of the threshold déviatoire*

**“X11”**

: *Components of the kinematic tensor of work hardening*

**“X22”**

: *Components of the kinematic tensor of work hardening*

**“X33”**

: *Components of the kinematic tensor of work hardening*

**“X12”**

: *Components of the kinematic tensor of work hardening*

**“X13”**

: *Components of the kinematic tensor of work hardening*

**“X23”**

: *Components of the kinematic tensor of work hardening*

**“DIST\_DEV”**

: *Outdistance standardized with the threshold déviatoire*

**“DEV\_SUR\_CRIT”**

: *Relationship between the threshold déviatoire and the threshold deviatoric*

*critical*

*“DIST\_ISO”*

*: Outdistance standardized with the isotropic threshold*

*“NB\_ITER”*

*: Iteration count internal*

*“STOP”*

*: Value of the local test of stop of the iterative process*

*“NB\_REDE”*

*: Numbers of local recutting of the step of time*

*“SIGN”*

*: Sign contracted product of the deviatoric constraint by deviatoric plastic deformation*

**Note:**

*When the variable to be extracted does not form part of the internal variables of the laws concerned, an alarm is emitted but the field is affected all the same with R8VIDE ().*

### **3.5.4 Options of calculation of energies**

*/ “ECIN\_ELEM\_DEPL”*

*Kinetic energy of an element.*

*/ “ENEL\_ELNO\_ELGA”*

*“ENEL\_ELGA”*

*Calculation of the density of energy elastic at the points of Gauss or the nodes of each element.*

*This option differs from the option EPOT\_ELEM\_DEPL which calculates the deformation energy rubber band integrated in each element, this energy being a scalar for an element given. Here, one calculates the density of energy elastic which is written:*

*1*

*E*

*To 1*

*p =*

*-*

*2*

*This calculation is pressed on the stress field at the points of Gauss, obtained by SIEF\_ELGA*

or *SIEF\_ELGA\_DEPL*.

/ “*EPOT\_ELEM\_DEPL*”

*Calculation of the potential energy of deformation integrated on an element, from displacements U and of the temperatures T*

.  
*for the elements of continuous mediums 2D and 3D:*

*1*  
*1*  
*EPOT =*  
*(U). With (U) FD -*  
*(U)*  
*HT*  
*. With (T) FD +*  
*HT*  
*(T)*  
*HT*  
*. WITH (T)*

*FD*  
*2*  
*2*  
*element*  
*element*  
*element*

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.

*for the elements of beams:*

*1 T*

*T*

*T*

*HT*

*1 HT*

*HT*

*EPOT = the U.K. have - U B A + A*

*2*

*2*

.

*and for the elements of plates and hulls:*

*1 T*

*T*

*T*

*HT*

*EPOT = THE U.K.U - U B A*

*E*

*2*

*/ "EPGR\_ELGA"*

*/ "EPGR\_ELNO"*

*Deformations of clean creep of the concrete (model of Granger [R7.01.01]).*

*/ "ETOT\_ELGA"*

*/ "ETOT\_ELNO\_ELGA"*

*/ "ETOT\_ELEM"*

*Calculation of the total deformation energy (see option ENER\_TOTALE of POST\_ELEM) with*

*points of Gauss, with the nodes or integrated on the element.*

*/ “PRES\_DBEL\_DEPL”*

*Calculation of the pressure to the nodes of the elements (in decibels) starting from the fields of displacements for the elements of vibroacoustic.*

### ***3.5.5 Options of calculation of criteria***

*/ “CRIT\_ELNO\_RUPT”*

*Calculation of the criteria of rupture for the composite material hulls [R4.01.01]. To leave constraints calculated for a given layer (option “SIGM\_ELNO\_DEPL”, and words keys NUME\_COUCHE and NIVE\_COUCHE), and of the ultimate stresses provided under ELAS\_ORTH in DEFI\_MATERIAU, field “CRIT\_ELNO\_RUPT” contains 6 components:*

*L*

*CRIL =*

*feel*

*in*

*traction*

*in*

*rupture*

*of*

*criterion*

*L, if*

*> ,*

*0*

*X*

*L*

*T*

*L*

*CRILP =*

*compressio*

*in*

*rupture*

*of*

*criterion*

*feel*

*in*

*N*

*L, if*

*<,*

*0*

*X*

*L*

*C*

*T*

*CRIT =*

*feel*

*in*

*traction*

*in*

*rupture*

*of*

*criterion*

*T, if*

*>,*

*0*

*Y*

*T*

*T*

*T*

*CRITP =*

*compressio*

*in*

*rupture*

*of*

*criterion*

*feel*

*in*

*N*

*T, if*

*<,*

*0*

*Y*

*T*

*C*

*LT*

*CRILT =*

*cisailleme*

*in*

*rupture*

*of*

*criterion*

*NT*

*S \_ LT*

*and*

*CRITH =*

*Tsai*

*of*

*criterion*

*- Hill*

*(see example in test SSLS121 [V3.03.121])*

*All these quantities are calculated in the reference mark of orthotropism of the stage coach considered.*

/ "ENDO\_ELNO\_SIGA"  
"ENDO\_ELNO\_SINO"

*Calculation of the rate of triaxiality and the constraint equivalent of damage (to the nodes (\_SINO) or at the points of Gauss (\_SIGA) starting from the constraints.*

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*That is to say S the diverter of the tensor of the constraints:*

$$I$$
$$S = - \text{tr} ( ). I$$
$$3$$

$$3$$
$$=$$
$$S: S$$
$$eq$$

$$2$$
$$1$$
$$= \text{tr} ( )$$

$$H$$
$$3$$

*The rate of triaxiality is defined by:*



=  $H$

eq

The equivalent constraint of damage is:

$$2 \sqrt{\frac{1}{2} \text{tr}(\mathbf{D}) + (3I - 2) \frac{1}{2}}$$

eq

3

/ "ENDO\_ELGA"

Calculation of the damage  $D$  at the points of Gauss starting from the tensor of the constraints and of cumulated plastic deformation  $p$ . the kinetics of damage is given by the law of Lemaître-Sermage:

$Y S$

$$d\mathbf{D} = \frac{p}{Y} \mathbf{D}$$

& if  $p > p_0$

$S$   
threshold

2  
\*

with  $Y =$

$$2 \sqrt{\frac{1}{2} \text{tr}(\mathbf{D}) + (3I - 2) \frac{1}{2}}$$

where  $S$  and  $S_0$  are coefficients characteristic of material and  $p_0$  the threshold  
threshold

of damage related to the energy stored in material (if  $S = 1$  one obtains the law of Traditional Lemaître).

Systematic calculation of the rate of triaxiality and the equivalent constraint of damage \*:

2

2  
*SI\_ENDO*: \* =  
(1+ ) + (31-  
2 )  
*eq*  
)  
3

*TRIAX*: =  
*H*

*eq*

*with*

3

=

:''

*eq*

2

1

= *tr*

*H*

( )

3

1

'= - *tr* ( ) *I*.

3

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*Calculation of the total damage by linear office plurality*

*D\_CUMULE:  $D = D$ :*

*I*

*I*

*TRIAx value of the rate of triaxiality*

*SI\_ENDO value of the constraint of damage of Lemaître-Sermage*

*COENDO value of the constraint of damage of Lemaître-Sermage standardized*

*DOM\_LEM value of the damage of Lemaître-Sermage*

*D\_CUMULE value of the damage of cumulated Lemaître-Sermage*

*/ “ENDO\_ELNO\_ELGA”*

*Damage of Lemaitre-Sermage obtained by extrapolation with the nodes of the values at the points of Gauss (cf ENDO\_ELGA).*

*/ “EQUI\_ELGA\_EPSI”*

*/ “EQUI\_ELGA\_EPME”*

*Deformations “equivalent” to the points of Gauss (calculated starting from the fields*

*EPSI\_ELGA\_DEPL, or EPME\_ELGA\_DEPL):*

*2*

*INVA\_2: second invariant of  $INVA_2 =$*

*ij*

*ij*

*3*

*INVA\_2SG: second invariant of signed by the trace of*

*PRIN\_1, PRIN\_2, PRIN\_3: principal deformations*

*For the elements PIPE, the components calculated are INVA\_2 and INVA\_2SG*

/ "EQUI\_ELGA\_SIGM"

Constraints "equivalent" to the points of Gauss:

3

VMIS =

\$

ij \$

2

ij

VMIS: constraint of von Mises:

tr

\$

= -

ij

ij

3 ij

VMIS\_SG: constraint of von Mises signed by the trace of

INVA\_2: second invariant of

INVA\_2SG: second invariant of signed by the trace of

PRIN\_1, PRIN\_2, PRIN\_3: principal constraints

TRESCA: constraint of Tresca

VECT\_1\_X, VECT\_1\_Y, ..., VECT\_3\_Z: principal constraints, deformations and directions, only for modelings below:

3D, 3D\_SI, 3D\_GRAD\_VARI

SHB8 only for the constraints

AXIS, AXIS\_SI, AXIS\_GRAD\_VARI

D\_PLAN, D\_PLAN\_SI, D\_PLAN\_GRAD\_EPSI, D\_PLAN\_GRAD\_VARI

C\_PLAN, C\_PLAN\_SI, C\_PLAN\_GRAD\_EPSI, C\_PLAN\_GRAD\_VARI

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*For the elements PIPE, the components calculated are VMIS and VMIS\_SG and their version signed \*\_SG.*

*/ "EQUI\_ELNO\_EPSI"*

*/ "EQUI\_ELNO\_EPME"*

*Deformations "equivalent" to the nodes (calculated starting from fields EPSI\_ELNO\_DEPL, or EPME\_ELNO\_DEPL):*

*INVA\_2: second invariant of*

*INVA\_2SG: second invariant of signed by the trace of*

*PRIN\_1, PRIN\_2, PRIN\_3: principal deformations*

*/ "EQUI\_ELNO\_SIGM"*

*Constraints "equivalent" to the nodes:*

*VMIS: constraint of von Mises*

*VMIS\_SG: constraint of von Mises signed by the trace of*

*PRIN\_1, PRIN\_2, PRIN\_3: principal constraints*

*TRESCA: constraint of Tresca*

***For the elements of continuous mediums 2D and 3D, they are (starting from version 7.2) extrapolated with the nodes starting from the constraints equivalent calculated to the points of Gauss, they same calculated starting from the stress fields at the points of Gauss (SIEF\_ELGA\_DEPL into linear, and SIEF\_ELGA into nonlinear).***

*If one calculates then the values realised with the nodes, by the option*

*“EQUI\_NOEU\_SIGM” of CALC\_NO, the interpolations, one does not have inevitably VMIS = ABS (VMIS\_SG).*

*For the elements of hulls, they are calculated directly on the local constraints (in a point thickness) to nodes (SIGM\_ELNO\_DEPL into linear and SIGM\_ELNO\_COQU in nonlinear).*

*/ INDI\_LOCA\_ELGA'*

*Indicator of localization, based on the acoustic tensor (criterion of RICE), defined by:  $\det (N.H.N) \leq 0$ , where H appoints the tangent operator and NR the normal with the directions of localization.*

*This definite indicator a state from which the local problem integration of the behavior its character of unicity loses.*

*The method is developed only in the case 2D and for the law of behavior of the type DRUCKER\_PRAGER.*

*The OPTION INDI\_LOCA\_ELGA which contains the following components:*

*.*

*INDEX*

*: Indicator of localization being worth 0 if  $\det (N.H.N) > 0$ , and being worth 1 if not, which corresponds has the initiation of the localization,*

*.*

*DIR1*

*:*

*corresponds to the first normal at the zone of localization,*

*.*

*DIR2*

*:*

*with the second normal*

*.*

*DIR3*

*:*

*with the third normal*

*.*

*DIR4*

*:*

*with the fourth normal*

*/ EPEQ\_ELNO\_TUYO'*

| *SIEQ\_ELNO\_TUYO'*

*Calculation of the generalized strains and the stresses for elements pipe. It is equivalent values of type EQUI\_ELGA\_SIGM and EQUI\_ELGA\_EPSI in a point of section. It is an extraction carried out according to the same principle as the already existing option SIGM\_ELNO\_TUYO. The calculation of the deformations is carried out in a layer and a sector angular of elements Pipe.*

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| *“PMPB\_ELGA\_SIEF”*

| *“PMPB\_ELNO\_SIEF”*

*Calculation of criteria of the RCC-M G3000 for the elements of beams POU\_D\_E and POU\_D\_T. Two quantities are calculated: PM and PMPB.*

*NR*

*PM = S*

*NR*

*M. R*

2

2

*PMPB =*

+

with  $M = M_y + M_z$

$S$

$I$

This corresponds to the maximum value of  $SIXX$  in a circular section [R3.08.01].

$PMPB\_ELGA\_SIEF$ : values of  $PM$  and  $PMPB$  at the points of Gauss, calculated from  $SIEF\_ELGA$ .

$PMPB\_ELNO\_SIEF$ : values of  $PM$  and  $PMPB$  to the nodes, calculated from  $SIEF\_ELNO\_ELGA$ .

In any rigour, these criteria are to be applied to the primary constraints. This distinction is to make by the user.

### 3.5.6 Options of calculation of indicators of error

/ “ $DCHA\_ELGA\_SIGM$ ”

Local indicator of discharge at the points of Gauss [R4.20.01].

/ “ $DCHA\_ELNO\_SIGM$ ”

Local indicator of discharge to the nodes [R4.20.01].

#### Note:

For options  $DCHA\_ELGA\_SIGM$  and  $DCHA\_ELNO\_SIGM$ , it should be known that calculation require to compare the stress fields with the moments  $T_i$  and  $t_{i+1}$ . The result is arranged with the sequence number associated with the moment  $T_i$ .

-

+

$I$

The indicator of discharge is calculated by:  $ID$

$I$

$I$

=

.

$i+1$

By defect, calculation is done for the sequence numbers  $I$  with  $nI$ .

If one specifies the list of moment (with “holes” possibly), calculation will only concern



*the required moments but it the moment  $T_i$  with the moment  $t_{i+1}$  in the list will always compare of moments having been used to make non-linear calculation.*

*/ “ERRE\_ELEM\_NOZ1”  
(respectively “ERRE\_ELEM\_NOZ2”)*

*Calculation of the estimator of error of ZHU\_ZIENKIEWICZ (linear elasticity 2D) from option “SIGM\_NOZ1\_ELGA” (respectively “SIGM\_NOZ2\_ELGA”). If this last field do not exist in resu, there is automatically built as a preliminary, to see [R4.10.01].*

*/ “ERRE\_ELGA\_NORE”*

*Estimator of error in residue in mechanics, calculated by element [R4.10.02].*

*The Councils of use of option ERRE\_ELGA\_NORE*

*For carrying out well the estimate of error of mechanical calculation (within the theoretical limits of the formula developed within the elliptic framework with regular border....), it should be carried out on all the model:*

*ALL = “YES” (default value)*

*It should be noted that the model is not inevitably defined on all the geometry.*

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*It is also necessary to carry out beforehand in CALC\_ELEM the calculation of the constraints to the nodes (cf [R3.06.03]), by SIGM\_ELNO\_DEPL or SIRE\_ELNO\_DEPL into linear, SIEF\_ELNO\_ELGA in nonlinear. If not an alarm is emitted and the error analysis is not carried out without causing the stop execution. If the stress field to the nodes already exists in the structure of data result it is not recomputed.*

*With regard to the loadings:*

*It is necessary to provide to CALC\_ELEM the loadings used for mechanical calculation: EXCIT=\_F (CHARGE=....)*

*by taking well guard with the rules of different overloads for the mechanical solver and for this option of CALC\_ELEM.*

*Thus, mechanical calculation (MECA\_STATIQUE, STAT\_NON\_LINE...) incorporate the conditions with*

*limits whereas the error analysis will not retain, for a type of boundary conditions given, that the last listed in the EXCIT of CALC\_ELEM.*

*The order thus has a crucial importance! One thus should not, for a type of conditions with limits, that only one occurrence in the AFFE\_CHAR...*

*One holds account only loading of the type: GRAVITY, ROTATION, FORCE\_INTERNE, PRES\_REP, FORCE\_FACE, FORCE\_ARETE.*

*Only the three last can be variable.*

*It is advised to use finite elements of order 2 in the case of voluminal forces, if not this term is very badly calculated since DIV (SIGMA) is quasi null!*

*To take into account the error relating to a CL null it should be forced as a function via a AFFE\_CHAR\_MECA\_F. Via a constant, it will not be taken into account.*

*Grid:*

*The grid must be triangular or tetrahedral, with any GROUP\_NO if one wants to re-mesh then via LOBSTER.*

*In 2D, it takes into account only the errors on (and between) the isoparametric elements SEG2/3, TRIA3/6, QUAD4/8/9.*

*In 3D, idem with FACE3/4/6/8/9, TETRA4/10, PENTA6/13/15 and HEXA8/20/27... thus not PYRAM nor elements of structure (hull, plate, beam...).*

*In addition, it is necessary to take care not to intercalate segments between two quadrangles or two*

*triangles (resp. quad or triangle between two hexa), if not one cannot calculate the term of jump relating to this vicinity. In the place, one enquérit (wrongly) of possible a CL.*

/ “ERRE\_ELNO\_ELGA”

*Estimator of error in residue to the nodes [R4.10.02].*

/ “RADI\_ELGA\_SIGM”

*Indicator of loss of radiality at the points of Gauss [R4.20.01].*

/ “RADI\_ELNO\_SIGM”

*Indicator of loss of radiality to the nodes [R4.20.01].*

/ “SIGM\_NOZ1\_ELGA”

*Calculation of the constraints to the nodes (linear elasticity 2D); the constraints are obtained by a total smoothing (within the meaning of least squares) of the constraints at the points of GAUSS. See Estimate of error by smoothing of the constraints [R4.10.01].*

/ “SIGM\_NOZ2\_ELGA”

*Calculation of the constraints to the nodes (linear elasticity 2D); the constraints are obtained by a local smoothing with a patch of elements (within the meaning of least squares) of the constraints with points of GAUSS, to see [R4.10.01].*

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### **3.5.7 Others** **options**

| “VNOR\_ELEM\_DEPL”

*Projection of a field speed on the normal of the elements of the hull type or plate.  
 This option is used in particular for the chaining with the code VARIED.*

| “VALE\_NCOU\_MAXI”

*NOM\_CHAM = CH [cham\_elem\_\*]*

*NOM\_CMP*

=  
*cmp [TXM]*

*Extraction of the extreme values, in each point of linear Gauss of a pipe section,  
 component cmp of the CH field, on all the points of integration of the section.  
 The possible fields are: stress fields (SIEF\_ELGA\_, SIEF\_ELGA\_DEPL),  
 fields of deformations (EPSI\_ELGA\_DEPL), fields of equivalent values  
 (EQUI\_ELGA\_SIGM, EQUI\_ELGA\_EPSI), internal fields of variables (VARI\_ELGA).*

*The field creates name VALE\_NCOU\_MAXI contains for each moment the components:*

*MIN*

*value minimum*

*MAX*

*maximum value*

*NCOUMIN*

*number of the layer for the value min*

*NCOUMAX*

*number of the layer for the value max*

*NSEGMIN*

*number of the angular sector for the value min*

*NSEGMAX*

*number of the angular sector for the value max*

*NPCOUMIN*

*number of the point of layer NCOUMIN*  
*NPCOUMAX*  
*number of the point of layer NCOUMAX*  
*NPSECMIN*  
*number of the point on sector NSECMIN*  
*NPSECMAX*  
*number of the point on sector NSECMAX*

### **3.5.8 Word**

*key*

**EXCIT**

#### **3.5.8.1 Operand**

**CHARGE**

*This key word factor makes it possible to define the thermal or mechanical loadings and of coefficients which were useful in the structural analysis of data RESULT that one enriches.*

**Operand CHARGES**

*CHARGE = load*

*Necessary to recover the values of temperature (for an analysis thermomechanical) and loadings distributed for the models containing of the beams.*

**Field of temperature for a thermomechanical analysis**

*The field of temperature thus recovered intervenes in 2 ways:*

*·*  
*possible modification of the characteristics of materials,*

*·*  
*taking into account of thermal dilation for the calculation of the deformations and of constraints.*

**Important remark:**

*It is a rather traditional error of use to forget to inform the key word CHARGES in a thermomechanical analysis. In this case the calculated constraints are **false**. It is wise to take the practice always to indicate the loads taken in count during the calculation of displacement (even if they are not used for nothing!).*

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### ***Loadings distributed for the models containing of the beams***

*For the models containing of the beams, one stipulates under the key word CHARGES, the loadings distributed. However the loadings could be multiplied in other orders by coefficients that one informs then under the key words.*

*COEF\_MULT = cm*

*Real multiplying coefficient used in orders DYNA\_LINE\_HARM [U4.53.11], and DYNA\_LINE\_TRAN [U4.53.02].*

*COEF\_MULT\_C = cmc*

*Multiplying coefficient complexes used in order DYNA\_LINE\_HARM [U4.53.11].*

*FONC\_MULT = Fm*

*Real multiplying function used in order DYNA\_LINE\_HARM [U4.53.11] (it depends on the frequency) and orders MECA\_STATIQUE [U4.51.01] and DYNA\_LINE\_TRAN [U4.53.02] (it depends on time).*

*FONC\_MULT\_C = FMC*

*Multiplying function complexes used in order DYNA\_LINE\_HARM [U4.53.11]  
(it depends on the frequency).*

*PHAS\_DEG = Pd*

*This operand makes it possible to define the phase of each component of the excitation in degrees by report/ratio with a reference of single phase. It is used in order DYNA\_LINE\_HARM [U4.54.02].*

*PUIS\_PULS = N*

*This number makes it possible to define the power of pulsation when the loading is related to the frequency. It is used in order DYNA\_LINE\_HARM [U4.53.11].*

### **3.5.9 Operand NORMALIZES**

*For options “DCHA\_...” or “RADI\_...”, one must choose a “standard” for the tensor of the constraints [R4.20.01] the choice is made thanks to the key word NORMALIZES.*

*/“VMIS”  
[DEFECT]*

*One takes the second invariant of the diverter of the tensor of the constraints.*

*/“VMIS\_CINE”*

*Before taking the second invariant of the diverter, one withdraws with the tensor of the constraints it tensor X characterizing the kinematic state of work hardening.*

*/“TOTAL”*

*The second invariant of the tensor is taken (by taking account of the trace).*

*/“TOTAL\_CINE”*

*One withdraws initially X before taking the second invariant of the total tensor of the constraints (holding count trace).*

#### **Note:**

*Standards “VMIS\_CINE” and “TOTAL\_CINE” are usable only if calculation elastoplastic was made with behavior “VMIS\_CINE\_LINE”.*

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### **3.5.10 Operands *NUME\_COUCHE/NIVE\_COUCHE***

*NUME\_COUCHE* = *nume*

*In the case of a multi-layer material (multi-layer hull defined by *DEFI\_COQU\_MULT*), or of an element of structure with local nonlinear behavior, integrated by layers, *NUME\_COUCHE* is, whole value ranging between 1 and numbers it layers, necessary for to specify the layer where one wishes to carry out elementary calculation. By convention, layer 1 is the sub-base (in the direction of the normal) in the case of elements of mechanical hull or of thermal hull and corresponds to the layer interns an element *PIPE* in the case of.*

*NIVE\_COUCHE*

=

*For the *nume* layer defined by *NUME\_COUCHE*, allows to specify the ordinate where one wishes to carry out elementary calculation:*

“*INF*”

*lower ordinate of the layer*

*(skin interns),*

“*SUP*”

*higher ordinate of the layer*

*(external skin),*

“*MOY*”

*average ordinate of the layer*

*(average layer).*

### 3.5.11 Operand *PLAN*

*PLAN*

=

/

*“EMAIL”*

*[DEFECT]*

*/“MOY”*

/

*“INF”*

/“SUP”

*This operand makes it possible to specify the plan of calculation of the elementary fields for a model with elements of plates by taking account of possible offsetting.*

*Limitations: this option is available only for the calculation of the efforts generalized by elements to nodes starting from displacements (linear elasticity), option EFGA\_ELNO\_DEPL.*

*Moreover, this option is usable only for DKT, DST, Q4G, GRID.*

.  
“EMAIL”: plan of the grid,

.  
“MOY”: average plan,

.  
“INF”: higher plan (in the direction of the normal),

.  
“SUP”: lower plan (in the direction of the normal).

### **3.6**

#### **Operands for the thermal options**

##### **3.6.1 Operand**

###### **OPTION**

/  
“FLUX\_ELGA\_TEMP”

*Calculation of the heat flows at the points of integration of GAUSS starting from the temperature.*

/  
“FLUX\_ELNO\_TEMP”

*Calculation of the heat flows to the nodes starting from the temperature.*

/ “ERTH\_ELEM\_TEMP”,  
/ “ERTH\_ELNO\_ELEM”

*Estimators of error in residue in thermics. [R4.10.03]. It is necessary beforehand to carry out in CALC\_ELEM the calculation of flows to the nodes via FLUX\_ELNO\_TEMP.*

*The key word INFORMATION gets all intermediate postings of calculations (connectivities, normals,*

*diameters, values of the fields, jacobien).*

*Option “ERTH\_ELNO\_ELEM” makes it possible to bring back the field by element*

*ERTH\_ELEM\_TEMP has one*

*field with the nodes by element, which makes it possible to make statements of values or impressions /visualizations.*

|  
“SOUR\_ELGA\_ELEC”

*Calculation of a heat source (which can be introduced into a thermal calculation via the key word SOURCE = (SOUR\_CALCULEE: ...) order AFFE\_CHAR\_THER [U4.44.02].*

*This source is calculated starting from an electric potential via the law of Ohm. This electric potential must be calculated by operator THER\_LINEAIRE [U4.54.01] by making the analogies necessary.*

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| “DEUL\_ELGA\_TEMP”

| “DETE\_ELNO\_DLTE”

*Derived Eulérienne from the field of temperature at the points of Gauss or the nodes [R4.03.01].*

*Require the knowledge of the Lagrangienne derivative of the temperatures, therefore to have activated the option SENSITIVITY in THER\_LINEAIRE, and to use the key word SENSITIVITY in*

## **CALC\_ELEM.**

| “DURT\_ELGA\_META”

“DURT\_ELNO\_META”

*Calculation of hardness (at the points of Gauss or the nodes) starting from the metallurgical phases (cf [R4.04.01]).*

| “HYDR\_ELNO\_ELGA”

*Calculation of the hydration to the nodes starting from the hydration at the points of Gauss, calculated by*

*THER\_NON\_LINE for the modeling of the concrete [R7.01.12].*

### **3.7**

#### **Operands for the acoustic options**

##### **3.7.1 Operand**

###### **OPTION**

| “PRES\_ELNO\_DBEL”

*Calculation of the pressure to the nodes in decibels.*

| “PRES\_ELNO\_REEL”

*Calculation of the real parts of the field of pressure to the nodes.*

| “PRES\_ELNO\_IMAG”

*Calculation of the real imaginary parts of the field of pressure to the nodes.*

| “INTE\_ELNO\_ACTI”

*Calculation of the acoustic intensity activates with the nodes.*

| “INTE\_ELNO\_REAC”

*Calculation of the acoustic intensity reactivates with the nodes.*

*The definitions are in [R4.02.01].*

### **3.8 Operand**

#### **TITRATE**

*TITRATE = title*

*Titrate that one wants to give to the result of the order [U4.02.01].*

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## **4 Examples**

### **4.1**

*Calculation of flow for a evol\_ther*

```
evoth = CALC_ELEM (reuse=evoth, RESULT = evoth, MODEL = Mo,  
CHAM_MATER = chmat,  
TOUT_ORDRE  
=  
“YES”,  
OPTION  
=  
“FLUX_ELNO_TEMP”  
)
```

*4.2 Calculation of the estimator of error ZZ2 for a few moments of one concept of the evol\_elas type*

```
evolas = CALC_ELEM (reuse= evolas,  
RESULT = evolas,  
MODEL = Mo,  
CHAM_MATER= chmat, INST = (1. , 10. , 20.), OPTION = “ERRE_ELEM_NOZ2”)
```

### 4.3

#### *Constraints at the points of GAUSS for a thermomechanical calculation*

```
evol = CALC_ELEM (reuse = evol,  
RESULT = evol, MODEL = Mo,  
CHAM_MATER = chmat, LOAD = ch_ther, TOUT_ORDRE = "YES",  
OPTION
```

```
= 'SIEF_ELGA_DEPL'  
)
```

### 4.4

#### *Calculation of the potential energies for a clean mode*

```
mode = CALC_ELEM (reuse = mode, RESULT = mode, MODELS = Mo,  
CHAM_MATER = chmat, NUME_MODE = 3, OPTION = 'EPOT_ELEM_DEPL')
```

### 4.5

#### *Calculation of derived from the constraints*

```
evol = CALC_ELEM (reuse = evol,  
RESULT = evol, MODEL = Mo,  
CHAM_MATER = chmat, SENSIBILITE = (ps1, ps2),  
OPTION
```

```
= 'SIEF_ELGA_DEPL'  
)
```

### 4.6

#### *Calculation of the damage of Lemaître or Lemaître-Sermage*

```
evol = CALC_ELEM (reuse = evol, MODELE = mo, CHAM_MATER = chmat,  
  
OPTION = ("ENDO_ELGA", "ENDO_ELNO_ELGA"),
```

```
RESULTAT = evol,);
```

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***Operator CALC\_NO***

## ***1 Goal***

***To enrich a structure of data result by options of postprocessing. It acts in particular options nodal forces, reactions of support and more generally all options of sizes elementary with the nodes (options xxxx\_NOEU\_xxxx) transforming a cham\_lem with the nodes into one chamno.***

***The concept result is réentrant.***

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## ***2 Syntax***

***resu [\*]***

***=***

***CALC\_NO***

***(reuse=***

***resu,***

***RESULT***

***=***

***resu,***

***[/evol\_elas]***  
***/***  
***[mode\_stat\_depl]***  
***[/evol\_noli]***  
***/***  
***[mode\_stat\_acce]***  
***[/evol\_ther]***  
***/***  
***[mode\_stat\_forc]***  
***[/mult\_elas]***  
***/***  
***[mode\_stat]***  
***[/fourier\_elas]***  
***/***  
***[mode\_acou]***  
***[/mode\_flamb]***  
***/***  
***[dyna\_trans]***  
***[/base\_modale]***  
***/***  
***[dyna\_harmo]***  
***[/mode\_meca]***  
***/***  
***[acou\_harmo]***

***SENSITIVITY = (... to see [U4.50.02])***

***/TOUT\_ORDRE = "YES"***

***,***  
***[DEFECT]***

/  
**NUME\_ORDRE** =  
*l\_nuor*  
,  
**[l\_I]**  
/  
**LIST\_ORDRE** =  
*l\_ordr*  
,  
**[listis]**  
/  
**NOEUD\_CMP**  
=  
*l\_mode*  
,  
**[l\_Kn]**  
/  
**NUME\_MODE**  
=  
*l\_numo*  
,  
**[l\_I]**  
/  
**NOM\_CAS** =  
*nomcas*  
,  
**[KN]**  
/  
/  
**INST**  
=  
*l\_inst*  
,  
**[l\_R]**  
/  
**LIST\_INST**  
=  
*l\_inst*  
,  
**[listr8]**  
/  
**FREQ**  
=

*l\_freq*

,

*[l\_R]*

/

*LIST\_FREQ*

=

*l\_freq*

,

*[listr8]*

*I PRECISION*

=

/

*prec,*

*[R]*

/

*1.0D-3*

,

*[DEFECT]*

*I CRITERION =/"RELATIVE"*

*, [DEFECT]*

/

*"ABSOLUTE"*

,

*/ALL*

*= "YES"*

,

/

*NET*

=

*lma*

,

*[l\_maille]*  
/  
**GROUP\_MA**

=  
*lgma*  
,  
*[l\_gr\_maille]*

**/NOEUD\_RESU**  
=  
*lno*  
,  
*[l\_noeud]*  
/  
**GROUP\_NO\_RESU**

=  
*lgno*  
,  
*[l\_gr\_noeud]*  
/  
**MAILLE\_RESU**

= *lma*  
,  
*[l\_maille]*  
/  
**GROUP\_MA\_RESU**  
=  
*lgma*  
,  
*[l\_gr\_maille]*

**OPTION**  
= /  
/“**FORC\_NODA**”  
,

**/ "REAC\_NODA"**

**,**

**MODEL**

**=**

**model**

**,**

**[model]**

**CHAM\_MATER = chmater, [cham\_mater]**

**CARA\_ELEM**

**= carac**

**, [cara\_elem]**

**EXCIT = \_F**

**(**

***CHARGE = load,/[char\_meca]***  
***/***  
***[char\_ther]***  
***/***  
***[char\_acou]***

***FONC\_MULT = coef,***  
***[function/formula]***

***TYPE\_CHARGE=***  
***/***  
***“FIXE\_CSTE”***  
***[DEFECT]***  
***/***  
***“FIXE\_PILO”***  
***/***  
***“SUIV”***



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**/**  
**/ "EFGE\_NOEU\_DEPL"**

**,**

**/ "EFGE\_NOEU\_CART"**

**,**

**/“EPSI\_NOEU\_DEPL”**

,

**/“SIGM\_NOEU\_DEPL”**

,

**/“SIGM\_NOEU\_CART”**

,

**/“SIPO\_NOEU\_DEPL”**

,

**/“EQUI\_NOEU\_SIGM”**

,

**/“EQUI\_NOEU\_EPSI”**

,

***/“EQUI\_NOEU\_EPME”***

,

***/“FLUX\_NOEU\_TEMP”***

,

***/“SIEF\_NOEU\_ELGA”***

,

***/“VARI\_NOEU\_ELGA”***

,

***/“PRES\_NOEU\_DBEL”***

,

**/“PRES\_NOEU\_REEL”**

,

**/“PRES\_NOEU\_IMAG”**

,

**/“INTE\_NOEU\_ACTI”**

,

**/“INTE\_NOEU\_REAC”**

,

**/“META\_NOEU\_TEMP”**

,

**/“DCHA\_NOEU\_SIGM”**

,  
  
*/“RADI\_NOEU\_SIGM”*

,  
  
*/“ENDO\_NOEU\_SINO”*

,  
  
*/“ERRE\_NOEU\_ELGA”*

,  
  
*/“DEGE\_NOEU\_DEPL”*

,  
  
*/“SIRE\_NOEU\_DEPL”*

**/“EPSG\_NOEU\_DEPL”**

,

**/“DURT\_NOEU\_META”**

,

**/“DETE\_NOEU\_DLTE”**

,

**/“ENEL\_NOEU\_ELGA”**

,

**/  
“SIGM\_NOEU\_ZAC”,**

/  
“EPSP\_NOEU\_ZAC”,

/“PMPB\_NOEU\_SIEF”  
,

/“EPMG\_NOEU\_DEPL”  
,

/“DEDE\_NOEU\_DLDE”  
,

/“DESI\_NOEU\_DLSI”  
,

**/“EPSP\_NOEU”**

,

**/“EPSA\_NOEU”**

,

**/“HYDR\_NOEU\_ELGA”**

,

**/“SIGM\_NOEU\_COQU”**

,

**/“SIGM\_NOEU\_SIEF”**

,

**/“SIPO\_NOEU\_SIEF”**

,



| **“VARI\_NOEU”**

,

| **“SIEF\_NOEU”**

,

| **“EXTR\_NOEU\_VARI”**

,

| **“EXTR\_ELNO\_VARI”**

,

)  
**If RESULT = [typeres]**

**then [\*]**

**->**

**[typeres]**

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### **3 Operands**

#### **3.1 Operand**

**RESULT**

**RESULT = resu**

**Name of the result enriched in the order.**

#### **3.2 Operand**

**SENSITIVITY**

**SENSIBILITE= (....)**

**This key word is followed of a sensitive parameter list. It specifies that one is not interested in result in itself but with derived from the result compared to a parameter. Thus a sequence this type:**

**RESULT = resu, SENSITIVITY = (PS), OPTION = ("SIEF\_NOEU\_ELGA")**

**mean that one wants to calculate with the nodes the derivative of the constraints compared to the parameter PS.**

**See [U4.50.02] for the details on the parameters associated with the key word.**

**3.3 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/  
NUME\_MODE/NOEUD\_CMP/NOM\_CAS/INST/LIST\_INST/FREQ/  
LIST\_FREQ/PRECISION/CRITERION**

**See [U4.71.00] for the description of these operands.**

#### **3.4 Operands**

**ALL/GROUP\_MA/MESH**

**ALL = "YES",**

**The options are calculated on all the grid.**

***GROUP\_MA = lgma,***

***The options are calculated on the groups of meshes contained in the list lgma.***

***NET = lma,***

***The options are calculated on the meshes contained in the list lma.***

### ***3.5 Operands***

***GROUP\_NO\_RESU/NOEUD\_RESU/GROUP\_MA\_RESU/  
MAILLE\_RESU***

***These key words make it possible to specify the nodes where the results are wanted.***

***GROUP\_NO\_RESU = lgno,***

***The results are stored on the groups of nodes contained in the list lgno.***

***NOEUD\_RESU = lno,***

***The results are stored on the nodes contained in the list lno.***

***GROUP\_MA\_RESU = lgma,***

***The results are stored on the groups of meshes contained in the list lgma.***

***MAILLE\_RESU = lma,***

***The results are stored on the meshes contained in the list lma.***

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**3.6 Operand**

**OPTION: "FORC\_NODA"/"REAC\_NODA"**

**OPTION = ' FORC\_NODA '**

**Option of calculation of the nodal forces starting from the constraints at the points of GAUSS.  
Calculation is done in the following way:**

**(U) D =**  
**K**  
**(U)**

**dK = K**  
**K**  
**BuK dK**

**K K**  
**K K**  
**K**  
**with**  
**: constraint**

**of**  
**Gauss**

**of**  
**points**  
**with**

**S**  
**element K**  
**the U.K.: déplacements élémentaires**  
**T**  
**E**

=

 $F U$ with  $F =$  $K K$  $K$  $T$  $K$  $B dK$  $K$  $K$ 

where  $B$  is the matrix connecting the deformations of the 1st order to displacements.

See also the document [U2.01.05].

For the elements of beam, the constraints at the points of GAUSS are in fact the nodal efforts in the reference mark of the element (obtained by the product of the matrix of rigidity of the element by displacement and by taking account of the efforts of thermal origin and the efforts distributed).

**Calculation**

nodal forces is done by projecting the nodal efforts contained in the field of name symbolic system "SIEF\_ELGA\_DEPL" in the total reference mark. Summation above on elements applies then.

For the axisymmetric elements, integration in theta is done on a sector of 1 radian. If one the integral of the surface effort on all the disc he wants is thus necessary to multiply by 2 pi.

The presence of the field of reference symbol "SIEF\_ELGA\_DEPL" or "SIEF\_ELGA" is obligatory in the concept *resu* result. One also recovers the name of the model subjacent with it field.

**OPTION = ' REAC\_NODA'**

Option of calculation of the nodal forces of reactions to the nodes, the constraints at the points of GAUSS.

For the concepts result of the *evol\_elas* type, *mult\_elas*, *fourier\_elas* or *evol\_noli*, it calculation is done by the formula:

(U)

***D - L (U)***

***with L (U) = F U.***

***D + F U.***

***D + I***

***F***

***I***

***where***

***F***

***voluminal***

***forces***

***are***

***F***

***surface***

***forces***

***S***

***F***

***specific***

***forces***

***I***

***I***

***node***

***with***

***S***

***If one notes RK the vector of the nodal reactions on the element K, one a:***

***R = F -***

***K***

***K***  
***fdK -***  
***F K - I***  
***F***  
***K***  
***K***

***I K***

***in other words one cuts off with the nodal forces the external forces applied to the element K.***

***It should be noted that the change temperature does not appear in the external forces.***

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***For the concepts result of the mode\_meca type, the formula is:***

***(U)***

***D - 2***

***Driven***

***where***

***M***

***mass***

***of***

*stamp*

*is*

*clean*

*pulsation*

*U*

*field*

*déplacemen*

*of*

*T*

*See also the document [U2.01.05] and the examples [§3.4.6].*

*Note:*

*If key word GROUP\_MA is indicated, options “FORC\_NODA” and “REAC\_NODA” are calculated as follows:*

*F is calculated only on the required elements then assembled. The result is*

*K*

*different from a total calculation on all the field then reduced to the elements requested.*

*established method makes it possible to measure the reaction of a piece of model on another (see examples [§3.4.6]).*

### ***3.6.1 Operand***

***MODEL***

***MODEL = Mo,***

***Name of the model on which the options are calculated.***

### ***3.6.2 Operand***

***CHAM\_MATER***



**CHAM\_MATER = chmater,**

*Name of the material field where the material characteristics of the elements are defined. This argument is necessary for the calculation of the reactions (option "REAC\_NODA"), which requires calculation*

*precondition of the elementary vector of the loadings.*

### **3.6.3 Operand**

**CARA\_ELEM**

**CARA\_ELEM = carac,**

*The concept of the elementary characteristics of cara\_elem type is necessary for calculation nodal forces or reactions, if there exists in the model of the elements of structure.*

### **3.6.4 Operand**

**EXCIT**

**EXCIT = \_F**

*For the calculation of REAC\_NODA only:*

*Key word factor allowing to define the various loadings which made it possible to calculate it stress field at the points of GAUSS.*

*One defines a concept of the type charges by occurrence of key word EXCIT.*

#### **3.6.4.1 Operand**

**CHARGE**

**CHARGE =**

**charge,**

*Name of a concept of the type charges, for the calculation of the associated elementary vector. Necessary for the calculation of the nodal reactions.*

#### **3.6.4.2 Operand**

**FONC\_MULT**

**FONC\_MULT = coef,**

***Name of a concept of the function type providing the value of the multiplying factor of charge.***

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### **3.6.4.3 Operand**

#### ***TYPE\_CHARGE***

*TYPE\_CHARGE*

=

/

“*FIXE\_CSTE*”,  
*load fixes (defect)*

/

“*FIXE\_PILO*”, *controlled load (stored real amplitude  
in the SD evol\_noli)*

/

“*SUIV*”,  
*following load*

*If the result comes from a nonlinear calculation with piloting, it is necessary for  
to calculate option REAC\_NODA, to indicate under EXCIT at the same time the fixed loads of type  
 (“*FIXE\_CSTE*”) and them controlled loads of type (“*FIXE\_PILO*”). Indeed, the amplitude  
of these last is a parameter of the SD evol\_noli and will be recovered by the code*

*in order to rebuild the true loading:*

(  
L v)  
Lfixe  
Lpilo  
=  
+  
(cf document [R5.03.01] of operator STAT\_NON\_LINE).

*To avoid putting questions, one suggests recopying in CALC\_NO the block EXCIT having been used for nonlinear calculation having produced the result: thus one is sure not to forget loads.*

### **3.6.5 Operands**

#### **ALL/GROUP\_MA/MESH**

*ALL = "YES",*

*The options are calculated on all the grid.*

*GROUP\_MA = lgma,*

*The options are calculated on the groups of meshes contained in the list lgma.*

*NET = lma,*

*The options are calculated on the meshes contained in the list lma.*

#### **Note:**

*If key word GROUP\_MA is indicated, options "FORC\_NODA" and "REAC\_NODA" are calculated as follows:*

*K*

*F is calculated only on the required elements then assembled. The result is different from a total calculation on all the field then reduced to the elements asked. The established method makes it possible to measure the reaction of a piece of model on another (see examples [§3.4.6]).*

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### **3.7 Examples**

#### **3.7.1 Example 1: Structure charged with nodal force $F$ (2 elements QUAD4)**

$F = -1000$  NR

M1

M2

y

X

0

$F$  1000

-

FORC\_NODA

1

384.2

384

-

.2

$F$

$F$

500

500

*REAC\_NODA*

2

.

384 2

-

384

-

.2

*R*

500

*F*

*R*

500

-500

500

*M1*

*FORC\_NODA on M1 mesh*

3

384.2

*F*

115 8

.

500

*F 0.*

500

-

*R 500*

*M1*

*REAC\_NODA on M1 mesh*

4

.

384 2

*R*

115

500

8

.

*R 0.*

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500

F -500

M2

FORC\_NODA on mesh m2

5

115

-

.8

384

-

.2

F

F

0.

500

500

*R*

500

*M2**REAC\_NODA on mesh m2*

6

115

-

.8

384

-

.2

*R**R*

0.

500

*On this example, the reactions to nodes 2 are quite equal to the nodal forces 1 minus loading. They represent the reactions to the supports of the structure.*

*If one restricts calculation with the M1 mesh, forces 3 with the nodes belonging to the border between M1 and*

*M2 are different. They represent the reaction of the formed model of M1 to the formed model of m2.*

*With*

*to note that the nodal loading is divided by 2 bus the 2 meshes contribute to it. Nodal reactions 4 are still equal to the nodal forces minus the loading.*

*On the calculation restricted with the mesh m2, the nodal forces 5 following OX are of sign contrary to calculation*

*restricted with the M1 mesh, illustrating the principle of the action and the reaction.*

### ***3.7.2 Example 2: Structure with loading temperature***

- *F*



*F*

*y*

*y*

*- F1x*

*X*

*T = 0°*

*T = 100°*

*T = 0°*

*- F1x*

*FORC\_NODA = REAC\_NODA*

*M1*

*y*

*M2*

*M3*

*F1x*

*F1x*

*- Fy*

*F*

*y*

*- F2x - F2x*

*- Fy*

*Fy*

*M2*

*FORC\_NODA restricted with m2*

*- F*

*F*

*y*

y

F2x

F2x

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*Data:*

*E*

9

= 1.10 Pa

= 0.3

-6

= 1.10

:

*Results*

*F*

4

= 3

- .4 10 NR

y

*F*

$3$   
 $= 78$   
 $. 10 NR$   
 $1x$   
 $F$   
 $3$   
 $= 1$   
 $- .2 10 NR$   
 $2x$

*On this example, the nodal forces and the nodal reactions coincide because the only loading is one loading temperature.*

*If one restricts calculation with the mesh m2, the forces according to OY remain the same ones but are different according to OX.*

### **3.8 Operand OPTION**

*Options of calculation transforming a field by element with the nodes into a field with the nodes, in making a simple arithmetic mean (not balanced by the size of the meshes) of the values met on the elements in a given node. These fields by elements with the nodes must have summer calculated before and thus to appear in the resu object.*

*The orders calculating and documenting these fields are:*

*CALC\_ELEM [U4.81.01] for the fields relating to the options:*

“DCHA\_NOEU\_SIGM”  
“HYDR\_NOEU\_ELGA”  
“DEGE\_NOEU\_DEPL”  
“INTE\_NOEU\_ACTI”  
“DEDE\_NOEU\_DLDE”  
“INTE\_NOEU\_REAC”  
“DETE\_NOEU\_DLTE”  
“PMPB\_NOEU\_SIEF”  
“DESI\_NOEU\_DLSI”  
“PRES\_NOEU\_DBEL”  
“DURT\_NOEU\_META”  
“PRES\_NOEU\_REEL”  
“EFGE\_NOEU\_CART”  
“PRES\_NOEU\_IMAG”  
“EFGE\_NOEU\_DEPL”

“RADI\_NOEU\_SIGM”  
“ENEL\_NOEU\_ELGA”  
“SIGM\_NOEU\_CART”  
“ENDO\_NOEU\_SINO”  
“SIGM\_NOEU\_COQU”  
“EPMG\_NOEU\_DEPL”  
“SIGM\_NOEU\_DEPL”  
“EPSI\_NOEU\_DEPL”  
“SIGM\_NOEU\_SIEF”  
“EPSG\_NOEU\_DEPL”  
“SIPO\_NOEU\_DEPL”  
“EPSA\_NOEU”  
“SIPO\_NOEU\_SIEF”  
“EPSP\_NOEU”  
“SIRE\_NOEU\_DEPL”  
“EQUI\_NOEU\_EPSI”  
“EXTR\_NOEU\_VARI”  
“EQUI\_NOEU\_EPME”  
“EQUI\_NOEU\_SIGM”  
“ERRE\_NOEU\_ELGA”  
“FLUX\_NOEU\_TEMP”

*STAT\_NON\_LINE [U4.51.03] for the fields relating to the options:*

“VARI\_NOEU” “VARI\_NOEU\_ELGA”  
“SIEF\_NOEU” “SIEF\_NOEU\_ELGA”

*POST\_ZAC [U4.83.21] for the fields:*

“EPSP\_NOEU\_ZAC”  
“SIGM\_NOEU\_ZAC”

*CALC\_META [U4.85.01] for the field:*

“META\_NOEU\_TEMP”

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***Notice 1:***

*The moyennations with the nodes of computed fields in local reference marks are licit only if the angles between these reference marks are weak. In the contrary case, they do not have a direction.*

***Notice 2:***

*Key word GROUP\_MA and MESH also apply to the calculation of these options. In it case, the arithmetic mean is made on the required meshes. There still, local calculation is different from total calculation.*

*Example: by taking again example 1 of [§3.4.6], the shear stress xy is worth:*

*0.*

*410.*

*-410.*

*M1*

*M2*

*Total calculation*

*-410.*

*0.*

*410.*

*-590.*

-410.

*M1*

*Calculation on M1*

-410.

-590.

*In total calculation, xy is null on M1 m2 like average of 2 opposite values. These values are far from being null, as calculation shows it on M1 alone. Values on the border required field are thus to interpret with precaution.*

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**4 Elements  
concerned**

*For each modeling, the list of the calculable options by CALC\_NO is provided in documents [U3.11.XX] with [U3.33.XX] in the paragraph postprocessing of calculation.*

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*Operator CALC\_CHAM\_ELEM*

## ***1 Goal***

***To calculate an elementary field, in thermics and accoustics, starting from fields already calculated of cham\_no\_\* type. Nature of the sizes concerned:***

***.  
in thermics the starting field is a field of temperature, and one can calculate flow thermics,***

***.  
in accoustics the starting field is a field of pressure, and one can calculate the intensity accoustics, and acoustic pressure.***

***These fields are calculated:***

***.  
maybe with the nodes of the element \_ELNO. For a given node, they are different from an element with the other,***

***.  
maybe at the points of integration \_ELGA.***

***Let us note that one can also have access to the field (at the points of Gauss!) co-ordinates of points of Gauss, obtained directly starting from the model.***

***.  
Product a concept of the cham\_elem\_\* type or \* indicates the name of the size.***

***For mechanics, the fields (forced or deformations, efforts generalized, energy, indicators...) must be calculated with ugly order CALC\_ELEM [U4.81.01].***

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## **2 Syntax**

**chamel**  
**[cham\_elem\_\*] = CALC\_CHAM\_ELEM**

(  
**MODEL =**  
**Mo,**  
**[model]**

**CHAM\_MATER**  
**=**  
**chmater,**  
**[cham\_mater]**

**CARA\_ELEM**  
**=**  
**carac**  
**,**  
**[cara\_elem]**

**# Selection of the meshes concerned with calculation**  
**/**  
**ALL**  
**=**  
**“YES”,**  
**[DEFECT]**

// **GROUP\_MA**

=

*l\_grma,*

*[l\_gr\_maille]*

/

*NET = l\_mail,*

*[l\_maille]*

*INST*

= *N,*

*[R]*

/

*0.,*

*[DEFECT]*

/

*# options*

*thermics*

*OPTION =*

/

*“FLUX\_ELNO\_TEMP”,*

/

“FLUX\_ELGA\_TEMP”,

*TEMP*

=

*temp*,

[*cham\_no\_TEMP\_R*]

*EXCIT*

= *F*

(*LOAD = l\_charge*,

[*l\_char\_meca*]

*/COEF\_MULT = cm*,

[*R*]

/

*FONC\_MULT*

=

*Fm*,

[*function*]

[*tablecloth*]

[*formula*]

)

*MODE\_FOURIER*  
*=/nh,*

*[I]*

*/*  
*0,*  
*[DEFECT]*

*/*  
*# options*  
*acoustics*

*OPTION=/*  
*“PRES\_ELNO\_DBEL”,*

*/*  
*“PRES\_ELNO\_REEL”,*

/  
"PRES\_ELNO\_IMAG",

NEAR  
=  
near,  
[cham\_no\_PRES\_C]

/  
# different  
options

OPTION=  
"COOR\_ELGA",

);

# standard of produced field: [cham\_elem\_\*] with:

If  
OPTION  
: then  
[\*]  
->

# options thermal:

FLUX\_ELGA\_TEMP  
FLUX\_R

***FLUX\_ELNO\_TEMP  
FLUX\_R***

***# options acoustic:***

***PRES\_ELNO\_DBEL  
DBEL\_R  
PRES\_ELNO\_IMAG  
PRES\_R  
PRES\_ELNO\_REEL  
PRES\_R***

***# different  
options***

***COOR\_ELGA  
GEOM\_R  
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***3 Operands***

***3.1 Operands***

## ***MODEL/CHAM\_MATER/CARA\_ELEM***

***MODEL = Mo,***

***Name of the model on which the option is calculated.***

***CHAM\_MATER = chmater,***

***Material field associated with the model Mo.***

***CARA\_ELEM = carac,***

***Elementary characteristics associated the model Mo, if it contains elements of structure or if the isoparametric elements are affected of a local reference mark of anisotropy.***

### ***3.2***

#### ***Selection of the meshes concerned with calculation***

***The key words ALL = “YES”, GROUP\_MA and MESH make it possible the user to choose the meshes on which it wishes to make its elementary calculations of postprocessing.***

***/ALL = “YES”***

***All the meshes (carrying finite elements) will be treated. It is the default value.***

***/GROUP\_MA  
= l\_grma***

***/NET  
= l\_maille***

***Only the meshes included in l\_grma and/or l\_maille will be treated.***

### ***3.3 Options***

#### ***thermics***

***The options of elementary calculation in thermics can be calculated starting from a field of temperature:***

***TEMP = temp***

***The options available are:***

***/“FLUX\_ELGA\_TEMP”,***

/ **“FLUX\_ELNO\_TEMP”**,  
*Their significance is given in [U4.81.01].*

### **3.4 Options acoustics**

*The options of elementary calculation in accoustics can be calculated starting from a field of complex pressure:*

**CLOSE = near**

*The options available are:*

/  
**“PRES\_ELNO\_DBEL”**

*Calculation of the pressure by element to the nodes in decibels.*

/  
**“PRES\_ELNO\_REEL”**  
**“PRES\_ELNO\_IMAG”**

*Calculation of the real and imaginary parts of the field of pressure by element to the nodes.*

### **3.5 Option COOR\_ELGA**

*Calculation of the co-ordinates of the points of Gauss of each element (continuous mediums 2D and 3D).*

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**4**

**Examples of calculations with CALC\_CHAM\_ELEM**

**4.1 Flow with the nodes starting from the field of temperature temp in axisymmetric FOURIER mode 1**

**epsno = CALC\_CHAM\_ELEM**

**(MODEL = moaxfour,**

**TEMP = temp,**

**OPTION**

**=**

**“FLUX\_ELNO\_TEMP”, MODE\_FOURIER**

**=**

**1**

**);**

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***Operator INTE\_MAIL\_2D***

## ***1 Goal***

***To define a curve in a grid 2D. At the points of intersection of the curve thus defined with grid could be carried out, using operator POST\_RELEVE\_T, of the statements of values, of calculations (averages, invariants,...) and the storage of the result of these operations in a concept of type counts.***

***The produced concept is of curved type.***

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## ***2 Syntax***

***crb [curve] = INTE\_MAIL\_2D***

***(***

***GRID***

***=***

***my,***

***[grid]***

***/ALL = "YES",***

***/***

**GROUP\_MA**

=

*lgrma,*

*[l\_gr\_maille]*

/

**NET**

=

*lmail,*

*[l\_maille]*

/

**I**

**DEFI\_SEGMENT=\_F (/ORIGIN = (teststemxà, ya),**

*[l\_R]*

/

**NOEUD\_ORIG**

=

*node,*

*[node]*

/

**GROUP\_NO\_ORIG=**

*grno, [group\_no]*

**/END = (xb, yb),**

*[l\_R]*

/

**NOEUD\_EXTR**

=

*node,*

*[node]*

/

**GROUP\_NO\_EXTR=**  
**grno, [group\_no]**

),

**I**  
**DEFI\_ARC = \_F**  
**(/CENTER = (xc, yc),**  
**[l\_R]**  
**/**  
**NOEUD\_CENTRE**

**=**  
**node,**  
**[node]**  
**/**  
**GROUP\_NO\_CENTRE=**  
**grno,**  
**[group\_no]**

**/RAY = R,**

**[R]**

**SECTOR = (inf, sup), [l\_R]**

**//ORIGIN**

**= (teststemxà, ya), [l\_R]**

**/**

**NOEUD\_ORIG**

**=**

**node,**

**[node]**

**/**

**GROUP\_NO\_ORIG=grno,**

**[group\_no]**

**/EXTREMITE=**

**(xb, yb),**

**[l\_R]**

**/**

**NOEUD\_EXTR=**

**node,**

**[node]**

**/**

**GROUP\_NO\_EXTR=grno,**

**[group\_no]**

**PRECISION**

= / ,

**[R]**

/

**10-3,**

**[DEFECT]**

**CRITERION**

=

**/“RELATIVE”, [DEFECT]**

/

**“ABSOLUTE”**

,

),

**/DEFI\_CHEMIN=\_F (**

/

**NET = email, [l\_maille]**

/

**GROUP\_MA**

=

**grma,**

**[l\_gr\_maille]**

),

**/NOEUD\_ORIG**

=

**node,**

**[node]**

/

**GROUP\_NO\_ORIG**

=

**grno,**

**[group\_no]**

**PRECISION**

= / ,

**[R]**

/

**10-3,**

**[DEFECT]**



## ***INFORMATION***

=  
/

***1,***  
***[DEFECT]***

***/ 2,***

***)***

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***3 Operands***

***3.1 Operand***

***GRID***

***GRID***

***=***

*my*: name of the concept of the grid type on which the curve is located.

### 3.2 Operands

**ALL/GROUP\_MA/MESH**

*Apply only for DEFI\_SEGMENT and DEFI\_ARC.*

**/ALL = "YES",**

*The location is carried out on all the grid.*

**/GROUP\_MA = lgrma,**

*The location is carried out only on the groups of meshes of the list lgrma.*

**/**

**NET**

**=**

**lmail,**

*The location is carried out only on the meshes of the list lmail.*

### 3.3

*Way: Key words DEFI\_SEGMENT/DEFI\_ARC/DEFI\_CHEMIN*

#### 3.3.1 Word

*key*

**DEFI\_SEGMENT**

**/I**

**DEFI\_SEGMENT = \_F**

*Key word factor whose each occurrence defines a segment of right-hand side by the data of its points origin and end (in the form of co-ordinates or of names of nodes or group\_no). The segment is directed origin towards the end.*

#### 3.3.2 Word

*key*

**DEFI\_ARC**

**I DEFI\_ARC = \_F**

*Key word factor whose each occurrence defines an arc of circle by the data of its center*

and, either of a ray and an angular sector, or of 2 points origin and end of the arc.

The center of the circle is introduced by one of the 3 key words:

*CENTER* = (xc, yc),  
co-ordinates of the center of the circle,  
*NOEUD\_CENTRE* = node,  
name of the node centers circle,  
*GROUP\_NO\_CENTRE* = grno,  
name of the group\_no containing the only node centers,

The radius of the circle is introduced by the key word:

*RAY* = R  
with  $R > 0$

The angular sector by the key word:

*SECTOR* = (inf, sup)  
with (inf, sup) angles in degrees checking  
 $180. < \text{inf} \text{ sup} < 180$

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The point origin of the arc by one of the 3 key words:

*ORIGIN = (teststemxà, ya), coordinated node origin,  
NOEUD\_ORIG = node,  
name of the node origin,  
GROUP\_NO\_ORIG = grno,  
name of the group\_no containing the only node origin.*

*The point end of the arc by one of the 3 key words:*

*END = (xb, yb),  
co-ordinates of the node end,  
NOEUD\_EXTR = node,  
name of the node end,  
GROUP\_NO\_EXTR= grno,  
name of the group\_no containing the only node end.*

*PRECISION =*

*Precision valid for an occurrence of the key word factor DEFI\_ARC. Allows to overload  
precision valid for all the order [§3.3].*

*CRITERION*

*=  
/  
“RELATIVE”, [DEFECT]  
/  
“ABSOLUTE”  
,*

*If Q is the quantity sought with a precision, then the interval of research is:*

*[Q (1), Q (1+)] in “RELATIVE”  
[Q, q+] in “ABSOLUTE”*

### **3.3.3 Word**

**key**

**DEFI\_CHEMIN**

*/DEFI\_CHEMIN = \_F*

*Key word factor whose each occurrence admits for argument a list of names of meshes (word key NETS) or a list of names of groups of meshes (key word GROUP\_MA). These meshes being type SEG2 or SEG3.*

*The way (or possibly ways) is made up starting from the meeting of different meshes. INTE\_MAIL\_2D analyzes this unit to determine topology. It detects:*

.  
*the existence or not of several independent ways:*

*3 ways*

.  
*for each way, one distinguishes the open cycles and arcs:*

*cycle*

*arc open*

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*The ways are directed starting from the mesh of smaller number for the cycles and from the mesh end of smaller number for the open arcs. This number corresponds to the order of appearance in the file of grid.*

*The user can nevertheless impose the node origin of the way by key word **NOEUD\_ORIG** (name of the node origin) or **GROUP\_NO\_ORIG** (name of the formed group\_no of the only node origin).*

### ***3.4 Operand***

#### ***PRECISION***

## **PRECISION**

=

,

*Optional key word allowing the user to define the threshold in lower part of which 2 points are regarded as confused.*

### **3.5 Operand INFORMATION**

*Impressions on the file "MESSAGE makes it possible to obtain".*

*INFORMATION = 1, not of impressions*

*INFORMATION = 2, impression of the meshes crossed by the way*

## **4**

### **Phases of checking**

.

#### **Phase 1: syntactic checking**

*The key word factor **DEFI\_CHEMIN** is of a set of priorities higher than that of **DEFI\_SEGMENT** and **DEFI\_ARC**. Thus, one seeks initially an occurrence of **DEFI\_CHEMIN**; if such an occurrence is then found **DEFI\_SEGMENT** and **DEFI\_ARC** do not have to appear, if not the occurrences of **DEFI\_ARC** and **DEFI\_SEGMENT** are sought. If no occurrence is found an error message is emitted.*

.

#### **Phase 2: semantic checking**

*The dimension of all the lists of realities is controlled, it must be worth 2 exactly. For the argument of the key word **RAY** one checks that  $R > 0$  as well as the constraint*

*$180. < \text{inf sup } 180.$  for the list of arguments of the key word **SECTOR**.*

.

#### **Phase 3: checking with the execution**

*One checks, initially, the existence of the objects indicated in the arguments of key words **NOEUD\_**, **GROUP\_NO\_**, **MESH** and **GROUP\_MA**, then in the second time that them meshes are of type **SEG2** or **SEG3**. In the event of failure, a fatal error message is transmitted.*

*In the case of a way, if a node origin is given and if the way is an opened arc, one check that this node is one of the ends of the arc. In the contrary case, one emits one fatal error message.*

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## **5 Phases of *exécution***

.

*Case of a curve obtained like meeting of segments of right-hand side and/or arcs of circle:*

***the 1st time:***

*Location of each segment and/or arc in the meshes 2D of the field.*

***the 2nd time:***

*Calculation of connexity for each segment and/or arc. This for the taking into account of holes possible in the field.*

.

*Case of a curve obtained like meeting of meshes 1D of the field:*

***the 1st time:***

*Reduction of the lists of meshes and the lists of groups of meshes to a list of meshes where*

*each mesh appears only once.*

***the 2nd time:***

*Calculation of connexity on the lists of meshes obtained at the end of the 1st time. This calculation tiny room in the search of simple ways and cycles (within the meaning of the graph theory) in the list of meshes.*

***the 3rd time:***

*Location of each way in the meshes 2D of the field.*

.

*In all the cases:*

*If an occurrence of `DEFI_SEGMENT`, `DEFI_ARC` or `DEFI_CHEMIN` defines a curve which do not cut the grid, a fatal error message is emitted.*

*refused*

*accepted*

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**6**

***Possibilities and operational limits***



## ***6.1 Curves obtained like meeting of segments of right-hand side and/or arcs of circle***

### ***Example 1***

*Let us suppose that the border of the field is reduced locally to 2 segments of right-hand side and an arc of circle and that the user is interested in the behavior of the structure in the vicinity of this border. It will be able to then define curves such as A11, B11, A12, B12 or A21, B21, A22, B22.*

*(border of the field)*

*R*

*B 11*

*1*

*R*

*A11*

*2*

*R*

*With*

*B*

*21*

*21*

*C*

*With*

*With*

*12*

*22*

*B*

*B*

*22*

*12*

*Related component 2*

*Related component 1*

*Corner*

*=*

*INTE\_MAIL\_2D*

*(*

*GRID*

*=*

*name*

*grid,*

*DEFI\_SEGMENT*

=

(

*\_F (ORIGIN = (xA11, yA11), END = (xB11, yB11),),*

*\_F (ORIGIN = (xA21, yA21), END = (xB21, yB21),),*

*\_F (ORIGIN = (xA12, yA12), END = (xB12, yB12),),*

*\_F (ORIGIN = (xA22, yA22), END = (xB22, yB22),),),*

*DEFI\_ARC*

=

(

*\_F*

(

*CENTER*

= (*xc1*

,

*yc1*),

*RAY*

=

*r1*

,

*SECTOR*

=

(  
0.,  
90.), ),  
\_F  
(  
CENTER  
= (xc2  
,  
yc2),  
RAY  
  
=  
r2  
,  
SECTOR  
=  
(  
0.,  
90.), ),),  
  
)

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**Example 2: Study in the vicinity of an interior hole in a field**

With

**B**

(border of the field)

**D**

**C**

.

Curve ABCD is defined like meeting of 4 segments of right-hand side.

turn

=

**INTE\_MAIL\_2D**

(

**GRID**

=

**carré\_percé,**

**DEFI\_SEGMENT**

=

(

**\_F (ORIGIN = (teststemxà, yA), END = (xB, yB)**

**),**

**\_F (ORIGIN = (xD, yD), END = (xC, yC)**

**),**

**\_F (ORIGIN = (teststemxà, yA), END = (xD, yD)**

**),**

$\_F$  (*ORIGIN* = (*xB*, *yB*), *END* = (*xC*, *yC*),),

)

### ***Example 3: an operational limit***

*It relates to the possibility of intersection of the segments and/or the arcs in points which are not not one of their end.*

*With*

*D*

*C*

*B*

*This case is not the subject of any particular treatment. The 2 segments of right-hand side are taken as two pieces perfectly independent of the same concept. Their intersection is ignored. management of such cases is the responsibility of the user.*

## **6.2**

### ***Curves obtained like meeting of meshes 1D of the field***

#### ***Example 1***

*M5*

*M2*

*M4*

*M1*

*M3*

*Grp1: M4, M5, M6*

*M6*

*M8*

*Grp2: M7, M8*

*M7*

*The curve is reduced to the simple way made up of the M1 meshes, m2, m3 and with the corresponding cycle*

*with the groups of meshes Grp1 and Grp2. The simple way and the cycle constitute both related components of the curve.*

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*The order in which the meshes of a way are traversed depends on classification on meshes.*

*In the case of a way simple (open arc) it is the classification of the meshes “end” which determine the order of course.*

*For example:*

*M10*

*M17*

*M18*

*nsde parcoursdu way*

*Course*

=

*INTE\_MAIL\_2D*

(

*GRID*

=

*Maya,*

*DEFI\_CHEMIN*

=

*\_F*

(

*NET*

=  
(“M1”, “m2”, “m3”),  
GROUP\_MA  
=  
(“Grp1”,  
“Grp2”),  
)

)  
  
M33  
*In the case of a cycle, the way is*  
M13  
*feel*  
*traversed on the basis of the email E moreover*  
*course*  
*small number and in the direction of*  
*way*

M18  
*connectivity of this email E*  
M14  
M21

**Example 2: an important restriction**  
*The operator supposes that the cycles and*  
**This case is not detected but must be**  
*the simple ways are disjointed, thus*  
**avoided.**  
*the following case is illicit.*

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**Example 3:** *an operational limit for the curved edge*

*For a field of which part of the border is an arc of circle, it is trying to define an arc of circle, by means of the key word `DEFI_ARC`, which would cut the grid in the vicinity of the border. Unfortunately, the edge of the grid is not an arc of circle but a polygon and the way defined can leave the grid.*

*For example:*

*C 1*

*With*

*With*

*3*

*2*

*A4*

*With*

*C*

*1*

*2*

*A5*

*To 6*

*C: ring external*

*1*

*C: ring interior*

*2*

*: broken line*

.

*The arc of circle C, which coincides with part of, cuts the grid of only in*

*1*

*nodes: `INTE_MAIL_2D` will give an empty intersection.*

.

*The arc of circle C is strictly included in but in the grid of*

*2*



*INTE\_MAIL\_2D will locate 2 holes.*

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**Example 4:** study on the border of a plate

*B\_charge*

*M1*

*M4*

*M2*

*M5*

*M3*

*M6*

*B\_encast*

*Edge*

=

*INTE\_MAIL\_2D*

(

*GRID*

=

*plate,*

*DEFI\_CHEMIN*

=

*\_F*

(*MESH* = ("*M1*", "*m2*", "*m3*", "*M4*", "*M5*", "*M6*"),

*GROUP\_MA*

=

(“*B\_charge*”,  
“*B\_encast*”),)

)

*To study the behavior of the structure on its embedded edge, it is advised to define one other curves as follows:*

*Bord\_Enc*

=

*INTE\_MAIL\_2D*

(

*GRID*

=

*plate,*

*DEFI\_CHEMIN = \_F (GROUP\_MA = (“*B\_encast*”),),*

)

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*Operator INTE\_MAIL\_3D*

*1 Goal*

*To define a way of the segment type of right-hand side in a grid 3D. At the points of intersection of curve thus defined with the grid could be carried out, using operator POST\_RELEVE\_T [U4.81.21] of the statements of values and/or calculations of average.*

*These postprocessings do not function with the elements of structure (hulls, plates, beams).*

*The produced concept is of type surfaces (although the only possible way is a segment of right-hand side).*

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**2 Syntax**

**srfc [surface] = INTE\_MAIL\_3D**

**(**  
**GRID = my**

**,**  
**[grid]**

**/ALL =**  
**“YES”,**  
**/**  
**GROUP\_MA**  
**= lgrma**

**,**

*[l\_group\_ma]*

/

*NET*

*= lma*

,

*[l\_maille]*

*DEFI\_SEGMENT = \_F*

*(/ORIGIN = (teststemxà, yA, zA), [l\_R]*

/

*NOEUD\_ORIG*

*=*

*node,*

*[node]*

/

*GROUP\_NO\_ORIG*

*=*

*grno,*

*[group\_no]*

**/END = (xB, yB, zB), [l\_R]**

**/**

**NOEUD\_EXTR**

**=**

**node,**

**[node]**

**/**

**GROUP\_NO\_EXTR=**

**grno**

**,**

**[group\_no]**

**)**

**PRECISION**

**=**

**/**

**epsi**

**,**

**[R]**



**/ 10-6 ,  
[DEFECT]**

**INFORMATION**

**=  
/  
1,  
[DEFECT]**

**/ 2,**

**)**

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## **3 Operands**

### **3.1 Operand**

#### **GRID**

**GRID =**

*Name of the concept of the grid type in which the location is carried out.*

### **3.2 Operands**

#### **ALL/GROUP\_MA/MESH**

*These operands make it possible to possibly specify the place where the location of the segment will be carried out.*

**ALL = "YES"**

*The location is carried out on all the grid.*

**GROUP\_MA = lgrma**

*The location is carried out on the list of groups of meshes lgrma.*

**NET = lma**

*The location is carried out on the list of meshes lma.*

### **3.3 Word**

**key**

#### **DEFI\_SEGMENT**

**DEFI\_SEGMENT = \_F**

*Key word factor whose each occurrence defines a segment of right-hand side by the data of its points origin and end (in the form of co-ordinates or of names of node or group\_no).*

*The point origin of the arc is specified by one of the key words:*

**ORIGIN = (teststemxà, yA, zA),**

**NOEUD\_ORIG = node,**

*GROUP\_NO\_ORIG = grno,*

*The point end of the arc is specified by one of the key words:*

*END = (xB, yB, zB),*

*NOEUD\_EXTR = node,*

*GROUP\_NO\_EXTR = grno,*

### **3.4 Operand**

#### **PRECISION**

*PRECISION = epsi*

*Fix by the value of epsi the precision used like criterion of statement of the co-ordinates.*

*One considers a triangle which meets a segment of right-hand side according to the diagram:*

*With*

*N1*

*N2*

*B*

*C*

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*R is posed*

1

2

$l = \text{YEAR}$  and  $r2 = \text{YEAR}$  and one  $R = R$  supposes

1

$2 = R$

AB

AC

If  $R < \text{epsi}$ , *INTE\_MAIL\_3D* considers that the triangle ABC meets the segment considered in one only point: point A. the triangle ABC does not contribute to the location.

Whereas if the user chooses a *epsi* such as  $\text{epsi} < R$  then the triangle contributes to the location with feel *INTE\_MAIL\_3D*.

### **3.5 Operand INFORMATION**

The impression defines

.

*INFORMATION* = 1 step of impression

.

*INFORMATION* = 2 for each segment are printed:

- the component count related,
- the interval of elementary segments of each related component,
- the curvilinear interval of X-coordinate of each related component.

and for each elementary segment:

- the type of the elementary segment (interior, of face or edge),
- the number of the mesh 3D the container,
- numbers of face and edge which contain its points ends,
- the curvilinear interval of X-coordinate (according to the segment) which it covers,
- the value of the co-ordinates of reference of its points ends in their face,
- the value of the co-ordinates of reference of its points ends in the mesh 3D.

4

## **Phases of checking/execution**

4.1

### **Phase of checking**

For each occurrence of the key word factor *DEFI\_SEGMENT*, the length of the lists argument of

key words *ORIGIN* and *END* is controlled; it must be worth three.

## **4.2 Phase of execution**

One checks the existence of the objects indicated in the arguments of key words *NOEUD\_* and *GROUP\_NO\_*

For each segment:

- .
- location of the segment in the meshes 3D of the grid,
- .
- reorganization of the elementary segments thus detected in related components.

If no elementary segment is located, a message of alarm is transmitted.

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## **5 Example of use**

One defines 2 segments *seg1* and *seg2* by *INTE\_MAIL\_3D* on which, one will extract the temperatures by *POST\_RELEVE\_T*:

*seg1* = *INTE\_MAIL\_3D* (*GRID* = *email*,

*DEFI\_SEGMENT*

=\_F

(

*ORIGIN*

=

(.015,

.02,

0.),

*END*

=(.055,

.05,

0.),),

*INFORMATION*

=

1)

*seg2 = INTE\_MAIL\_3D (MAILLAGE= email,*

*DEFI\_SEGMENT=\_F (*

*ORIGIN = (.015, .02, 0.001),*

*END*

=(.055,

.05,

0.001),),

*INFORMATION*

=

1)

%

*POST\_RELEVE\_T (ACTION = (\_F (WAY = seg1, CHAM\_GD = t2,*

*NOM\_CMP*

=

*“temp”, OPERATION*

*= 'extraction'),*

*- F (WAY = seg2, CHAM\_GD = t2,*

*NOM\_CMP*

=

*“temp”, OPERATION=' extraction'))*

*%*

*POST\_RELEVE\_T (ACTION= (\_F (*

*WAY = seg1, RESULT = temple,*

*NOM\_CHAM= “temp”, TOUT\_ORDRE=' OUI', NOM\_CMP=' temp', OPERATION= “extraction”)))*

*%*

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*Date:*

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*Author (S):*

***C. Key DURAND***

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## ***Operator MACR\_LIGN\_COUPE***

### ***1 Goal***

***Extraction in a table of the values of a result on lines of cut defined by two points and an interval or groups of nodes.***

***The result can be mechanical (evol\_elas, evol\_noli...) or thermics (evol\_ther).***

### ***Principle:***

***This macro-order creates a grid linear, right and regular of segments to two nodes, definite by the data of its ends and a number of intervals the component. Fields of the result provided (by defect displacement or temperature) are projected on this grid thanks to the order PROJ\_CHAMP. Then the nodal values on the line of cut of the field post-to be treated are recovered in a table by POST\_RELEVE\_T. It is this table which is produced by the macro-order.***

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### ***2 Syntax***

**[Table] = MACR\_LIGN\_COUPE (**

**RESULT**

**=**

**resu,  
[evol\_elas,  
evol\_noli,  
evol\_ther]**

**NOM\_CHAM**

**=**

**/**

**“SIGM\_NOEU\_DEPL”, [DEFECT  
if  
mechanics]**

**/**

**“TEMP”, [DEFECT  
if  
thermics]**

**/**

**field,  
[K16]**

**MODEL**

=

***model, [model]***

***UNITE\_MAILLAGE = 25,  
[DEFECT]***

***LIGN\_COUPE***

***=\_F (***

***ENTITLE***

=

***txt,  
[KN]***

/

***GROUP\_NO***

=

***gno,  
[grno]***

/

***NB\_POINTS***

=

***Nb,***

**[I]**

***COOR\_ORIG***  
***= (x1, y1, (z1)),***  
***[l\_R]***

***COOR\_EXTR***  
***= (x2, y2, (z2)),***  
***[l\_R]***

***),***

***)***

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### **3 Operands**

#### **3.1 Operand**

**RESULT**

**RESULT** = *resu*,

[*evol\_elas, evol\_noli, evol\_ther*]

*Name of the concept result of the evol type containing the field post-to be treated.*

#### **3.2 Operand**

**NOM\_CHAM**

**NOM\_CHAM**

=

/

**“SIGM\_NOEU\_DEPL”, [DEFECT**

**if**

**mechanics]**

/

**“TEMP”, [DEFECT**

*if  
thermics]*

*/  
field,  
[K16]*

*Name of the field of the resu result which one wishes to record the values on a line of cut. If this key word is not indicated, one projète by defect the field of displacement for a result of mechanical type and the temperature for result of a thermal type.*

*Note:*

*The macro-order treats all types of fields: NODE, ELEM, ELNO.*

*3.3 Operand  
MODEL*

*MODEL  
=  
model, [model]*

*Name of the model associated with the concept evol\_xxx result. The model is necessary at the time of projection of the field by PROJ\_CHAMP.*

*3.4 Operand  
UNITE\_MAILLAGE*

*UNITE\_MAILLAGE = 25,  
[DEFECT]*

*Specify the logical number of unit in which the linear grid of the line of cut is created. This unit is by defect 25; one makes it possible to the user to modify it if unit 25 would be already assigned to another use in its study.*

*3.5 Word  
key  
LIGN\_COUPE*

## **LIGN\_COUPE**

=

*Key word répétable allowing to define one or more lines of cut. A line of cut is a right segment, defined by its two ends and a number of regular intervals cutting out it. One can also define the line of cut by the data of groups of nodes in the grid supporting the fields: the line of cut is then the way defined by the succession of the nodes of these groups.*

### **3.5.1 Operand**

#### **ENTITLE**

#### **ENTITLE**

=

*txt,*  
*[KN]*

*Label of heading in the table allowing to distinguish the various lines from cut. If it key word is not indicated, the label of heading is worth “l.coupe (N)” where (N) is the number of occurrence of the line of cut.*

### **3.5.2 Operand**

#### **NB\_POINTS**

#### **NB\_POINTS**

=

*Nb,*

*[I]*

*A number of points of the line of cut.*

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*8.2*

*Titrate:*

## ***Operator MACR\_LIGN\_COUPE***

***Date:***

***31/01/06***

***Author (S):***

***C. Key DURAND***

***:***

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### ***3.5.3 Operands***

***COOR\_ORIG/COOR\_EXTR***

***COOR\_ORIG***

***=***

***(x1, y1, (z1)),***

***[l\_R]***

***COOR\_EXTR***

***=***

***(x2, y2, (z2)),***

***[l\_R]***

***Co-ordinates of each end of the line of cut: 2 realities in the plan, 3 in space.***

### ***3.5.4 Operand***

***GROUP\_NO***

***GROUP\_NO***

***=***

***gno,***

***[grno]***

***This key, alternative word with the definition of a line of cut by co-ordinates of ends, allows to extract the values on a group from nodes given. In the case of treatment of fields with the nodes, it is perfectly similar to POST\_RELEVE\_T.***

## ***4 Example***



**resu = STAT\_NON\_LINE**

( . . . )

**tab1 = MACR\_LIGN\_COUPE (RESULT**

**= resu**

**LIGN\_COUPE = (**

**\_F (**

**NB\_POINTS**

**=**

**17**

**COOR\_ORIG**

**=**

**(0.,0.,0.),**

**COOR\_EXTR**

**=**

**(10.,0.,0.),**

**ENTITLE**

**=**

**“ligne1”,**

**),**

**\_F (**

**NB\_POINTS**

**=**

**25**

**COOR\_ORIG**

**=**

**(-10.,0.,0.),**

**COOR\_EXTR**

**=**

**(0.,20.,0.),**

**),**

**),**

**)**

**IMPR\_TABLE (TABLE**

**= tab1)**

*In this example, one records the values of the displacement obtained in the resu result with all them moments of calculation on two lines of cut.*

*The table tab1 contains the sequence numbers, the curvilinear X-coordinates, the co-ordinates of the points then finally values of the nodal size (on the nodes of the line) of the treated field, here by defect displacement.*

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Operator *POST\_RELEVE\_T*

Date:

22/02/06

Author (S):

**X. DESROCHES, L. VIVAN** Key

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Organization (S): *EDF-R & D /AMA, CS IF*

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### **Operator POST\_RELEVE\_T**

#### **1 Goal**

**To extract from the values of components of fields of sizes and to carry out calculations of averages and of invariants. The values are recorded on nodes, meshes, broken lines connecting of the nodes or on beforehand definite loci like concepts of the type (INTE\_MAIL\_2D curves [U4.81.11]) or surfaces (INTE\_MAIL\_3D [U4.81.12]). They can be the object, by this same procedure:**

**.  
calculations of:  
- averages,  
- resultants and moments of vector fields,  
- invariants of tensorial fields,  
- directional trace of fields,  
.**

**of expression in the reference marks TOTAL, LOCAL, POLAR, USER or CYLINDRICAL.**

**POST\_RELEVE\_T produces a concept of the type counts, which can be printed using IMPR\_TABLE [U4.91.03].**

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**2 Syntax**

**general**

**tresu [tabl\_post\_rele] = POST\_RELEVE\_T**

**(**

**ACTION = \_F (**

**ENTITLE**

**= name**

**,**

**[K8]**

**/**

**WAY**

**=**

**/**

**curve, [curve]**

**/**

**surface,**

**[surface]**

**/**

**/NODE = lnoe, [l\_noeud]**

**/GROUP\_NO**

**=**

**lgrno, [l\_gr\_noeud]**

**/ALL = "YES",**

**/**

**/NET**

**=**

**lmail,**

**[l\_maille]**

**/GROUP\_MA=**

**lgrma,**

**[l\_gr\_maille]**

**FORMAT\_C**

**= /**

**"MODULE",**

**[DEFECT]**

**/**

**"REAL"**

,  
/  
**“IMAG”**

,  
  
**/CHAM\_GD = chpgd,/[cham\_no\_DEPL\_R]**

**/**  
**[cham\_no\_TEMP\_R]**

**/**  
**[cham\_no\_PRES\_R]**

**/**  
**[cham\_no\_VARI\_R]**

**/**  
**[cham\_elem\_SIEF\_R]**

**/**  
**[cham\_elem\_EPSI\_R]**

**/**  
**[cham\_elem\_FLUX\_R]**

**/**  
**[cham\_elem\_CRIT\_R]**

**/**  
**[cham\_elem\_ENER\_R]**

**/**  
**[cham\_elem\_DBEL\_R]**

**/**  
**[cham\_elem\_PRES\_R]**

**/**  
**[cham\_elem\_ERREUR]**

**/**  
**[cham\_elem\_VARI\_R]**

**/**  
**[cham\_no\_DEPL\_C]**

**/**  
**[cham\_no\_TEMP\_C]**

**/**  
**[cham\_no\_PRES\_C]**

**/**  
**[cham\_elem\_SIEF\_C]**

**/**  
**[cham\_elem\_EPSI\_C]**

/

**[cham\_no\_FACY\_R]**

/

**RESULT**

=

**resu,**

/

**[evol\_elas]**

/

**[evol\_ther]**

/

**[evol\_noli]**

/

**[mode\_flamb]**

/

**[dyna\_trans]**

/

**[dyna\_harmo]**

/

**[mode\_meca]**

/

**[mode\_stat]**

/

**[fourier\_elas]**

/

**[mult\_elas]**

/

**[mode\_acou]**

/

**[acou\_harmo]**

/

**[base\_modale]**

**SENSITIVITY = (see [U4.50.02])**

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**NOM\_CHAM**

**= chpsymbo,**

**[K16]**

**/TOUT\_ORDRE = "YES",**

**/  
NUME\_ORDRE =  
lordre, [l\_I]**

**/  
LIST\_ORDRE =  
lenti,**



**[listis]**

/  
**NUME\_MODE**  
=  
**lmode,**  
**[l\_I]**

/  
**LIST\_MODE**  
=  
**lenti,**  
**[listis]**

/  
**NOM\_CAS =**  
**nomcas, [K24]**

/  
**NOEUD\_CMP**  
=  
**noeucmp,**  
**[K24]**

/  
**FREQ**  
=  
**lfreq,**  
**[l\_R]**

/  
**LIST\_FREQ**  
=  
**lreel,**  
**[listr8]**

/  
**INST**  
=  
**linst,**  
**[l\_R]**

/  
**LIST\_INST**  
=  
**lreel,**  
**[listr8]**

/  
**PRECISION=**  
**prec, [R]**

/  
**1.D6,**  
**[DEFECT]**

/  
**CRITERE=**/  
**“RELATIVE”, [DEFECT]**

**/“ABSOLUTE”,**

**/TOUT\_CMP**  
**= “YES”,**

/  
**NOM\_CMP =**  
**lcmp,**  
**[l\_K8]**

**LOCATE**  
**=**  
/  
**“TOTAL”**  
**, [DEFECT]**

/  
“POLAR”,

/  
“LOCAL”

,

*VECT\_Y = (oy1, oy2, oy3), [l\_R]*

/  
“USER”,

*ANGL\_NAUT = (,), [l\_R]*

/

**“CYLINDRICAL”**,

***ORIGIN = (X, y, Z),  
[l\_R]***

***AXE\_Z = (oz1, oz2, oz3), [l\_R]***

***/TRAC\_NOR = “YES”***,

***/TRAC\_DIR = “YES”***,

***DIRECTION = (X, y, [Z]), [l\_R]***

***/INVARIANT = "YES",***

***/***  
***ELEM\_PRINCIPAUX=***  
***"YES",***

***/RESULTING = lcmp,***  
***[l\_K8]***

***MOMENT =***  
***lcmp,***  
***[l\_K8]***

***NOT = (X, y, [Z]), [l\_R]***

**OPERATION**  
= / “**EXTRACTION**”,  
[**K16**]

/ “**AVERAGE**”,

**MOYE\_NOEUD=**  
/  
“**YES**”,  
[**DEFECT**]  
/  
“**NOT**”,

**TITRATE**  
= *title*  
[*l\_Kn*]

)

)

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***3***

***Principles of use of POST\_RELEVE\_T:  
operand ACTION***

***The postprocessing carried out by POST\_RELEVE\_T requires the data of three information:***

***.***

***place,***

***.***

***object,***

***.***

***nature.***



*Each occurrence of the key word factor ACTION defines this triplet.*

*The place of postprocessing indicates a geometrical figure connecting the points of postprocessing.  
This place  
is defined by means of the key words:*

**WAY**

**NODE**

**GROUP\_NO**

*The object of postprocessing is defined by the choice of a field of size, components and possibly of associated quantities chosen by various key words.*

*The fields of size are chosen by one of the key words:*

*RESULT and key words allowing for choice of the fields with the nodes or the fields with elements of the structure of data result (see booklet [U5.01]).*

*CHAM\_GD field of size produced by an operator elementary, or extracted from a concept result by RECU\_CHAMP [U4.71.01].*

*components by:*

**TOUT\_CMP**

**NOM\_CMP**

*and quantities associated by:*

**INVARIANT**

**ELEM\_PRINCIPAUX**

**TRAC\_NOR**

**TRAC\_DIR and DIRECTION**

**RESULTANT and, optionally, MOMENT and NOT**

*The nature of postprocessing corresponds to the operations: key word OPERATION*

*of extraction of values: "EXTRACTION"*

*of calculation of averages, of minimum and maximum: "AVERAGE"*

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*Choice of the place of postprocessing*

*4.1 Syntax*

*/*

*WAY*

*=*

*/*

*curve, [curve]*

*/*

*surface,*

*[surface]*

*/*

*/ NODE*

*= lnoe,*

**[l\_noeud]**

**/GROUP\_NO**

=

**lgrno, [l\_gr\_noeud]**

**/ALL = "YES",**

**//MESH**

=

**lmail,**

**[l\_maille]**

**/GROUP\_MA**

=

**lgrma, [l\_gr\_maille]**

#### **4.2 Operands**

**WAY/NODE/GROUP\_NO/ALL/MESH/**

**GROUP\_MA**

.

*The argument of WAY is a concept produced by one of the following operators:*

**INTE\_MAIL\_2D [U4.81.11]**

*The concept is reduced then is with the intersection of segment of right-hand side and/or arc of circle with the meshes 2D of the grid, that is to say with a whole of ways built on meshes 1D of the grid of.*

**INTE\_MAIL\_3D [U4.81.12]**

*The concept is then reduced to the intersection segments of right-hand side with the meshes 3D of grid of.*

*The place obtained in this case is always included in.*

.

*The argument of NODE is a list of nodes while that of GROUP\_NO is a list of groups of nodes. The nodes are treated in the order provided by the user. To reorder the nodes of a list, it is necessary to use order **DEFI\_GROUP OPTION "NOEUD\_ORDO"** [U4.22.01]*

•  
*The key words NETS and GROUP\_MA make it possible to limit postprocessing to a list of meshes ou/et a list of groups of meshes.*

*ALL = "YES" returns to the standard case (one considers all the meshes). These key words are not usable that with NODE and/or GROUP\_NO.*

### **4.3** *Concepts of points of postprocessing and examples*

*The points of postprocessing are the points of where the components (or derived quantities) are evaluated. The operation of extraction carries out this evaluation.*

*The points of postprocessing can be classified according to two families:*

•  
*Nodes:*

*Case where the place of postprocessing is defined is by means of the key words NODE and/or GROUP\_NO, is by means of the key word WAY with concept of a curved type obtained like lists of mesh ID.*

•  
*Geometrical points:*

*Case where the place of postprocessing is defined by means of the key word WAY with a concept of curved type or surface obtained like meeting of segments of right-hand side and/or arcs of ring.*

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### ***4.3.1 Example of curves and parts of curve of a WAY***

***Y***  
***M***  
***M***  
***5***  
***6***  
***M7***  
***M4***  
***X***  
***M8***  
***With***  
***O***  
***0***  
***M3***  
***B***  
***M***  
***C***  
***2***  
  
***M***  
***D***  
***1***

***Appear 4.3.1-a***

***The way represented on this figure consists of two curves: the first curve corresponds with the segment of right-hand side [AD] and the second with the arc of circle of center O which connects the M1 point to the point***

***M8. The curve corresponding to the arc connecting M1 and M8 breaks up into four parts: arcs connecting respectively M1 with m2, m3 with M4, M5 with M6, M7 with M8, the other ends of arc being external with field.***

***The curve corresponding to segment [AB] breaks up into two parts: segment [AB] and it segment [CD] bus [BC] is external with the field.***

### ***4.3.2 Example of points of postprocessing corresponding to a WAY***

***With***

***M1***

***NR***

***M***

***NR***

***1***

***2***

***N5***

***6***

***N2***

***N3***

***M***

***NR***

***3***

***7***

***N4***

***M***

***NR***

***4***

***8***

***N9***

***B***

***N10***

***Appear 4.3.2-a***

***On this figure two ways are visualized.***

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**U4.81.21-G1 Page:****7/22****Way n°1: segment [AB]**

.

**The points of postprocessing are reduced to {A, M1, m2, m3, M4, B}.****The Mi point is located by the curvilinear X-coordinate (Semi) = AMi**

.

**In the case of one****arc of circle the curvilinear X-coordinate is defined by S****= R or R is it****ray and is the angle corresponding to the point in question.****Way n°2: meeting of two ways (two parts)**

.

**The points of postprocessing are reduced to {N1, N2, N3, N4} and {N5, N6, N7, N8, N9, N10}.**

.

**The curvilinear X-coordinate locating Neither on the way of points of postprocessing {Ni,... Np} is defined by the relations:****(sN1) = 0**

(

**j=i 1**

-

**S Ni)****= NR NR****for****I****= 2, ...,****J****J 1****+****p****J 1****=****4.3.3 Example of points of postprocessing specified by the key words NODE or GROUP\_NO**

**N47**  
**N427**  
**N104**  
**N61**

**Appear 4.3.3-a**

***This figure visualizes a place of postprocessing built starting from a list of nodes.***

***The points of postprocessing are the nodes represented, the place of postprocessing is the broken line connecting according to the order provided by the user, which makes it possible to define a curvilinear X-coordinate in***

***means of the relations presented for the ways seen previously. The value extracted on these ways is interpolated linearly between the values recorded on the nodes. Thus it is necessary to notice that if the operation of postprocessing is a calculation of average, all occurs like if the segment [N47 N61] was contained entire in.***

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***5***  
***Object-choice of postprocessing***

***These key words make it possible to define the object of postprocessing. They indicate:***

***.***



*a field of size: key words CHAM\_GD, RESULT (and its associated key words),*

.

*a quantity associated with the components with the field: key words TOUT\_CMP, NOM\_CMP, INVARIANT, ELEM\_PRINCIPAUX, TRAC\_NOR, TRAC\_DIR, DIRECTION, REFERENCE MARK, SOMME, RESULTANT, MOMENT, NOT.*

## **5.1**

*Field of size*

### **5.1.1 Syntax**

*/CHAM\_GD = chpgd,*

*/RESULT = resu,*

*SENSITIVITY = list of the sensitive parameters [listk8]*

*NOM\_CHAM*

=

*chpsymbo, [K16]*

*/TOUT\_ORDRE*

=

*“YES”,*

/

*NUME\_ORDRE*

=

*lordre, [l\_I]*

/

*LIST\_ORDRE*

=

*lenti,  
[listis]*

/

*NUME\_MODE*

=

*lmode,*

**[l\_I]**

/  
**LIST\_MODE**

=  
**lenti,**  
**[listis]**

/  
**NOM\_CAS**

=  
**nomcas, [K24]**

/

/

**FREQ**

=  
**lfreq,**  
**[l\_R]**

/

**LIST\_FREQ**

=  
**lreel,**  
**[listr8]**

/

**INST**

=  
**linst,**  
**[l\_R]**

/

**LIST\_INST**

=  
**lreel,**

**[listr8]**

/  
**PRECISION =**  
/  
**prec, [R]**

/  
**1.D6,**  
**[DEFECT]**

/  
**CRITERION =/**  
**“RELATIVE”,**  
**[DEFECT]**

**/“ABSOLUTE”,**  
**FORMAT\_C**  
**=**  
/  
**“MODULE”,**  
**[DEFECT]**

/  
**“REAL”,**

/  
“IMAG”,

### **5.1.2 Operand CHAM\_GD**

*The argument of CHAM\_GD is the name of a concept of the cham\_no\_\* type or cham\_elem\_\*.*

### **5.1.3 Operands**

**RESULT/NOM\_CHAM/TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/  
NUME\_MODE/LIST\_MODE/NOM\_CAS/FREQ/LIST\_FREQ/INST/LIST\_INST  
/PRECISION/CRITERION**

*See [U4.71.00].*

### **5.1.4 Operand SENSITIVITY**

**SENSITIVITY = list of the significant parameters [listk8]**

*This key word is followed of a sensitive parameter list. It specifies that one is not interested in result in itself, but with derived from the result compared to a parameter. Thus one sequence of this type:*

**RESULT = resu,  
SENSITIVITY = (PS),  
NOM\_CHAM = “DEPL”**

*mean that one will operate on the derivative of the field of displacement of the resu result by report/ratio*

*with the parameter PS. See [U4.50.02] for the details on the parameters associated with the key word.*

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### **5.1.5 Operand**

#### **FORMAT\_C**

*In the case of the complex fields, one can extract:*

*/“MODULE” the module*

*/*

*“REAL”*

*the real part*

*/*

*“IMAG”*

*the imaginary part*

## **5.2**

### **Components of the field and quantities derived**

*For the vectors and the tensors of order 2, it is possible to ask the evaluation of the components in a reference mark and to derive from the quantities obtained by contracted product. The key words LOCATES,*

*TRAC\_NOR, TRAC\_DIR and DIRECTION make it possible to define these quantities.*

#### **5.2.1 Syntax**

*/TOUT\_CMP*

*= “YES”,*

/  
*NOM\_CMP* =  
*lcmp*,  
*[L\_K8]*

*/REFERENCE MARK =/“TOTAL”*,

*[DEFECT]*

*/“POLAR”*,

*/“LOCAL”*,

*VECT\_Y= (oy1, oy2, oy3), [L\_R]*

*/“USER”*,

*ANGL\_NAUT* = (,), [*l\_R*]

*/“CYLINDRICAL”*,

*ORIGIN* = (*X*, *y*, *Z*), [*l\_R*]

*AXE\_Z* = (*oz1*, *oz2*, *oz3*), [*l\_R*]

*/TRAC\_NOR*

=

*“YES”*,

*/TRAC\_DIR*

=

*“YES”*,

*DIRECTION* = (*X*, *y*, [*Z*]), [*l\_R*]

*/INVARIANT* = *“YES”*,

*/ELEM\_PRINCIPAUX=*  
*“YES”,*

*/RESULTING = lcmp,*  
*[l\_K8]*

*MOMENT =*  
*lcmp,*  
*[l\_K8]*

*NOT = (X, y, [Z]), [l\_R]*

### **5.2.2 Operand**

#### **TOUT\_CMP**

*/TOUT\_CMP*

*This key word admits for argument only the text “YES” and selects all the components defined in the catalogue of the sizes for the size relating to the fields specified by key words RESULT and CHAM\_GD.*

### **5.2.3 Operands**

#### **NOM\_CMP**

*Allows to define the components of the size of the treated field:*

*/NOM\_CMP:*

*the components are introduced by name*

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### **5.2.4 Operand**

#### **LOCATE**

#### **/REFERENCE MARK**

*The choice of a reference mark allows among the following reference marks:*

.

*TOTAL reference mark: Cartesian reference mark of definition of the grid,*

.

*POLAR reference mark: standard polar reference mark of plan (OXY) (order of the components: (R,)),*

.

*locate LOCAL: locate plan made up of the tangent and normal vectors (in this order) instead of postprocessing. The normal vector is defined in each point of postprocessing like average of the normals on the right and on the left.*

#### **Definition of the normal instead of postprocessing.**

*In each point of postprocessing the normal is defined like average of the normals on the right and on the left.*

**N**

**N**

**N**

**G**

**D**

**T**

**NR**

#### **Appear 5.2.4-a**

*The tangent vector is obtained by a rotation of - starting from the normal vector.*

2

*In the case of the LOCAL reference mark and of a way 3D (case of ASPIC for example), it will be necessary to provide:*

$VECT\_Y = (oy1, oy2, oy3)$

*Co-ordinates of a vector of which projection on the orthogonal level with the directing axis of the way will be taken as the normal with the way. The order of the components in a local reference mark is (T, N, K).*

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**Example of use:**

**y**

**Z**

**C**

**X**

**X**

**y**

**Z**

**B**

**Z**

**X**

**O**

**Y**

**y**

**Z**

**With**

**X**

### ***Appear 5.2.4-b***

*One wants to make an extraction on the way ABC according to the definite local reference mark above (local axis y in total direction OX).*

*Here, one can find a vector constant in any point of the way to define the vector*  
 $VECT\_Y = (1. , 0. , 0.).$

*This is possible bus in any point this vector is already in the orthogonal plan with the way.*

*y*

*y*

*Z*

*C*

*X*

*X*

*Z*

*y*

*B*

*Z*

*X*

*With*

*Y*

*y*

*Z*

*X*

### ***Appear 5.2.4-c***

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*So on the other hand, one wishes to have local axis Z in total direction OX [Figure 5.2.4-c], it vector VECT\_Y will depend on the point considered:*

*(0. , 0. , 1.) is appropriate except in A (where (0. , - 1. , 0.) is appropriate)  
(0. , - 1.0.) is appropriate except out of C (where (0. , 0. , 1.) is appropriate)*

*It will thus be necessary in this case to cut out the way in two ways (AB and BC) and to define a VECT\_Y different on each way.*

.  
*locate USER: defined by the data of 3 nautical angles (in degrees):*

*ANGL\_NAUT = (,)*

.  
*CYLINDRICAL reference mark defined by:*

*ORIGIN = (X, y, Z)  
co-ordinates of the origin O of the reference mark  
AXE\_Z= (oz1, oz2, oz3) co-ordinates of a vector defining axis OZ (axis of roll).  
The order of the components in a cylindrical reference mark is (R, Z,).*

### **5.2.5 Operand**

**TRAC\_NOR**

*/TRAC\_NOR*

:  
*only for modelings 2D and 3D.*

*Determination of the normal trace of a vector or a tensor of order 2: it is the particular case directional trace obtained when direction U.S. 'identifies with normal N instead of postprocessing.*

### **5.2.6 Operands**

**TRAC\_DIR/DIRECTION**

*/TRAC\_DIR*

:

*only for modelings 2D and 3D.*

**DIRECTION**

*Determination of the directional trace of a vector  $\mathbf{v} = (v_i)$  or of a tensor of order 2  $= (ij)$  in the direction  $\mathbf{U} = (u_j)$ ; i.e. scalar  $v U$   $K K$  or of the vector  $ik$  the U.K.*

*The direction  $\mathbf{U}$  is defined by means of the key word DIRECTION whose arguments are them components of the vector  $\mathbf{U}$  given in order X, Y, Z and evaluated in the total reference mark. If this list then contains only two values, conventionally, the component according to Z of vector  $\mathbf{U}$  is regarded as null.*

### **5.2.7 Operand**

**INVARIANT**

*Postprocessing of a tensor of constraint or deformation of order 2 associated the directions principal of the tensor:*

*2 or 3*

*TRACE*

*Tr ()*

=

*II*

*I = 1*

*2 or 3 3*

*1*

*2*

*PUT VON\_*

*VM ()*

=

-

(

*Tr)*

*2 ij*

*ij*

*3*

*I, j=1*

*TRESCA*

*TR ()*

*=*

*(*

*Max*

*-*

*I*

*J)*

*with*

*v*

*clean aleurs of*

*I*

*DETER*

*DET () = determinant of*

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### ***5.2.8 Operand***

***ELEM\_PRINCIPAUX***

*/ELEM\_PRINCIPAUX*

*Determination of the principal values of a tensor 2x2 or 3x3 of order 2. They are arranged in the order ascending their values.*

### ***5.2.9 Operands***

## **RESULTANT/MOMENT/NOT**

*Determination of the resultant and the moment of a field of torque on the place of postprocessing.*

*By means of computer, these key words can apply to any field of size but for that the results have a physical direction, one will have to limit oneself to the fields of nodal forces and nodal reactions.*

*In this last case, 2 possibilities arise:*

.  
*the user wants to calculate the resultant of certain components of the field: he will enter behind the key word RESULTANT a list of components to be taken among {"DX", "DY"} in 2D and {"DX", "DY", "DZ"} in 3D or structural elements (the resultant of components of rotations not having a physical direction),*

.  
*the user wants to calculate the resultant and the moment of certain components of the field: it will enter behind the key words RESULTANT and MOMENT 2 lists of of the same components length to be taken among*

*{"DX", "DY", "DZ"}  
behind the key word RESULTANT  
{"DRX", "DRY", "DRZ"}  
behind the key word MOMENT*

*Moreover, it will introduce behind the key word NOT the list of the co-ordinates of the point by report/ratio to which moment is evaluated.*

*If one notes P this point and Mi the points of postprocessing, the evaluated quantities will be:*

.  
*Resultant: F =*  
*F*  
*=*  
*I*  
*(FXM, M*  
*FY, FZM*  
*I*  
*I*  
*I)*  
*I*  
*I*

.

*Moment: m = (PM*

*C*

*I*

*Fi) + semi*

*I*

*I*

*where MCI indicates the list of the concentrated moments corresponding to the components of rotation introduced by the key word*

*C*

*MOMENT. mid 0. only in the case of structural elements (beams, hulls, discrete).*

**Note:**

*In continuous mediums, one should not introduce behind MOMENT of the components of translation who would be regarded as concentrated moments and thus summoned with true moments.*

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**6**

**Nature of postprocessing**

**6.1 Operand**

**OPERATION**



**OPERATION**

=

/

**“EXTRACTION”**

*The operation extraction of a field of size makes it possible to recover the values of one or several components or of quantities derived from these components at the points of the place of postprocessing.*

*In the case of an extraction on a cham\_elem, values of the components extracted from this field are calculated as follows:*

.

*if the place of postprocessing is determined by key words NODE or GROUP\_NO, for each node the components are realised on all the elements contributing in it node,*

**Note:**

*The moyennations with the nodes of computed fields in local reference marks are not licit that if the angles between these reference marks are weak. In the contrary case, they do not have no the direction.*

.

*if the place of postprocessing is a way confused with one or more edges of grid, one makes the average on the elements having an intersection of nonnull measurement with the way.*

*This can lead, for the same place of postprocessing, with appreciably different results:*

2

4

NR

3

NR

NR

N1

N5

*If the place of postprocessing is defined by NODE = (N1, N2, N3, N4, N5), the values are realised on all the elements of the grid above.*

*If the place of postprocessing is defined as being the segment of N1 origin and end N5, then values will be realised on the hatched elements.*

*In the case of quadratic elements (presence of nodes mediums), the average with the nodes tops can lead to more important weights of certain elements (function of cutting) per report/ratio with the nodes mediums which realise on 2 elements (thus of the same weight). One can thus be in presence of oscillations between the values at the tops and the mediums.*

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“AVERAGE”

*This operation is limited to 6 components of field at the same time. Being given a field scalar  $U$  (typically a component of a size), the “AVERAGE” operation calculates following quantities ( $L$  indicating the length of the place of postprocessing  $C$  considered):*

$I$

$MOMENT_0$

=

$U ()$

$S$

$ds$

$L C$

12

$L$   
 $MOMENT\_1$

=

$U ()$

$S$

$S$

$ds$

-

$2$

$L$

$C$

$2$

$MINIMUM$

=

$Min U$

$C$

$MAXIMUM$

=

$Max U$

$C$

$1$

$MOYE\_INT$

=

$MOMENT\_0 -$

$MOMENT\_1$

$2$

$1$

$MOYE\_EXT.$

=

$MOMENT\_0 +$

$MOMENT\_1$

$2$

*It is important that the place of postprocessing is traversed in a direction. If one uses a group of nodes, one will take care to reorder the nodes, by using order  $DEFI\_GROUP OPTION$  "NOEUD\_ORDO", [U4.22.01]. Thus, the curvilinear X-coordinate is defined since the node origin of the group, in according to the broken line consisted the nodes.*

The integrals above are evaluated by supposing  $U$  linear between two nodes. Thus, while noting  $U_i$  values of the field to the nodes (numbered by  $I =, \dots$

1 NR) of X-coordinate if, one  $a$ :

-1

1

NR

$MOMENT_0 = ($

$S$

$S U$

$U$

2  $S -$

$I$

$I$

$I$

$I$

NR

$I$

$S) (+ -$

$I$

$)( + + I)$

$i=1$

NR -1

NR -1

2

3

$MOMENT_1 =$

$S$

$S U.S.$

2s

$U$

2s

$S$

$S$

$S U$

$U$

2  $(i+ -$

$I$

$I) (I (i+ +$

$I$

$I) +$

$i+1 ($

$i+ +$

*I*  
*I) -*  
 -  
 +  
 (*S -*  
*I*  
*I*  
*I*  
*I*  
*S*  
*S*  
*S*  
*NR*  
*I )*  
 ( -  
*I I*  
*NR*  
*I) (+I*  
 )(   
 +*I )*  
 =  
*i=1*

## **6.2 Operand**

### **MOYE\_NOEUD**

*Key word allowing for choice of an impression detailed or realised in a point. This key word is not significant that for the sizes of the cham\_elem type and the operation EXTRACTION.*

*MOYE\_NOEUD = “YES”*

*For each point of postprocessing, the posted value of a component or a quantity deduced is obtained like average of the values given by each convergent mesh in it not. The way of making the average is the same one as for the fields - NOEU - calculated by CALC\_NO [U4.81.02].*

*MOYE\_NOEUD = “NOT”*

*The list of the values obtained for each convergent mesh at the point of postprocessing is posted.*

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7

***Operands of access and impression of the contents of the tables created by *POST\_RELEVE\_T****

7.1

***Principles of addressing of the contents of the tables***

*The statements of values are arranged in concepts of the type counts. The tables are Bi-subscripted. first index is the parameter, this one is defined by the operator according to the action planned (see [Table 7.4-a]). The second index is the variable, this one is defined by the user. Variables can be the names of the nodes, the names of the components or the numbers of the points of postprocessing along a way.*

7.2 Operand

***ENTITLE***

*ENTITLE*

=

*matable*

[K8]

*Name of the table of statements of values.*

7.3 Operand

***TITRATE***

*TITRATE = title*

*Titrate that one wants to give to the table statements of values. For more details, to see [U4.03.01].*

## **7.4** **Definition of the parameters and the variables**

*With the impression on the file RESULT, each parameter is printed on a column, the variables being printed line by line.*

### **Variable key words Parameters**

*OPERATION = "AVERAGE"*

*MINIMUM MOMENT\_0 MOMENT\_1*

*Names of the components*

*(key words TOUT\_CMP, NOM\_CMP)*

*MAXIMUM MOYE\_INT MOYE\_EXT*

*(example [§9.2.2])*

*OPERATION = "EXTRACTION"*

-

*Names of the nodes if NODE or*

*(key word IMPR\_NOEUD = "YES")*

*GROUP\_NO*

*Number of the point if WAY*

*OPERATION = "EXTRACTION"*

*Names of the concaténés nodes*

*(key word IMPR\_NOEUD = "NOT")*

-

*with the names of the meshes if NODE*

*or GROUP\_NO*

*Number of the point if WAY*

*TOUT\_CMP NOM\_CMP*

*ABSC\_CURV COOR\_X COOR\_Y*

-

*(examples [§9.1] and [§9.2.1])*

*COOR\_Z followed by the name of  
components*

*NOM\_CMP TRAC\_NOR TRAC\_DIR*

*ABSC\_CURV COOR\_X COOR\_Y*

-

*(examples [§9.3] and [§9.4])*

*COOR\_Z*  
*DIR\_1 DIR\_2 DIR\_3*  
*INVARIANT*  
*ABSC\_CURV COOR\_X COOR\_Y*

-  
*(example [§9.5])*  
*COOR\_Z VON\_MIS TRESCA*  
*TRACE DETER*  
*ELEM\_PRINCIPAUX*  
*ABSC\_CURV COOR\_X COOR\_Y*

-  
*(example [§9.6])*  
*COOR\_Z VAL\_PR\_1 VAL\_PR\_2*  
*VAL\_PR\_3*  
*RESULTANT MOMENT*  
*Names of the components*

-  
*(examples [§9.7] and [§9.8])*

*LOCATE = "POLAR"*  
*ABSC\_CURV COOR\_X COOR\_Y*

-  
*(example [§9.9])*  
*COOR\_Z followed by the name of*  
*components*

**Table 7.4-a**  
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8

## ***Phase of checking***

*It is checked that the headings all are different.*

8.1

### ***During the execution***

*This phase checks the coherence of the arguments between them. It relates to all the occurrences of key word factor ACTION. One distinguishes 2 groups from checks.*

*The first group is common to the arguments of the key word CHAM\_GD and RESULT (which are excluded*

*mutually) and is reduced to the following checks:*

.

*acceptability of the components:*

*it is checked that the required components are quite present at the catalogue of description size to be treated,*

.

*coherence of the grid:*

*it is checked that the grid on which the size was calculated is the grid on which is built the place of postprocessing (case of the key word WAY) or contains the nodes passed in argument (case of the key words NODE and/or GROUP\_NO).*

*The second group is specific to the key word RESULT, and is reduced to the checks:*

.

*checking of the acceptability of the field symbolic system:*

*one makes sure that the field symbolic system argument of key word NOM\_CHAM exists well for type of concept argument result of the key word RESULT,*

.

*existence of at least a structure of data for the field symbolic system to treat.*

*At the exit of the phase of checking, in production run the following alternative arises:*

.

*all the occurrences of ACTION are correct and the operations are launched,*

.

*at least an occurrence of ACTION is incorrect, then a fatal error message is*

*product with stop of the order. Information informs about the nature of the errors and the means of correcting them.*

## **8.2**

### ***During the treatment***

*A new filter of checking is presented but never causes the stop of the order. This filter is reduced to the following checks:*

*.  
existence of the structure of data indicated by CHAM\_GD or RESULT and one of the words keys giving access in a structure of data RESULT.*

*In the event of failure a message is transmitted and the following occurrence is treated,*

*.  
in the case of a calculation of tensorial invariants, one checks that the object of the treatment indicates well*

*a tensor of order 2,*

*.  
in the case of a calculation of average or a request for extraction of values, one checks that the components to be treated were indeed calculated on the place of postprocessing. In the event of failure*

*of this checking, a message details the components nonavailable according to meshes or nodes of the place of postprocessing.*

*If this last filter does not detect any impossibility of calculation, postprocessing is launched and the results are inserted in the table.*

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## **9 Examples**

*The examples which follow apply to the same physical problem (case test SHLV100G).*

### **9.1 Key words**

**“AVERAGE” “EXTRACTION”/**

#### **9.1.1 “EXTRACTION”**

##### **9.1.1.1 Orders**

*# extraction of the CMP of the tensor of the constraints on a list of nodes*

*#*

**t2 = POST\_RELEVE\_T (ACTION = \_F (  
 ENTITLE = “ex\_2”,  
 NODE = (“N1”, “N347”, “N21”, “N432”, “N39”, “N229”),  
 CHAM\_GD = SIGMA,  
 NOM\_CMP = (“SIXX”, “SIYY”, “SIZZ”, “SIXY”),  
 OPERATION = “EXTRACTION”))**

##### **9.1.1.2 Result**

**--- POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER: 1**

**FIELD BY ELEMENT WITH THE NODES**

**EXTRACTION TENSOR FORCED**

**TOTAL REFERENCE MARK**

**WAY OF NODES**

**T2 CONCEPT OF the TYPE TABL\_POST\_RELE CALCULATES FROM the CONCEPT SIGMA  
 COUNT: EX\_2 RESULTING FROM the T2 TABLE**

**ABSC\_CURV COOR\_X COOR\_Y COOR\_Z SIXX SIYY SIZZ SIXY**

**N1 0.00000E+00 1.00000E-01 0.00000E+00 0.00000E+00 -9.96843E-01 1.66549E+00 2.00595E-01 -  
 2.97371E-04**

**N347 1.00000E-01 2.00000E-01 0.00000E+00 0.00000E+00 -2.39383E-04 6.67596E-01 2.00207E-01 -  
 2.65146E-05**

**N21 2.14214E-01 9.23880E-02 3.82683E-02 0.00000E+00 -6.06951E-01 1.27563E+00 2.00603E-01 -  
 9.41280E-01**

**N432 3.14214E-01 1.84776E-01 7.65367E-02 0.00000E+00 9.75617E-02 5.69793E-01 2.00206E-01 -  
2.36114E-01**  
**N39 4.28428E-01 7.07107E-02 7.07107E-02 0.00000E+00 3.34029E-01 3.34628E-01 2.00597E-01 -  
1.33117E+00**  
**N229 5.28428E-01 1.41421E-01 1.41421E-01 0.00000E+00 3.33660E-01 3.33711E-01 2.00211E-01 -  
3.33924E-01**

## **9.1.2 “AVERAGE”**

### **9.1.2.1 Orders**

*# average of the CMP of the tensor of the constraints on a list of nodes*

*#*

**T3 = POST\_RELEVE\_T (ACTION=\_F (ENTITLES = “ex\_3”,  
NODE = (“N1”, “N347”, “N21”, “N432”, “N39”, “N229”),  
CHAM\_GD = SIGMA,  
NOM\_CMP = (“SIXX”, “SIYY”, “SIZZ”, “SIXY”),  
OPERATION = “AVERAGE”,),)**

### **9.1.2.2 Result**

**--- POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER: 1**

**FIELD BY ELEMENT WITH THE NODES**

**AVERAGE TENSOR FORCED**

**TOTAL REFERENCE MARK**

**WAY CONNECTING THE NODES:**

**N1 N347 N21 N432 N39 N229**

**CONCEPT T3 OF the TYPE TABL\_POST\_RELE CALCULATES FROM the CONCEPT SIGMA  
COUNT: EX\_3 RESULTING FROM TABLE T3**

**MOMENT\_0 MOMENT\_1 MINIMUN MAXIMUN MOYE\_INT MOYE\_EXT**

**SIXX -9.83430E-02 1.17015E+00 -9.96843E-01 3.34029E-01 -6.83419E-01 4.86733E-01**

**SIYY 7.66354E-01 -1.17020E+00 3.33711E-01 1.66549E+00 1.35145E+00 1.81254E-01**

**SIZZ 2.00403E-01 -1.44941E-05 2.00206E-01 2.00603E-01 2.00411E-01 2.00396E-01**

**SIXY -5.40089E-01 -1.03327E+00 -1.33117E+00 -2.65146E-05 -2.34562E-02 -1.05672E+00**

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## **9.2 Operands**

**WAY/TRAC\_NOR**

### **9.2.1 Orders**

*# traces normal A a segment of the tensor of the constraints*

*#*

*t4 = POST\_RELEVE\_T (ACTION = \_F (  
ENTITLE = "ex\_4",  
WAY = AB,  
CHAM\_GD = SIGMA,  
NOM\_CMP = ("SIXX", "SIYY", "SIZZ", "SIXY"),  
TRAC\_NOR = "YES",  
OPERATION = "EXTRACTION",))*

### **9.2.2 Result**

**--- POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER: 1**

**FIELD BY ELEMENT WITH THE NODES**

**FORCED EXTRACTION TRACE\_NORMALE TENSOR**

**LOCATE LOCAL**

**SEGMENT OF RIGHT-HAND SIDE**

**ORIGIN: (1.000000E-01, 0.000000E+00)**

**END: (2.000000E-01, 0.000000E+00)**

**CURVILINEAR X-COORDINATES: (0.000000E+00, 1.000000E-01)**

**T4 CONCEPT OF the TYPE TABL\_POST\_RELE CALCULATES FROM the CONCEPT SIGMA COUNT: EX\_4 RESULTING FROM the T4 TABLE**

**ABSC\_CURV COOR\_X COOR\_Y COOR\_Z DIR\_1 DIR\_2 DIR\_3**  
**00000001 0.00000E+00 1.00000E-01 0.00000E+00 0.00000E+00 2.97371E-04 -1.66549E+00**  
**0.00000E+00**  
**00000002 9.99995E-03 1.10000E-01 0.00000E+00 0.00000E+00 1.65667E-04 -1.43451E+00 0.00000E**  
**+00**  
**00000003 1.99999E-02 1.20000E-01 0.00000E+00 0.00000E+00 1.49649E-04 -1.25935E+00 0.00000E**  
**+00**  
**00000004 2.99999E-02 1.30000E-01 0.00000E+00 0.00000E+00 1.28087E-04 -1.12286E+00 0.00000E**  
**+00**  
**00000005 3.99999E-02 1.40000E-01 0.00000E+00 0.00000E+00 1.10722E-04 -1.01444E+00 0.00000E**  
**+00**  
**00000006 4.99999E-02 1.50000E-01 0.00000E+00 0.00000E+00 9.64779E-05 -9.26905E-01 0.00000E**  
**+00**  
**00000007 6.00000E-02 1.60000E-01 0.00000E+00 0.00000E+00 8.49028E-05 -8.55210E-01 0.00000E**  
**+00**  
**00000008 7.00000E-02 1.70000E-01 0.00000E+00 0.00000E+00 7.51468E-05 -7.95754E-01 0.00000E**  
**+00**  
**00000009 7.99999E-02 1.80000E-01 0.00000E+00 0.00000E+00 6.71302E-05 -7.45902E-01 0.00000E**  
**+00**  
**00000010 8.99999E-02 1.90000E-01 0.00000E+00 0.00000E+00 6.04973E-05 -7.03691E-01 0.00000E**  
**+00**  
**00000011 1.00000E-01 2.00000E-01 0.00000E+00 0.00000E+00 2.65146E-05 -6.67596E-01 0.00000E**  
**+00**

### **9.3 Operands**

**TRAC\_DIR/DIRECTION**

#### **9.3.1 Orders**

**# traces directional data by a vector**

**#**

**t5 = POST\_RELEVE\_T (ACTION = \_F (**  
**ENTITLE = "ex\_5",**  
**WAY = AB,**  
**CHAM\_GD = SIGMA,**  
**NOM\_CMP = ("SIXX", "SIYY", "SIZZ", "SIXY"),**  
**TRAC\_DIR**  
**= "YES",**  
**DIRECTION = (1. , 0. , 0. ),**  
**OPERATION = "EXTRACTION"),)**

### 9.3.2 Result

--- POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER: 1

**FIELD BY ELEMENT WITH THE NODES**  
**FORCED EXTRACTION TRACE\_DIRECTIONELLE TENSOR**  
**TOTAL REFERENCE MARK**

**SEGMENT OF RIGHT-HAND SIDE**  
**ORIGIN: (1.000000E-01, 0.000000E+00)**  
**END: (2.000000E-01, 0.000000E+00)**  
**CURVILINEAR X-COORDINATES: (0.000000E+00, 1.000000E-01)**

**T5 CONCEPT OF the TYPE TABL\_POST\_RELE CALCULATES FROM the CONCEPT SIGMA**  
**COUNT: EX\_5 RESULTING FROM the T5 TABLE**

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**Titrate:**

**Operator POST\_RELEVE\_T**

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**Author (S):**

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**ABSC\_CURV COOR\_X COOR\_Y COOR\_Z DIR\_1 DIR\_2 DIR\_3**  
**00000001 0.00000E+00 1.00000E-01 0.00000E+00 0.00000E+00 -9.96843E-01 -2.97371E-04**  
**0.00000E+00**  
**00000002 9.99995E-03 1.10000E-01 0.00000E+00 0.00000E+00 -7.66170E-01 -1.65667E-04**  
**0.00000E+00**  
**00000003 1.99999E-02 1.20000E-01 0.00000E+00 0.00000E+00 -5.91136E-01 -1.49649E-04**  
**0.00000E+00**  
**00000004 2.99999E-02 1.30000E-01 0.00000E+00 0.00000E+00 -4.54764E-01 -1.28087E-04**

**0.00000E+00**

**00000005 3.99999E-02 1.40000E-01 0.00000E+00 0.00000E+00 -3.46463E-01 -1.10722E-04**

**0.00000E+00**

**00000006 4.99999E-02 1.50000E-01 0.00000E+00 0.00000E+00 -2.59035E-01 -9.64779E-05**

**0.00000E+00**

**00000007 6.00000E-02 1.60000E-01 0.00000E+00 0.00000E+00 -1.87445E-01 -8.49028E-05**

**0.00000E+00**

**00000008 7.00000E-02 1.70000E-01 0.00000E+00 0.00000E+00 -1.28092E-01 -7.51468E-05**

**0.00000E+00**

**00000009 7.99999E-02 1.80000E-01 0.00000E+00 0.00000E+00 -7.83393E-02 -6.71302E-05**

**0.00000E+00**

**00000010 8.99999E-02 1.90000E-01 0.00000E+00 0.00000E+00 -3.62263E-02 -6.04973E-05**

**0.00000E+00**

**00000011 1.00000E-01 2.00000E-01 0.00000E+00 0.00000E+00 -2.39383E-04 -2.65146E-05**

**0.00000E+00**

## **9.4 Operand**

**INVARIANT**

### **9.4.1 Orders**

**# invariants of the tensor of the constraints**

**#**

**t6 = POST\_RELEVE\_T (ACTION = \_F (**

**ENTITLE = "ex\_6",**

**WAY = AB,**

**CHAM\_GD = SIGMA,**

**INVARIANT = "YES",**

**OPERATION = "EXTRACTION"),)**

### **9.4.2 Result**

**--- POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER: 1**

**FIELD BY ELEMENT WITH THE NODES**

**EXTRACTION INVARIANTS TENSOR FORCED**

**TOTAL REFERENCE MARK**

**SEGMENT OF RIGHT-HAND SIDE**

**ORIGIN: (1.000000E-01, 0.000000E+00)**

**END: (2.000000E-01, 0.000000E+00)**

**CURVILINEAR X-COORDINATES: (0.000000E+00, 1.000000E-01)**

**T6 CONCEPT OF the TYPE TABL\_POST\_RELE CALCULATES FROM the CONCEPT SIGMA**



**COUNT: EX\_6 RESULTING FROM the T6 TABLE****ABSC\_CURV COOR\_X COOR\_Y COOR\_Z VON\_MIS TRESCA TRACES DETER**

**00000001 0.00000E+00 1.00000E-01 0.00000E+00 0.00000E+00 2.30953E+00 2.66234E+00  
 8.69246E-01 -3.33035E-01**  
**00000002 9.99995E-03 1.10000E-01 0.00000E+00 0.00000E+00 1.91053E+00 2.20068E+00  
 8.68843E-01 -2.20368E-01**  
**00000003 1.99999E-02 1.20000E-01 0.00000E+00 0.00000E+00 1.60813E+00 1.85049E+00  
 8.68679E-01 -1.49235E-01**  
**00000004 2.99999E-02 1.30000E-01 0.00000E+00 0.00000E+00 1.37278E+00 1.57762E+00  
 8.68524E-01 -1.02346E-01**  
**00000005 3.99999E-02 1.40000E-01 0.00000E+00 0.00000E+00 1.18613E+00 1.36091E+00  
 8.68375E-01 -7.04321E-02**  
**00000006 4.99999E-02 1.50000E-01 0.00000E+00 0.00000E+00 1.03570E+00 1.18594E+00  
 8.68232E-01 -4.81069E-02**  
**00000007 6.00000E-02 1.60000E-01 0.00000E+00 0.00000E+00 9.12789E-01 1.04266E+00 8.68094E-  
 01 -3.21138E-02**  
**00000008 7.00000E-02 1.70000E-01 0.00000E+00 0.00000E+00 8.11140E-01 9.23846E-01 8.67961E-  
 01 -2.04163E-02**  
**00000009 7.99999E-02 1.80000E-01 0.00000E+00 0.00000E+00 7.26193E-01 8.24241E-01 8.67831E-  
 01 -1.17024E-02**  
**00000010 8.99999E-02 1.90000E-01 0.00000E+00 0.00000E+00 6.54545E-01 7.39918E-01 8.67704E-  
 01 -5.10453E-03**  
**00000011 1.00000E-01 2.00000E-01 0.00000E+00 0.00000E+00 5.93563E-01 6.67835E-01 8.67563E-  
 01 -3.19954E-05**

**9.5 Operand****ELEM\_PRINCIPAUX****9.5.1 Orders****# principal values of the tensor of the constraints**

#

**t7 = POST\_RELEVE\_T (ACTION = \_F (****ENTITLE = "ex\_7",****WAY = AB,****CHAM\_GD = SIGMA,****ELEM\_PRINCIPAUX = "YES",****OPERATION = "EXTRACTION",))****Instruction manual****U4.8- booklet: Postprocessing and dedicated analyses****HT-62/06/004/A**

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**Titrate:**

**Operator POST\_RELEVE\_T**

**Date:**

**22/02/06**

**Author (S):**

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### **9.5.2 Result**

**--- POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER: 1**

**FIELD BY ELEMENT WITH THE NODES**

**EXTRACTION TENSOR FORCED**

**TOTAL REFERENCE MARK**

**SEGMENT OF RIGHT-HAND SIDE**

**ORIGIN: (1.000000E-01, 0.000000E+00)**

**END: (2.000000E-01, 0.000000E+00)**

**CURVILINEAR X-COORDINATES: (0.000000E+00, 1.000000E-01)**

**T7 CONCEPT OF the TYPE TABL\_POST\_RELE CALCULATES FROM the CONCEPT SIGMA**

**COUNT: EX\_7 RESULTING FROM the T7 TABLE**

**ABSC\_CURV COOR\_X COOR\_Y COOR\_Z VAL\_PR\_1 VAL\_PR\_2 VAL\_PR\_3**

**00000001 0.00000E+00 1.00000E-01 0.00000E+00 0.00000E+00 -9.96844E-01 2.00594E-01 1.66549E+00**

**00000002 9.99995E-03 1.10000E-01 0.00000E+00 0.00000E+00 -7.66170E-01 2.00501E-01 1.43451E+00**

**00000003 1.99999E-02 1.20000E-01 0.00000E+00 0.00000E+00 -5.91137E-01 2.00463E-01 1.25935E+00**

**00000004 2.99999E-02 1.30000E-01 0.00000E+00 0.00000E+00 -4.54764E-01 2.00428E-01 1.12286E+00**

**00000005 3.99999E-02 1.40000E-01 0.00000E+00 0.00000E+00 -3.46464E-01 2.00393E-01 1.01444E+00**

00000006 4.99999E-02 1.50000E-01 0.00000E+00 0.00000E+00 -2.59035E-01 2.00361E-01 9.26905E-01  
 00000007 6.00000E-02 1.60000E-01 0.00000E+00 0.00000E+00 -1.87445E-01 2.00329E-01 8.55210E-01  
 00000008 7.00000E-02 1.70000E-01 0.00000E+00 0.00000E+00 -1.28092E-01 2.00298E-01 7.95754E-01  
 00000009 7.99999E-02 1.80000E-01 0.00000E+00 0.00000E+00 -7.83395E-02 2.00268E-01 7.45902E-01  
 00000010 8.99999E-02 1.90000E-01 0.00000E+00 0.00000E+00 -3.62266E-02 2.00239E-01 7.03691E-01  
 00000011 1.00000E-01 2.00000E-01 0.00000E+00 0.00000E+00 -2.39623E-04 2.00207E-01 6.67596E-01

## **9.6 Operand RESULTANT**

### **9.6.1 Orders**

*# calculation of the resultants of the CMP quoted on a group\_no*

T8 =  
 POST\_RELEVE\_T (ACTION = \_F  
 (  
 RESULT  
 =  
 resu,  
 NOM\_CHAM=' FORC\_NODA',  
 ENTITLE  
 =  
 "RESULTING",  
 LOCATE  
 =  
 "TOTAL",  
 OPERATION  
 =  
 "EXTRACTION",  
 GROUP\_NO  
 =  
 "known",  
 RESULTANTE=  
 ("DX", "DY", "DZ"),

))

## 9.6.2 Result

*---POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER*

*: 1*

*NUME\_ORDRE:*

*1*

*FIELD WITH THE NODES OF REFERENCE SYMBOL FORC\_NODA*

*NUMBER Of ODRDRE: 1 INST: 0.00000E+00*

*RESULTANTE\_MOMENT DISPLACEMENTS*

*LOCATE*

*TOTAL*

*WAY CONNECTING THE NODES:*

*N69*

*N70*

*N71*

*N87*

*N88*

*N89*

*N97*

*N98*

*T8 CONCEPT OF TABL\_POST\_RELE CALCULATES FROM CONCEPT RESU COUNTS:*

*RESULTAN\_1 RESULTING*

*OF*

*COUNT*

*T8 INST: 0.00000E+00*

*RESULTANT -1.000000000E+01*

*-2.724281611E-11 7.218027734E-11*

## 9.7 Operands

*MOMENT and NOT*

## 9.7.1 Orders

*# calculation of the resultants and the moments of the CMP quoted on a group\_no*

```
T9 =  
POST_RELEVE_T (ACTION = _F  
(  
RESULT  
=  
resu,  
NOM_CHAM=' FORC_NODA',  
ENTITLE  
=  
“RESULTANTE-MOMENT”,  
LOCATE  
=  
“TOTAL”,  
OPERATION  
=  
“EXTRACTION”,  
GROUP_NO  
=  
“known”,  
MOMENT  
=  
(“DRX”, “DRY”, “DRZ”), POINT=  
(  
0.,0.,0.)  
,)
```

)

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*Operator POST\_RELEVE\_T*

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**Author (S):**

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## **9.7.2 Result**

**---POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER**

**:**

**1**

**NUME\_ORDRE**

**:**

**1**

**FIELD WITH THE NODES OF REFERENCE SYMBOL FORC\_NODA**

**NUMBER Of ODRDRE: 1 INST: 0.00000E+00**

**RESULTANTE\_MOMENT**

**DISPLACEMENTS**

**MOMENT COMPARED TO THE POINT: 0.00000E+00**

**0.00000E+00**

**0.00000E+00**

**LOCATE**

**TOTAL**

**WAY CONNECTING THE NODES:**

**N69**

**N70**

**N71**

**N87**

**N88**

**N89**

**N97**

**N98**

**T9 CONCEPT OF the TYPE TABL\_POST\_RELE CALCULATES FROM CONCEPT RESU**

**COUNTS:**

**RESULTAN\_1**

**EXIT**

**OF**

**COUNT**

**T9**

**INST:**

**0.00000E+00**

**RESULT\_X RESULT\_Y RESULT\_Z MOMENT\_X**

**RESULTANT**

**-1.000000000E+01 -2.724281611E-11 7.218027734E-11**

**-9.744077883E-**

**12**

**RESULTANT**

**-2.000000000E+00**

**-3.000000000E+00**

**9.8 Operand**

**LOCATE: "POLAR"**

**9.8.1 Orders**

**# impression of the tensor of the constraints in POLAR reference mark on the arc AC**

**#**

**t10 = POST\_RELEVE\_T (ACTION = \_F (**

**ENTITLE = "ex\_10",**

**WAY = AC,**

**LOCATE = "POLAR",**

**CHAM\_GD = SIGMA,**

**NOM\_CMP = ("SIXX", "SIYY", "SIZZ", "SIXY"),**

**OPERATION = "EXTRACTION"),)**

**9.8.2 Results**

**--- POST\_TRAITEMENT NUMBER: 1 - FIELD NUMBER: 1**

**FIELD BY ELEMENT WITH THE NODES**

**EXTRACTION TENSOR FORCED**

**POLAR REFERENCE MARK**

**ARC OF CIRCLE**

**CENTER: (0.000000E+00, 0.000000E+00)**

**RAY: 1.000000E-01**

**ANGULAR SECTOR: (0.000000E+00, 2.250000E+01)**

**T10 CONCEPT OF the TYPE TABL\_POST\_RELE CALCULATES FROM the CONCEPT SIGMA COUNT: EX\_10 RESULTING FROM the T10 TABLE**

**ABSC\_CURV COOR\_X COOR\_Y COOR\_Z SIXX SIYY SIZZ SIXY**

**00000001 0.00000E+00 1.00000E-01 0.00000E+00 0.00000E+00 -9.80501E-01 1.64914E+00  
2.00593E-01 2.07951E-01**

**00000002 7.85455E-03 9.96917E-02 7.84647E-03 0.00000E+00 -9.88675E-01 1.65731E+00  
2.00591E-01 1.03814E-01**

**00000003 1.57084E-02 9.87688E-02 1.56438E-02 0.00000E+00 -9.88675E-01 1.65730E+00  
2.00588E-01 1.03815E-01**

**00000004 2.35622E-02 9.72369E-02 2.33448E-02 0.00000E+00 -9.88674E-01 1.65730E+00  
2.00589E-01 1.03810E-01**

**00000005 3.14159E-02 9.51056E-02 3.09017E-02 0.00000E+00 -9.88673E-01 1.65732E+00  
2.00594E-01 1.03813E-01**

**00000006 3.92699E-02 9.23880E-02 3.82683E-02 0.00000E+00 -9.96843E-01 1.66550E+00  
2.00598E-01 -3.06827E-04**

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**Date:**

**22/02/06**

**Author (S):**

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**Organization (S): EDF-R & D /AMA, CS IF**



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***Operator POST\_ELEM***

## ***1 Goal***

***To calculate quantities on whole or part of the structure. The calculated quantities correspond to particular options of calculation of affected modeling.***

***The currently available options are:***

- .  
calculation of the mass, inertias and the position of the centre of gravity,***
- .  
calculation of the potential energy,***
- .  
calculation of the kinetic energy,***
- .  
calculation of the work of the external efforts,***
- .  
calculation of the indicators of loss of proportionality of the loading in elastoplasticity,***

.  
*calculation of the limiting load,*

.  
*calculation of the constraint of Weibull,*

.  
*calculation of the growth rate of a spherical cavity (Rice - Tracey),*

.  
*calculation of elastic energy and total energy,*

.  
*calculation of the surface of a hole in a grid 2D.*

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*Author (S):*

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*2 Syntax*

*[tabl\_\*] = POST\_ELEM*

*(*

*# key word simple*

*MODEL*

*= Mo,*

*[model]*

**CHAM\_MATER**

=

**chmater,**  
**[cham\_mater]**

**CARA\_ELEM**

=

**carac,**  
**[cara\_elem]**

**CHARGE**

=

**lcha,**  
**/**  
**[l\_char\_meca]**  
**/**  
**[l\_char\_ther]**  
**/**  
**[l\_char\_acou]**

**/ NUME\_COUCHE**

=

**/**  
**nume,**  
**[I]**  
**/**  
**L,**  
**[DEFECT]**

**/ NIVE\_COUCHE**

=

/  
“INF”,  
/  
“SUP”,  
/  
“MOY”,  
[DEFECT]

MODE\_FOURIER  
=/nh,

[I]  
/  
0,  
[DEFECT]

GEOMETRY =/“DEFORMED”,

/  
“INITIAL”,  
[DEFECT]

/  
CHAM\_GD  
=  
cham,  
/  
[cham\_no\_DEPL\_R]  
/  
[cham\_no\_TEMP\_R]  
/  
[cham\_elem\_ENER\_R]

```
/
RESULT
= resu,
/
[evol_elas]
/
[evol_noli]
/
[evol_ther]
/
[mult_elas]
/
[fourier_elas]

/
[mode_meca]
/
[dyna_trans]

/
TOUT_ORDRE = "YES",

/
NUME_ORDRE =
l_nuor
,
[l_I]

/
LIST_ORDRE =
l_ordr
,
[listis]
```

/  
*NUME\_MODE*  
=  
*l\_numo*  
,*[l\_I]*

/  
*NOEUD\_CMP*  
=  
*l\_nomo*  
,*[l\_Kn]*

/  
*NOM\_CAS* =  
*l\_nocas*,  
*[l\_Kn]*

/  
/  
*FREQ*  
=  
*l\_freq*  
,*[l\_R]*

/  
*LIST\_FREQ*  
=  
*lreel*

,  
[listr8]

/  
/  
INST  
=  
l\_inst  
,  
[L\_R]

/  
LIST\_INST  
=  
lreel  
,  
[listr8]

/  
PRECISION =/prec,  
[R]  
/  
1.0D-3  
,  
[DEFECT]

/  
CRITERION  
=/"RELATIVE", [DEFECT]  
/  
/

“ABSOLUTE”

# key words factor

/ MASS\_INER: (see key word MASS\_INER [§ 3.9])  
/ ENER\_POT: (see key word ENER\_POT [§ 3.10])  
/ ENER\_CIN: (see key word ENER\_CIN [§ 3.11])  
/ ENER\_ELAS: (see key word ENER\_ELAS  
[§ 3.12] )  
/ ENER\_TOTALE: (see key word ENER\_TOTALE  
[§ 3.13] )  
/ WEIBULL: (see key word WEIBULL [§ 3.14])  
/ RICE\_TRACEY: (see key word RICE\_TRACEY [§ 3.15])  
/ INDIC\_ENER: (see key word INDIC\_ENER [§ 3.16])  
/ INDIC\_THRESHOLD: (see key word INDIC\_THRESHOLD [§ 3.17])  
/ CHAR\_LIMITE: (see key word CHAR\_LIMITE [§ 3.18])  
/ CARA\_GEOM: (see key word CARA\_GEOM [§ 3.19])  
/ CARA\_POUTRE: (see key word CARA\_POUTRE [§ 3.20])  
/ AIRE\_INTERNE: (see key word AIRE\_INTERNE [§ 3.21])  
/ TRAV\_EXT  
: (see key word TRAV\_EXT  
[§  
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)

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Titrator:

Operator POST\_ELEM

Date:

22/02/06

Author (S):

**X. DESROCHES, L. VIVAN** Key

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*INFORMATION*

=

/

1,

[DEFECT]

/ 2,

*TITRATE* = *Ti*,

)

*The table result of operator POST\_ELEM is a typified table*

*if MASS\_INER then \* = mass\_iner*

*if ENER\_POT*

*then \* = ener\_pot*

*if ENER\_CIN*

*then \* = ener\_cin*

*if ENER\_ELAS*

*then \* = ener\_elas*

*if ENER\_TOTALE*

*then \* = ener\_totale*

*if WEIBULL*

*then \* = weibull*

*if RICE-TRACEY*  
*then \* = rice\_tracey*  
*if INDIC\_ENER then \* = indic\_ener*  
*if INDIC\_SEUIL*  
*then \* = indic\_seuil*  
*if CHAR\_LIMITE*  
*then \* = char\_limite*  
*if CARA\_GEOM then \* = cara\_geom*  
*if CARA\_POUTRE then \* = cara\_geom*  
*if AIRE\_INTERNE then \* = aire\_int*

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### **3 Operands**

#### **3.1 Operand**

##### **MODEL**

**MODEL = Mo,**

***Name of the model on which the option is calculated. The name of the model is optimal because it is contained in the structure of data result.***

### **3.2 Operand**

#### **CHAM\_MATER**

*CHAM\_MATER = chmater,*

*Material field associated with the model Mo, optimal bus contained in the structure of data result.*

### **3.3 Operand**

#### **CARA\_ELEM**

*CARA\_ELEM = carac,*

*The elementary characteristics carac are necessary if there exists in the model of the elements of structure (discrete beam, plate, hull or elements), optimal bus contained in the structure of data result.*

### **3.4 Operand**

#### **CHARGE**

*CHARGE = lcha,*

*List containing the concepts of the type charges, optimal bus contained in the structure of data result.*

### **3.5 Operands**

#### **NUME\_COUCHE/NIVE\_COUCHE**

*NUME\_COUCHE = nume,*

*In the case of a multi-layer material, whole value ranging between 1 and number it layers, necessary to specify the layer where one wishes to carry out elementary calculation. By convention, layer 1 is the sub-base in the case of the elements of mechanical hull or hull thermics.*

*NIVE\_COUCHE =*

*For the nume layer defined by NUME\_COUCHE, allows to specify the ordinate where one wishes to carry out elementary calculation:*

*Lower ordered “INF” of the layer  
(skin interns),  
Higher ordered “SUP” of the layer  
(external skin),  
Average ordered “MOY” of the layer  
(average layer by defect).*

### **3.6 Operand**

#### **MODE\_FOURIER**

*MODE\_FOURIER =*

*Number of the harmonic of FOURIER: positive or null entirety (defect = 0).*

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### **3.7 Operand**

#### **GEOMETRY**

*GEOMETRY =*

*/“INITIAL”,*

*[DEFECT]*

*/“DEFORMATION”,*

Indicate if one works on the initial geometry or the deformation. In this last case, it is necessary to provide a field of displacements by *CHAM\_GD* or *RESULT*.

### **3.8 Operands**

#### **CHAM\_GD/RESULT**

Options *ENER\_POT* and *ENER\_CIN* are calculated starting from a field with the nodes or by elements existing or extracted from a result.

#### **3.8.1 Operand**

##### **CHAM\_GD**

*/CHAM\_GD = cham,*

Name of a field (for options *ENER\_POT* and *ENER\_CIN*).

For option *ENER\_POT*, it is necessary to provide a field of displacement or a field of temperature (see [§3.9]).

For option *ENER\_CIN*, it is necessary to provide a field speed (without providing frequency) or well a field of displacements and a frequency (see [§3.9]).

#### **3.8.2 Operand**

##### **RESULT**

*/RESULT = resu,*

Name of a concept result of the *evol\_elas* type, *evol\_ther*, *mode\_meca*, *evol\_noli*, *mult\_elas*, *fourier\_elas* or *dyna\_trans*.

Option *ENER\_POT*: *evol\_elas*, *evol\_ther*, *mode\_meca*, *mult\_elas*, *Fourier elas* *evol\_noli*, or *dyna\_trans*.

Option *ENER\_CIN*: *mode\_meca*,  
*evol\_elas*,  
*evol\_ther*,  
*evol\_noli*, or  
*dyna\_trans*.

Option *ENER\_ELAS* and *ENER\_TOTALE*: *evol\_noli*.

#### **3.8.2.1 Operands TOUT\_ORDRE/NUME\_ORDRE/NUME\_MODE/LIST\_ORDRE/NOEUD\_CMP/ FREQ/ LIST\_FREQ/INST/LIST\_INST/PRECISION/CRITERION**

See [U4.71.00].

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### **3.9 Word**

*key*

**MASS\_INER**

#### **3.9.1 Drank**

*Key word factor allowing to calculate the mass, inertias and the centre of gravity.*

*This option allows calculation on each element of the following characteristics:*

*(indicating the density defined in DEF1\_MATERIAU [U4.43.01] by ELAS or ELAS\_FO).*

*Mass:  $m =$*

*FD*

*v*

*l*

*l*

*l*

*gravity*

*of*

*Center*

*:  $X =$*

*x dv;  $y =$*

*y FD*

;  $Z =$   
 $ZFD$   
 $G$

$v$   
 $G$   
 $v$   
 $G$   
 $v$   
 $v v$   
 $v$   
*Tensor of*

,

*locate*

*in*

$G$

*gravity*

*of*

*center*

*with*

*inertia*  
*descriptio*

*of*

*global'*  
*grid*

$N$   
:

$$\begin{aligned}
 &I \\
 &2 \\
 &2 \\
 &xx(G) = \\
 &( \\
 &(y - yG) + (Z - Z)) \text{ FD } Ixy(G) = (X - X \\
 &G) (y - y) \\
 &\text{FD}
 \end{aligned}$$

$$\begin{aligned}
 &v \\
 &G \\
 &v \\
 &G \\
 &I \\
 &2 \\
 &2 \\
 &yy(G) = \\
 &( \\
 &(X - xG) + (Z - Z)) \text{ FD}
 \end{aligned}$$

$$Ixz(G) = (X - X$$

$$\begin{aligned}
 &G) (Z - Z) \text{ FD} \\
 &v \\
 &G \\
 &v \\
 &G \\
 &I \\
 &2 \\
 &2 \\
 &zz(G) = \\
 &( \\
 &(X - xG) + (y - y)) \text{ FD } Iyz(G) = (y - y
 \end{aligned}$$

$$\begin{aligned}
 &G) (Z - Z) \\
 &\text{FD}
 \end{aligned}$$

$$\begin{aligned}
 &v \\
 &G \\
 &v \\
 &G
 \end{aligned}$$

Then calculates by “summation” the quantities relating to the total structure.



### 3.9.2 Syntax

**/MASS\_INER**

**=\_F**

**(**

**TAILLE\_BLOC=**

**/ 400**

**,**

**[DEFECT]**

**/**

**tbloc,**

**[R]**

**/ALL = “YES”,**

**/**

**NET**

**=**

**l\_maille,**

**[l\_maille]**

**/**

**GROUP\_MA=**

**lgrma,**

**[l\_gr\_maille]**

**ORIG\_INER= (xp, YP [, zp]), [l\_R]**

**),**

**Simple key words: (see [§2])**

**MODEL**

= *Mo*,

*[model]*

**CHAM\_MATER**

=

*chmater*,

*[cham\_mater]*

**CARA\_ELEM**

=

*carac*,

*[cara\_elem]*

**/NUME\_COUCHE**

=

**/NIVE\_COUCHE**

=

**MODE\_FOURIER**

=

**GEOMETRY =**

**/CHAM\_GD**

=

/  
**RESULT**  
=

**CHARGE**  
=  
/  
**[char\_meca]**

**/[char\_ther]**

**/[char\_acou]**

**Foot-note**

*For the key word factor MASS\_INER, the model and the field of materials are obligatory.*

*If one wants to calculate the quantities on a deformed geometry, one will use the key word GEOMETRY and one will return a field of displacements by CHAM\_GD or RESULT.*

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### **3.9.3 Operands**

*/ALL = "YES",*

*On all the structure.*

*/MESH = l\_maille,*

*On a list of meshes.*

*/GROUP\_MA*

*= lgrma,*

*On a list of group of meshes.*

*ORIG\_INER = (xp, YP [, zp]),*

*[l\_R]*

*Not by report/ratio to which the tensor of inertia will be calculated.*

*The tensor of inertia at the point P of co-ordinates (xp, YP, zp) is obtained starting from the tensor of inertia in the centre of gravity G, mass m of the structure and co-ordinates of G by formulas:*

$$I(P) = I(G) + m x^2$$

*xx*

*xx*

*PG*

$$I(P) = I(G) + m y^2$$

*yy*

*yy*

*PG*

$$I(P) = I(G) + m z^2$$

*zz*

*zz*

*PG*

$$I(P) = I(G) + m X$$

*y*

*xy*

*xy*

*PG PG*

$$I(P) = I(G) + m X$$

*Z*

*xz*

*xz*

*PG PG*

$$I(P) = I(G) + m y$$

*Z*

*yz*

*yz*

*PG PG*

*with*

*X*

$$= X - X$$

*PG*

*G*

*P*

*y*

$$= y - y$$

*PG*

*G*

*P*

*Z*

$$= Z - Z$$

*PG*

*G*

*P*

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**3.10 Word**

*key*

**ENER\_POT**

**3.10.1 Drank**

***Key word factor allowing to calculate:***

***potential energy of deformation due to balance starting from displacements, in linear mechanics of the continuous mediums (2D and 3D):***

***1***

***1***

***EPOT =***

***(U). With (U) FD -***

***(U)***

***HT***

***. With (T) FD +***

***HT***

***(T)***

***HT***

***. WITH (T)***

**FD****2****2****element****element****element****where A indicates the tensor of elasticity,**

.

**potential energy of deformation due to balance starting from displacements, in linear mechanics for the elements of structures:****1 T****T****T****HT****1 HT****HT****EPOT = the U.K. have - U B A + A****2****2****where K indicates the matrix of rigidity**

.

**the energy dissipated thermically with balance in linear thermics from temperatures (cham\_no\_TEMP\_R):****1****With = + T.K.T D**

.

**2****Foot-note:****In the first both cases, one must give a field of displacement behind the operand RESULT or CHAM\_GD. In the last case a field of temperature. In any rigour, the potential energy of a structure is negative. Here one calculates rather a deformation energy.****3.10.2 Syntax****/ ENER\_POT****=\_F****(**



*/ALL = "YES",*

*/*

*NET*

*=*

*l\_maille,*

*[l\_maille]*

*/*

*GROUP\_MA=*

*lgrma,*

*[l\_gr\_maille]*

*)*

*Simple key words: (see [§2])*

*MODEL*

*= Mo,*

*[model]*

*CHAM\_MATER*

*=*

*chmater,*

*[cham\_mater]*

*CARA\_ELEM*

*=*

*carac,*

*[cara\_elem]*

*/ NUME\_COUCHE*

*=*

*/ NIVE\_COUCHE*

=

*MODE\_FOURIER*

=

*/CHAM\_GD*

=

*/  
RESULT*

=

*CHARGE*

=

*CH,*

*/*

*[char\_meca]*

*/[char\_ther]*

/[char\_acou]

### **Foot-note**

*For the key word factor ENER\_POT, the model, the field of materials and possibly it field of characteristics of elements of structure are obligatory to determine with precondition fields of energy by elements.*

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### **3.10.3 Operands**

*/ALL = "YES",*

*On all the structure.*

*/MESH = l\_maille,*

*On a list of meshes.*

*/GROUP\_MA  
= lgrma,*

*On a list of group of meshes.*

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### ***3.11 Word***

***key***

***ENER\_CIN***

#### ***3.11.1 Drank***

***Key word factor allowing to calculate the kinetic energy starting from a field speed or to leave of a field of displacement and a frequency.***

***1***

***If one gave a field speed, E***

***V T***

***=***

***MV***

***C***

***.***

***2***

***1***

*If one gave a field of displacement and a frequency, E*

*2*

*U T*

*=*

*DRIVEN*

*C*

*.*

*2*

### *3.11.2 Syntax*

*/ ENER\_CIN*

*=\_F*

*(*

*/ALL = "YES",*

*/*

*NET*

*=*

*l\_maille,*

*[l\_maille]*

*/*

*GROUP\_MA=*

*lgrma,*

*[l\_gr\_maille]*

*)*

*Simple key words: (see [§2])*

*MODEL*

*= Mo,*

*[model]*

*CHAM\_MATER*

*=*

*chmater,*

*[cham\_mater]*

**CARA\_ELEM**

=

**carac,**  
**[cara\_elem]**

**/NUME\_COUCHE**

=

**/NIVE\_COUCHE**

=

**MODE\_FOURIER =**  
**OPTION =/"MASS\_MECA",**  
**/"MASS\_MECA\_DIAG",**

**/CHAM\_GD**

=

**/**  
**RESULT**

=

**CHARGE**

=

**CH,**  
**/**  
**[char\_meca]**

*/[char\_ther]*

*/[char\_acou]*

***Foot-note 1***

***For the key word factor ENER\_CIN, the model, the field of materials and possibly it field of characteristics of elements of structure are obligatory to determine with precondition fields of energy by elements.***

***Foot-note 2***

***When one wishes to calculate energy by employing the diagonal mass (to be in coherence with the option which one chose in the elementary calculation of the matrices of mass), one can specify “MASS\_MECA\_DIAG” behind the key word OPTION (nonavailable in 2D). By defect one uses the matrix of complete mass.***

***3.11.3 Operands***

***/ALL = “YES”,***

***On all the structure.***

*/MESH = l\_maille,*

*On a list of meshes.*

*/GROUP\_MA*

*= lgrma,*

*On a list of group of meshes.*

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*3.12 Word*

*key*

*ENER\_ELAS*

*3.12.1 Drank*

*Allows to calculate the elastic deformation energy for each moment T after an elastic design or elastoplastic, starting from the stress field SIEF\_ELGA or SIEF\_ELGA\_DEPL by the expression:*

*l*

*E E (T)*

*T*

*=*

*(T) D-1*



**(T) FD**

**2 v**

*where D represents the operator of elasticity.*

### **3.12.2 Syntax**

**/ENER\_ELAS**

**=\_F**

**(**

**/ALL = "YES",**

**/**

**NET**

**=**

**l\_maille,**

**[l\_maille]**

**/**

**GROUP\_MA=**

**lgrma,**

**[l\_gr\_maille]**

**)**

*Simple key words: (see [§2])*

**MODEL**

**= Mo,**

**[model]**

**CHAM\_MATER**

**=**

**chmater,**

**[cham\_mater]**

**CARA\_ELEM**

=

**carac,**

**[cara\_elem]**

**/NUME\_COUCHE**

=

**/NIVE\_COUCHE**

=

**MODE\_FOURIER**

=

**RESULT =**

**CHARGE**

=

/

**[char\_meca]**

*/[char\_ther]*

*/[char\_acou]*

### **3.12.3 Operands**

*/ALL = "YES",*

*On all the structure.*

*/MESH = l\_maille,*

*On a list of meshes.*

*/GROUP\_MA = lgrma,*

*On a list of group of meshes.*

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**3.13 Word**

**key**

**ENER\_TOTALE**

**3.13.1 Drank**

**Key word factor allowing to calculate the total deformation energy for the elements of mediums continuous 2D or 3D with behavior VMIS\_ISOT\_LINE or VMIS\_ISOT\_TRAC (work hardening isotropic), starting from the material and internal variable, stress fields:**

**P**

**l**

**-**

**$E T = E el + E P$**

**T**

**=**

**$To 1 FD +$**

**R**

**$(Q) dq FD$**

**2 v**

**v**

**0**

**P being cumulated equivalent plastic deformation.**

**With option SIMO\_MIEHE, this energy applies to two models VMIS\_ISOT\_LINE or VMIS\_ISOT\_TRAC:**

**T**

**$E T =$**   
**+**  
**0**  
 **$ddv$**

**0**

**v0**

*where and are respectively the free energy and the potential of dissipation, V0 initial volume.  
For more precision, to see [R5.03.21].*

### **3.13.2 Syntax**

**/**  
**ENER\_TOTALE = \_F (**

**/ALL = “YES”,**  
**/**  
**NET**

**=**  
**l\_maille,**  
**[l\_maille]**

**/**  
**GROUP\_MA=**  
**lgrma,**  
**[l\_gr\_maille]**

**)**

*Simple key words: (see [§2])*

**MODEL**

= *Mo*,  
[*model*]

*CHAM\_MATER*  
=  
*chmater*,  
[*cham\_mater*]

*CARA\_ELEM*  
=  
*carac*,  
[*cara\_elem*]

*/NUME\_COUCHE*  
=

*/NIVE\_COUCHE*  
=

*MODE\_FOURIER*  
=

*RESULT*  
=

*CHARGE*  
=  
*CH*,  
/

***[char\_meca]***

***/[char\_ther]***

***/[char\_acou]***

### ***3.13.3 Operands***

***/ALL = "YES",***

***On all the structure.***

***/MESH = l\_maille,***

***On a list of meshes.***

***/GROUP\_MA = lgrma,***

***On a list of group of meshes.***

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**3.14 Word**

**key**

**WEIBULL**

**3.14.1 Drank**

**Key word allowing for each defined moment, the calculation of the elementary field of the power  $m$  - ième of the constraint of Weibull whose expression on the mesh  $K$  is given, without catch in count plastic deformation, by:**

**$m$  (  
 $l$   
 $K$ ) =  
 $m$   
 $W$   
 $dK$   
 $l$**

**ref.  
 $V$   
 $K$   
 $P$   
 $P$**

**and, with taking into account of the plastic deformation by:**



$m$   
 $1$   
 $m$   
 $K) =$   
 $mExp - p$   
 $W$   
 $dK$   
 $1$   
 $1$   
 $p$

2

$ref.$   
 $V$   
 $Kp$

$K p$  indicates the part of the mesh  $K$  which plasticized, i.e., the part of  $K$  where deformation  
 $p$   
 figure cumulated exceeds a certain threshold;  $1$  accounts for the maximum principal constraint and  $1$   
 represent the maximum principal plastic deformation.

The parameters material  $m$ ,  $Vref$  and the threshold of plasticity are defined in  $DEFI\_MATERIAU$  by  
 relation of behavior  $WEIBULL$  (cf [R7.02.06]).

Once determined this elementary field, the option calculates by “summation” the constraint of  
 Weibull  
 of a field  $D$  for each definite moment:

1

$m$   
 $(D) = C m (K)$   
 $W$   
 $W$

$K D$

where  $C$  is a coefficient intended for the taking into account of symmetries (case  $Bi$  and three-

*dimensional) and of the thickness (in the two-dimensional case) of the structure containing the field D (key word COEF\_MULT).*

*The probability of rupture of the field D is then calculated by:*

*m*

*P (D) = 1 - Exp*  
*W*

*W*

*-*

*Mr.*

*U*

*The parameter “forced of cleavage”  $\mu$  is, him also, defined in the relation of behavior WEIBULL.*

*Lastly, the preceding expressions of the constraint of Weibull and the probability of rupture are not valid that in the case of a monotonous way of loading. This type of postprocessing can nevertheless also to be applied to a way of loading plus general, including when the constraint on cleavage depends on the temperature (relation of behavior WEIBULL\_FO). Expressions of forced of Weibull and the probability of rupture are then different (cf [R7.02.06]).*

*Foot-note:*

*For the key word factor WEIBULL, the model and the field of material are obligatory.*

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### **3.14.2 Syntax**

**/  
WEIBULL = \_F (**

**/ALL = "YES",**

**/  
NET**

**=  
l\_maille  
,  
[l\_maille]**

**/GROUP\_MA = lgrma,  
[l\_gr\_maille]**

**OPTION  
= /  
"SIGM\_ELGA",  
[DEFECT]**

*/“SIGM\_ELMOY”,*

*CORR\_PLAST=“YES”,*

*/“NOT”,  
[DEFECT]*

*COEF\_MULT  
=  
coef,  
[R]*

*/1. , [DEFECT]*

)  
*Simple key words: (see [§2])*

*MODEL  
= Mo,  
[model]*

**CHAM\_MATER**

=

**chmater,**  
**[cham\_mater]**

**CARA\_ELEM**

=

**carac,**  
**[cara\_elem]**

**/NUME\_COUCHE**

=

**/NIVE\_COUCHE**

=

**MODE\_FOURIER**

=

**/CHAM\_GD**

=

/

**RESULT**

=

**CHARGE**

=

/

**[char\_meca]**

**/[char\_ther]**

**/[char\_acou]**

### **3.14.3 Operands**

#### **3.14.3.1 Operand *OPTION***

***/OPTION = "SIGM\_ELGA",***

***The value of the elementary field associated the mesh  $K$  is obtained by integration by***

***1***  
***squaring at the points of Gauss of the expression***

***m***

***1 dK.***

***Vp Kp***

*/OPTION = "SIGM\_ELMOY",*

*The value of the elementary field associated the mesh K is obtained starting from the value 1*

*principal maximum of the tensor dK whose value is approached by  $V_p K_p$  squaring at the points of Gauss.*

### *3.14.3.2 Operand CORR\_PLAST*

*/CORR\_PLAST = "YES",*

*The stress field of Weibull is evaluated with taking into account of the deformation plastic.*

*/  
CORR\_PLAST  
=  
"NOT",*

*The stress field of Weibull is evaluated without taking into account of the deformation plastic.*

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**3.14.3.3 Operand COEF\_MULT***/COEF\_MULT = value,**The default value of this coefficient is 1.0D0.**The following table, in which the thickness is noted E, indicates typical values of coefficient C according to the type of symmetry:*

- *simple symmetry: the symmetry plane of the grid passes by the plan of the defect and it defect is entirely with a grid,*
- *double symmetry: the symmetry plane of the grid also passes by the plan of defect but only one half of the defect is with a grid.*

**3D and 3D\_SI****AXIS and****D\_PLAN and****C\_PLAN****AXIS\_SI****D\_PLAN\_SI****SIMPLE****2****4****2nd****2nd****DOUBLE****4****without object****without object****without object****NOT****1****2****E****E****Values of the multiplying coefficient symmetry-thickness****Instruction manual**



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**3.15 Word**

**key**

**RICE\_TRACEY**

**3.15.1 Drank**

**R (tn)**

**This option allows, for each moment of calculation tn defined, the calculation of the growth rate -**

**R0**

**of a spherical cavity compared to a field D (R (tn) and R0 indicate the ray respectively running and the initial ray of the cavity). The law of evolution of Rice-Tracey is expressed by the relation:**

**D**

**R**

**3**

**D p**

**eq**

**Log**

**= 0 283**

**,**

**Sign**

*M*

*Exp*

*M*

*dt*

*R*

*2*

*dt*

*0*

*eq*

*eq*

*1*

*(*

*=*

*)*

*p*

*M*

*Trace*

*;*

*indicate*

*3*

*eq indicates the equivalent constraint of von Mises and eq equivalent deformation of von Mises).*

### *3.15.2 Syntax*

*/*  
*RICE\_TRACEY = \_F (*

*/ALL = "YES",*

/  
**NET**

=  
*l\_maille*, [*l\_maille*]

*/GROUP\_MA = lgrma,*  
*[l\_gr\_maille]*

**OPTION**  
=/  
“*SIGM\_ELGA*”,  
*[DEFECT]*

*/“SIGM\_ELMOY”,*

**ROOM**  
=/  
“*YES*”,  
*[DEFECT]*

*/“NOT”,*

)  
*Simple key words: (see [§2])*

**MODEL**  
= *Mo*,  
*[model]*

**CHAM\_MATER**  
=  
*chmater*,  
*[cham\_mater]*

**CARA\_ELEM**  
=  
*carac*,  
*[cara\_elem]*

**/NUME\_COUCHE**  
=

**/NIVE\_COUCHE**  
=

**MODE\_FOURIER**  
=

***/CHAM\_GD***

***=***

***/RESULT =***

***CHARGE***

***=***

***CH,***

***/***

***[char\_meca]***

***/[char\_ther]***

***/[char\_acou]***

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### **3.15.3 Operands**

#### **3.15.3.1 Operand *OPTION***

*OPTION*

=

/

“*SIGM\_ELGA*”,  
[*DEFECT*]

*The elementary fields of the constraints and the plastic deformations are used in their representations at the points of Gauss.*

/

“*SIGM\_ELMOY*”,

*The elementary fields of the constraints and the plastic deformations are realised by report/ratio at the points of Gauss before being used.*

#### **3.15.3.2 Operand *ROOM***

*ROOM*

= /

“*YES*”,  
[*DEFECT*]

*The law of Rice-Tracey is integrated on each mesh *K* of the field *D* and the result consists*

*in the maximum value obtained on the whole of the meshes of the field.*

/  
“NOT”,

*Fields of triaxiality*

*M (T*

*p*

*N)*

*and of variation of plastic deformation*

*eq (tn) is*

*eq*

*calculated on each mesh. Then, their respective averages, balanced by the volume of meshes of the field, are given. Finally, the law of Rice-Tracey is integrated on these realised values.*

### **3.15.3.3 Operands ALL/GROUP\_MA/MESH**

*The fields of calculation D are specified by:*

*/ALL = “YES”,*

*Only one field is defined, it coincides with the whole of the structure.*

*/GROUP\_MA = lgrma,*

*Each definite group of meshes of the list lgrma a field of calculation.*

*/MESH = l\_maille,*

*Each mesh of the list l\_maille definite a field of calculation.*

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## Operator POST\_ELEM

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### 3.16 Word

key

**INDIC\_ENER**

#### 3.16.1 Drank

**Key word factor allowing to calculate a total indicator of loss of proportionality of the loading in elastoplasticity, founded on the density of energy. This indicator is described in detail in the document**

**[R4.20.01].**

**One points out his function and his expression. This indicator is intended to detect if during history of the structure and until the current moment T, and for a zone of the structure chosen by modelisator, there was loss of proportionality of the loading (i.e it acts to have a total measurement change of the principal directions of the tensor of constraints for each point of the zone defined by the user).**

**This indicator is usable only for models whose material presents a work hardening isotropic and whose elements are isoparametric 2D or 3D.**

**This indicator has as an expression:**

**I**

**I =**

**I -**

**FD**

**V v**

**where:**

**V is the volume of the field defined by the user,**

is the density of total elastic energy associated the traction diagram if one considered the non-linear elastic material.

More exactly its expression is as follows:

$$\frac{1}{2} \mu \left( K \cdot \text{tr} (\epsilon) + 2 \right)$$

$$\text{if } \epsilon < R$$

$$\frac{1}{2} R (p) + \int_0^p R(S) ds$$

$$\frac{1}{2} R (p)$$

where:

$K$  is the module of compressibility,

$\mu$  is the coefficient of shearing of Lamé,

.

$R(p)$  is the threshold of the traction diagram associated with the deformation figure cumulated  $p$ ,

.

is the density of deformation energy defined by:

(

$T$

$T) =$

. &  $D$

$O$

one can break up (

$T$ ) in an elastic part and a plastic part:

(

$T) =$

$(T) +$

$(T)$

élas

plas

with:

$1$

$(T)$

élas

élas

$= .$

$2$

$T$

$(T)$

plas

$= R$

$(p) D p$

$O$

**Note:**

If one has (  
 $T) = 0$ , one poses  $I = 0$ .

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### 3.16.2 Syntax

/  
*INDIC\_ENER* = *\_F* (

*/ALL* = "YES",

/  
*NET*

=  
*l\_maille*, [*l\_maille*]

*/GROUP\_MA* = *lgrma*,

*[l\_gr\_maille]*

)  
***Simple key words: (see [§2])***

***MODEL***  
= *Mo,*  
*[model]*  
***CHAM\_MATER***  
=  
*chmater,*  
*[cham\_mater]*

***CHARGE***  
=  
***CH,***  
***/***  
***[char\_meca]***

***/[char\_ther]***

*/[char\_acou]*

*RESULT = resu, [evol\_noli]*

### **3.16.3 Operands**

*The indicator is calculated on the field defined by the key words:*

*/ALL = "YES",*

*On all the elements of the model Mo.*

*/MESH = l\_maille,*

*On the list l\_maille of meshes of the model Mo.*

*/GROUP\_MA = lgrma,*

*On the list lgrma of the groups of meshes of the model Mo.*

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### **3.17 Word**

**key**

**INDIC\_SEUIL**

#### **3.17.1 Drank**

*Key word factor allowing to calculate a total indicator of loss of proportionality of the loading in elastoplasticity.*

*This indicator makes it possible on the one hand to know, on average about the zone considered, if the tensor of constraints and that of the plastic deformations have the same directions and if the plastic threshold is reached at the current moment, and in addition if during the history the plastic deformation changed direction.*

*This indicator has as an expression:*

$p$

$I$

$I =$

$I - FD$

$V v$

$R$

$(p) \cdot p$

where:

.

*V* is the volume of the field defined by the user,

.

*c* is the tensor of the constraints at the moment running,

.

*p* is the tensor of the plastic deformations at the moment running,

.

*R* (*p*) is related to work hardening (with  $R(0) = R_0$  where  $R_0$  is the limit there of elasticity).

i.e it is the threshold of the traction diagram associated with the cumulated plastic deformation

*p*.

.

*p* is the cumulated plastic deformation.

**Note:**

If one has (

$R(p)$ ,  $p = 0$ , one poses  $I = 0$ .

The scalar product, *p* is associated the standard within the meaning of von Mises.

This indicator is standardized and has a value ranging between 0 and 1.

It is null if the loading preserved its character proportional in each point of *V* all to length past history.

This indicator is described in detail in the document [R4.20.01].

### 3.17.2 Syntax

/  
**INDIC\_SEUIL = \_F (**

**/ALL = "YES",**

/  
**NET**

=



***l\_maille***

,

***[l\_maille]***

***/GROUP\_MA = lgrma,***  
***[l\_gr\_maille]***

)

***Simple key words: (see [§2])***

***MODEL***  
***= Mo,***  
***[model]***

***CHAM\_MATER***  
***=***  
***chmater,***  
***[cham\_mater]***

***CHARGE***  
***=***  
***CH,***  
***/***  
***[char\_meca]***

/[char\_ther]

/[char\_acou]

*RESULT = resu, [evol\_noli]*

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### **3.17.3 Operands**

*The indicator is calculated on the field defined by the key words:*

*/ALL = "YES",*

*On all the elements of the model Mo.*

*/MESH = l\_maille,*

*On the list l\_maille of meshes of the model Mo.*

*/GROUP\_MA = lgrma,*

*On the list lgrma of the groups of meshes of the model Mo.*

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### 3.18 Word

*key*

**CHAR\_LIMITE**

#### 3.18.1 Drank

*Post\_traitement of the calculation of the limiting load [R7.07.01 §2.3].*

*This key word factor allows the calculation of the limiting load of a structure by a kinematic approach. Its employment requires as a preliminary to have carried out a nonlinear calculation (see operator STAT\_NON\_LINE [U4.51.03]) indicated by the key word RESULT and whose characteristics are them following:*

*.  
law of behavior NORTON\_HOFF,*

*.  
increasing list of moments of calculation corresponding to values of regularization of the law of NORTON\_HOFF which tends towards 1 (in practice, one recommends to be limited to moments ranging between 1 and 2 which does not lead to too long calculations while allowing to obtain an upper limit of the load limits sufficiently precise),*

*.  
loading (unit) controlled corresponding to the loading by report/ratio to which one seeks with to consider the limiting load, the method of piloting being STANDARD = "ANA\_LIM",*

*.  
possibly a constant loading whose it is then necessary imperatively to point out the existence by the key word CHAR\_CSTE = "YES".*

*Operator POST\_ELEM then produces a table which gives for each moment of calculation, i.e. for increasingly weak regularizations, a limit upper CHAR\_LIMI\_SUP of the load limit supported by the structure. Moreover, in the absence of constant loading, CHAR\_CSTE = "NOT", the table also contains an estimate CHAR\_LIMI\_ESTIM of a lower limit of charge limit. On the other hand, if a constant loading is present, CHAR\_CSTE = "YES", such estimate of the lower limit is not available any more but the table contains the power then PUIS\_CHAR\_CSTE of the constant loading in the field speed solution of the problem. A detailed example of calculation of limiting load is provided in [U2.05.04].*

#### 3.18.2 Syntax

*/ CHAR\_LIMITE = \_F (CHAR\_CSTE  
=/"NOT",  
[DEFECT]*

/“YES”,

)

**Simple key words: (see [§2])**

**MODEL**

= *Mo*,  
[*model*]

**CHAM\_MATER**

=  
*chmater*,  
[*cham\_mater*]

**RESULT**

= *resu*,  
[*evol\_noli*]

**CARA\_ELEM**

=  
*carac*,  
[*cara\_elem*]

**MODE\_FOURIER**

= *nh*,

[I]

*CHARGE*

= *CH*,

/

[*char\_meca*]

[*char\_ther*]

[*char\_acou*]

### **3.18.3 Operands**

*CHAR\_CSTE*

=/"*NOT*",

[DEFECT]

/

“YES”,

*Key word indicating if the loading is constant or not constant (default value).*

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### **3.19 Word**

**key**

**CARA\_GEOM**

#### **3.19.1 Drank**

*CARA\_GEOM is used by macro\_commande MACR\_CARA\_POUTRE [U4.42.02] to calculate them geometrical characteristics (centre of inertia, moments of inertia) of a section of beam with a grid in elements of continuous medium 2D.*

### 3.19.2 Syntax

/  
*CARA\_GEOM* = *\_F*  
(

*/ALL* = “*YES*”,  
/  
*GROUP\_MA*=  
*lgma*,  
*[l\_gr\_maille]*  
/  
*NET*

=  
*lma*  
,  
*[l\_maille]*

*SYME\_X* =/*“YES”*,  
/  
*“NOT”*,  
*[DEFECT]*

*SYME\_Y* =/*“YES”*,  
/  
*“NOT”*,  
*[DEFECT]*



*ORIG\_INER*

=

*(xp,*  
*YP),*  
*[l\_R]*

)

*Single-ended spanner words: (see [§2])*

*MODEL*

=

*Mo,*  
*[model]*

*CHAM\_MATER*

=

*chmater,*  
*[cham\_mater]*

*CHARGE*

=

*CH,*  
*/*  
*[char\_meca]*  
*/*  
*[char\_ther]*  
*/*  
*[char\_acou]*

### **3.19.3 Operands**

#### **3.19.3.1 Operands ALL/GROUP\_MA/MESH**

*Define the place of calculation. One can in particular make the calculation of the characteristics for one together of meshes, defined by GROUP\_MA or MESH.*

### **3.19.3.2 Operands SYME\_X/SYME\_Y**

*Taking into account of a symmetry compared to X or with Y (or both). Grid provided by the user corresponds then to half of the section (or the quarter).*

### **3.19.3.3 Operand ORIG\_INER**

*Allows to give the punctual coordinates per report/ratio to which the characteristics will be calculated geometrical [U4.42.02].*

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## **3.20 Word**

**key**

**CARA\_POUTRE**

### **3.20.1 Drank**

*CARA\_POUTRE is used exclusively by macro-order MACR\_CARA\_POUTRE [U4.42.02] to calculate the mechanical characteristics (constant of torsion, ray of torsion, constants of shearing, position of the center of shearing, constant of warping) of a section with a grid in elements 2D.*

*Its employment requires the preliminary call of many orders, specific to each option*

calculated. The operands will thus not be here detailed. For more detail one will refer to *MACR\_CARA\_POUTRE* [U4.42.02].

### 3.20.2 Syntax

/  
*CARA\_POUTRE* = *\_F* (

*/ALL* = ' *OUI*',  
/  
*GROUP\_MA*

=*lgma*,  
[*gr\_maille*]

*GROUP\_MA\_INTE*= *lgma\_inte*,  
[*l\_gr\_maille*]

*CARA\_GEOM* =, [*tabl\_cara\_geom*]

*LAPL\_PHI* =  
,  
[*evol\_ther*]

*LAPL\_PHI\_Y* = y,  
[evol\_ther]

*LAPL\_PHI\_Z* = Z,  
[evol\_ther]

*RT* =  
*rt*,

[R]

*CONNECTION*  
=  
/"KNEECAP",  
/  
"EMBEDDING",

*LENGTH*  
=  
*L*,  
[R]

*MATERIAL = chechmate*

,  
*[to subdue]*

*OPTION*

*=/“CARA\_TORSION”,*

*/*  
*“CARA\_CISAILLEMENT”,*

*/*  
*“CARA\_GAUCHI”,*

)

*Single-ended spanner words: (see [§2])*

*MODEL*

*=*

*Mo,*

*[model]*

*CHAM\_MATER*

*=*

*chmater,*

*[cham\_mater]*

*CHARGE*

*=*

*CH,*

*/*  
*[char\_meca]*

*/*  
*[char\_ther]*

/

[char\_acou]

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### **3.21 Word**

*key*

**AIRE\_INTERNE**

#### **3.21.1 Drank**

*Key word factor allowing the calculation of the surface of a hole in a grid 2D.*

#### **3.21.2 Syntax**

/

**AIRE\_INTERNE = \_F**  
**(GROUP\_MA\_BORD = lgma)**

*Single-ended spanner word: MODEL*

=

*Mo,*

[model]

### **3.21.3 Operand**

*GROUP\_MA\_BORD = lgma,*

*List groups of meshes of edge delimiting hole (SEG2 or SEG3)*

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### **3.22 Word**

*key*

**TRAV\_EXT**

#### **3.22.1 Drank**

***Mot clé factor allowing to calculate the work of external efforts real TRAV\_REEL or rubber band TRAV\_ELAS such as below definite:***

***T***

***T***

***TRAV\_REEL =***

***& =***

***F &******U******éq******3.22.1-1******int******T******T******0******0******1******TRAV\_ELAS =******1******= F U******éq******3.22.1-2******int******2******2***

***Calculation is carried out on the basis of SD result, well informed under the key word RESULT, for which nodal forces, i.e. the interior forces, were calculated beforehand by the operator CALC\_ELEM, option "FORC\_NODA" [U4.81.01]. In the case of real work, the initial moment T***

***0***

***corresponds to the first moment filed in the SD result (taking guard with the fact that the initial state is not***

***not filed automatically, to see key word ARCH\_ETAT\_INIT of operator STAT\_NON\_LINE [U4.51.03]); integration in time is carried out by a method of trapezoids. Two sizes***

***TRAV\_REEL and TRAV\_ELAS are calculated for each moment filed in the SD result.***

***These quantities can be interpreted graphically on the response curve forces displacement of the structure (provided that the force is dual displacement, for example pressure and volume in the case of a cavity under pressure).***

***force force******displacement***



*displacement*

*TRAV\_REEL*

*TRAV\_ELAS*

*A detailed example of use of these sizes to evaluate the dual size of the loading, dissipated energy or the residual rigidity of a damaged structure is provided by the study of a structure which is damaged in a fragile way [U2.05.02].*

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### **3.22.2 Syntax**

*TRAV\_EXT = \_F*

(  
*RESULT*

=

*resu*

)

/

*[evol\_elas]*

/

*[evol\_noli]*

/

*[dyna\_trans]*

### **3.22.3 Operand**

*RESULT = resu*

*Name of the structure of data result of calculation.*

### **3.23 Operand**

**TITRATE**

*TITRATE*

= *Ti*,

*Titrate attached to the concept produced by this operator [U4.03.01].*

### **3.24 Operand INFORMATION**

*INFORMATION*

=

/

1,

*[DEFECT]*

/ 2,

*Parameter of impression*

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*Titrate:*

*Operator POST\_ELEM*

*Date:*

22/02/06

*Author (S):*

**X. DESROCHES, L. VIVAN** *Key*

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### **4 Example**

***The example which follows applies to the calculation of total quantities to a dynamic modeling of one building engine. Are modelled: the external enclosure, the interior enclosure, internal structures, the well of tank.***

**60 m**  
**Noncontractual modeling**

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**The modeling of a half building is carried out by elements of beams, discrete elements representing the connections on the ground, the masses additional and the connections between nodes.**

**It is on this model of beams that operator POST\_ELEM will calculate:**

- 
- mass of the structure,**
- 
- co-ordinates of the centre of gravity,**
- 
- the tensor of inertia,**
- 
- potential energy of certain modes and its distribution in the structure,**
- 
- kinetic energy of certain modes and its distribution in the structure.**

## 4.1

### *Calculation of the mass, the centre of gravity and inertias*

.  
*for all the structure (ALL = "YES")*

.  
*for the group of meshes containing the beams (GROUP\_MA = "pou\_d\_t")*

.  
*for the group of meshes containing the connections on the ground (GROUP\_MA = "liai\_sol")*

.  
*for the group of meshes containing the additional masses (GROUP\_MA = "masses")*

.  
*for the group of meshes containing the connections between nodes (GROUP\_MA = "liai\_noe")*

### *Order*

*massestr = POST\_ELEM (MODELE= stickmod,*

*CHAM\_MATER = chmater, CARA\_ELEM = caraelem,  
 MASS\_INER=\_F (GROUP\_MA= ("pou\_d\_t", "liai\_sol", "masses", "liai\_noe"),  
 TOUT=  
 "YES"),*

*TITRE=' masses, center of revolves and inertias of the structure');*

*Impression on the file "RESULT"*

-----  
*mass, center of revolves and inertias of the structure*

*MASS CDG\_X CDG\_Y CDG\_Z*

*ALL: "YES" 9.49787E+07 0.00000E+00 0.00000E+00 1.94801E+01*

*GROUP\_MA: POU\_D\_T 5.55670E+05 0.00000E+00 0.00000E+00 2.95682E+01*

*GROUP\_MA: LIAI\_SOL 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00*

*GROUP\_MA: MASSES 9.44230E+07 0.00000E+00 0.00000E+00 1.94208E+01*

*GROUP\_MA: LIAI\_NOE 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00*

*IX IY IZ IXY*

*ALL: "YES" 5.75518E+10 5.71540E+10 2.12362E+10 0.00000E+00*

*GROUP\_MA: POU\_D\_T 1.64545E+07 1.58475E+07 1.04470E+07 0.00000E+00*

*GROUP\_MA: LIAI\_SOL 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00*

*GROUP\_MA: MASSES 5.74785E+10 5.70813E+10 2.12258E+10 0.00000E+00*

*GROUP\_MA: LIAI\_NOE 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00*

**IXZ IYZ**

**ALL: "YES" -1.84254E-08 0.00000E+00**

**GROUP\_MA: POU\_D\_T -1.84254E-08 0.00000E+00**

**GROUP\_MA: LIAI\_SOL 0.00000E+00 0.00000E+00**

**GROUP\_MA: MASSES 0.00000E+00 0.00000E+00**

**GROUP\_MA: LIAI\_NOE 0.00000E+00 0.00000E+00**

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**4.2**

**Calculation of the potential energy of modes 1, 2 and 7**

**.**

**for all the structure (ALL = "YES")**

**.**

**for the group of meshes containing the beams (GROUP\_MA = "pou\_d\_t")**

**.**

**for the group of meshes containing the connections on the ground (GROUP\_MA = "liai\_sol")**

**.**

**for the group of meshes containing the additional masses (GROUP\_MA = "masses")**

**.**

**for the group of meshes containing the connections between nodes (GROUP\_MA = "liai\_noe")**

**.**

**for meshes (MAILLE= "E101" with "E2601")**

**.**

*for meshes (MAILLE= "ELN1" with "ELN5")*

### **Order**

```
enerpot = POST_ELEM (RESULTAT= modes, MODELE= stickmod,  
NUME_MODE= (1,2,7),  
CHAM_MATER= chmater, CARA_ELEM= caraelem,  
ENER_POT = _F (TOUT= "YES",  
GROUP_MA= ("pou_d_t", "liai_sol", "masses", "liai_noe"),  
MAILLE= ("E101", "E201", "E301", "E401", "E501", "E601",  
"E701", "E801", "E901", "E1001", "E1101", "E1201",  
"E1301", "E1401", "E1501", "E1601", "E1701", "E1801",  
"E1901", "E2001", "E2101", "E2201", "E2301", "E2401",  
"E2501", "E2601",  
"ELN1", "ELN2", "ELN3", "ELN4", "ELN5")),  
TITRE= "potential energies of modes 1, 2 and 7",  
)
```

### **Impression on the file "RESULT"**

-----  
*potential energies of modes 1, 2 and 7*

**COUNT**

*0 ENERPOT\_CHAM\_ELEM! ==> TABLE hat containing a table of CHAM\_ELEM*

*1 ENERPOT\_NUME\_00001! and tables of result of modes 1, 2 and 7*

*2 ENERPOT\_NUME\_00002!*

*7 ENERPOT\_NUME\_00007!*

----->

**CONCEPT ENERPOT OF THE TYPE TABL\_ENER\_POT CALCULATES FROM THE CONCEPT MODES**

**COUNT: ENERPOT\_CHAM\_ELEM RESULTING FROM TABLE ENERPOT**

**CHAM\_ELEM**

*1 ENERPOT\_C\_NU\_00001! ==> TABLE of CHAM\_ELEM containing the fields of*

*2 ENERPOT\_C\_NU\_00002! distribution of energy on all them*

*7 ENERPOT\_C\_NU\_00007! meshes of the structure*

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----->  
**CONCEPT ENERPOT OF THE TYPE TABL\_ENER\_POT CALCULATES FROM THE CONCEPT MODES**

**FIELD: ENERPOT\_C\_NU\_00001 RESULTING FROM TABLE ENERPOT\_CHAM\_ELEM**  
**NUME\_MODE: 1 FREQ: 3.95868E+00! ==> impression of the percentage**  
**! of distribution of energy**

**(Distribution of the deformation energy in various meshes)**  
**TOTAL E101 TRAC\_COM TORSION FLEX\_Y FLEX\_Z! all meshes**  
**1 1.80451E-02 0. 0. 1.80451E-02 0. ! for mode 1**

----- ! a certain number of omitted lines -----

**TOTAL E2601 TRAC\_COM TORSION FLEX\_Y FLEX\_Z**  
**1 4.06820E-04 0. 0. 4.06820E-04 0.**

**TOTAL MAS1 DX DY DZ DRX DRY DRZ**

----- ! a certain number of omitted lines -----

**1 0. 0. 0. 0. 0. 0. 0.**  
**TOTAL MAS27 DX DY DZ DRX DRY DRZ**  
**1 0. 0. 0. 0. 0. 0. 0.**  
**TOTAL SOL1 DX DY DZ DRX DRY DRZ**  
**1 2.69881E-01 0. 5.20243E-02 0. 2.17857E-01 0. 0.**  
**TOTAL ELN1 DX DY DZ DRX DRY DRZ**  
**1 3.14406E-04 0. 3.14330E-04 0. 7.62943E-08 0. 0.**  
**TOTAL ELN2 DX DY DZ DRX DRY DRZ**  
**1 5.09467E-05 0. 3.55125E-05 0. 1.54342E-05 0. 0.**  
**TOTAL ELN3 DX DY DZ DRX DRY DRZ**  
**1 3.02716E-04 0. 1.72250E-04 0. 1.30466E-04 0. 0.**  
**TOTAL ELN4 DX DY DZ DRX DRY DRZ**



**1 2.14163E-04 0. 2.37436E-05 0. 1.90419E-04 0. 0.**  
**TOTAL ELN5 DX DY DZ DRX DRY DRZ**  
**1 5.19557E-04 0. 4.56885E-04 0. 6.26719E-05 0. 0.**

----->

**CONCEPT ENERPOT OF THE TYPE TABL\_ENER\_POT CALCULATES FROM THE CONCEPT MODES**

**COUNT: ENERPOT\_NUME\_00001 RESULTING FROM TABLE ENERPOT**

**NUME\_MODE: 1 FREQ: 3.95868E+00! impr of the TABLE of energy**

**TOTAL POUR\_CENT! potential for mode 1:**

**ALL: "YES" 7.72292E+09 1.00000E+02! total energy and percentage**

**GROUP\_MA: POU\_D\_T 5.62782E+09 7.28717E+01!**

**GROUP\_MA: LIAI\_SOL 2.08427E+09 2.69881E+01**

**GROUP\_MA: MASSES 0. 0.**

**GROUP\_MA: LIAI\_NOE 1.08259E+07 1.40179E-01**

**NET: E101 1.39361E+08 1.80451E+00**

----- ! a certain number of omitted lines -----

**NET: E2601 3.14184E+06 4.06820E-02**

**NET: ELN1 2.42813E+06 3.14406E-02**

**NET: ELN2 3.93457E+05 5.09467E-03**

**NET: ELN3 2.33785E+06 3.02716E-02**

**NET: ELN4 1.65396E+06 2.14163E-02**

**NET: ELN5 4.01250E+06 5.19557E-02**

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## 4.3

*Calculation of the kinetic energy of modes 1, 2 and 7*

.  
*for all structure (TOUT= "YES")*  
 .  
*for the group of meshes containing the beams (GROUP\_MA = "POU\_D\_T")*  
 .  
*for the group of meshes containing the connections on the ground (GROUP\_MA = "LIAI\_SOL")*  
 .  
*for the group of meshes containing the additional masses (GROUP\_MA = "MASSES")*  
 .  
*for the group of meshes containing the connections between nodes (GROUP\_MA = "LIAI\_NOE")*  
 .  
*for the meshes (MESH = "MAS1" with "MAS27")*  
 .  
*for the meshes (MESH = "E2001", "E2101", "E2201")*

**Order**

*enercin = POST\_ELEM (RESULTAT= modes, MODELE= stickmod,  
 NUME\_MODE= (1,2,7),  
 CHAM\_MATER= chmater, CARA\_ELEM= caraelem,  
 ENER\_CIN= \_F (TOUT= "YES",  
 GROUP\_MA= ("pou\_d\_t", "liai\_sol", "masses", "liai\_noe"),  
 MAILLE= ("MAS1", "MAS2", "MAS3", "MAS4", "MAS5", "MAS6",  
 "MAS7", "MAS8", "MAS9", "MAS10", "MAS11", "MAS12",  
 "MAS13", "MAS14", "MAS15", "MAS16", "MAS17", "MAS18",  
 "MAS19", "MAS20", "MAS21", "MAS22", "MAS23", "MAS24",  
 "MAS25", "MAS26", "MAS27",  
 "E2001", "E2101", "E2201"),),  
 TITRE= "kinetic energies of modes 1, 2 and 7",  
 )*

*Impression on the file "RESULT":*

-----  
*kinetic energies of modes 1, 2 and 7*

**COUNT**

*0 ENERCIN\_CHAM\_ELEM! ==> TABLE hat containing a table of CHAM\_ELEM  
 1 ENERCIN\_NUME\_00001! and tables of result of modes 1, 2 and 7*

**2 ENERCIN\_NUME\_00002!**

**7 ENERCIN\_NUME\_00007!**

**CONCEPT ENERCIN OF THE TYPE TABL\_ENER\_CIN CALCULATES FROM THE CONCEPT MODES**

**COUNT: ENERCIN\_CHAM\_ELEM RESULTING FROM TABLE ENERCIN CHAM\_ELEM**

**1 ENERCIN\_C\_NU\_00001! ==> TABLE of CHAM\_ELEM containing the fields of  
2 ENERCIN\_C\_NU\_00002! distribution of energy on all them  
7 ENERCIN\_C\_NU\_00007! meshes of the structure**

**----->  
CONCEPT ENERCIN OF THE TYPE TABL\_ENER\_CIN CALCULATES FROM THE CONCEPT MODES**

**FIELD: ENERCIN\_C\_NU\_00001 RESULTING FROM TABLE ENERCIN\_CHAM\_ELEM**

**NUME\_MODE: 1 FREQ: 3.95868E+00! ==> impression of the percentage  
! of distribution of energy**

**TOTAL E101 DX DY DZ DRX DRY DRZ! on all the meshes**

**1 0. 0. 0. 0. 0. 0. 0. ! for mode 1**

**TOTAL E201 DX DY DZ DRX DRY DRZ**

**1 0. 0. 0. 0. 0. 0. 0.**

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**----- ! a certain number of omitted lines -----**

**TOTAL E2501 DX DY DZ DRX DRY DRZ**

**1 0. 0. 0. 0. 0. 0.**

**TOTAL E2601 DX DY DZ DRX DRY DRZ**

**1 0. 0. 0. 0. 0. 0.**

**TOTAL E2001 DX DY DZ DRX DRY DRZ**

**1 8.74690E-04 0. 8.73486E-04 0. 0. 0. 1.20387E-06**

**TOTAL E2101 DX DY DZ DRX DRY DRZ**

**1 1.47949E-03 0. 1.47806E-03 0. 0. 0. 1.43435E-06**

**TOTAL E2201 DX DY DZ DRX DRY DRZ**

**1 8.74196E-04 0. 8.73476E-04 0. 0. 0. 7.20094E-07**

**TOTAL MAS1 DX DY DZ DRX DRY DRZ**

**1 9.45582E-04 0. 4.03156E-04 0. 5.42426E-04 0. 0.**

**TOTAL MAS2 DX DY DZ DRX DRY DRZ**

**1 1.62612E-03 0. 9.06238E-04 0. 7.19885E-04 0. 0.**

**----- ! a certain number of omitted lines -----**

**TOTAL MAS26 DX DY DZ DRX DRY DRZ**

**1 1.92897E-03 0. 1.92897E-03 0. 0. 0. 0.**

**TOTAL MAS27 DX DY DZ DRX DRY DRZ**

**1 8.12621E-04 0. 8.12621E-04 0. 0. 0. 0.**

**TOTAL SOL1 DX DY DZ DRX DRY DRZ**

**1 0. 0. 0. 0. 0. 0.**

**----- ! a certain number of omitted lines -----**

**TOTAL ELN4 DX DY DZ DRX DRY DRZ**

**1 0. 0. 0. 0. 0. 0.**

**TOTAL ELN5 DX DY DZ DRX DRY DRZ**

**1 0. 0. 0. 0. 0. 0.**

**----->**

**CONCEPT ENERCIN OF THE TYPE TABL\_ENER\_CIN CALCULATES FROM THE CONCEPT MODES**

**COUNT: ENERCIN\_NUME\_00001 RESULTING FROM TABLE ENERCIN**

**NUME\_MODE: 1 FREQ: 3.95868E+00! impression of the TABLE of energy**

**TOTAL POUR\_CENT! kinetics for mode 1:**

**ALL: "YES" 7.72292E+09 1.00000E+02! total energy and percentage**

**GROUP\_MA: POU\_D\_T 2.49325E+07 3.22838E-01!**

**GROUP\_MA: LIAI\_SOL 0. 0.**

**GROUP\_MA: MASSES 7.69798E+09 9.96772E+01**

**GROUP\_MA: LIAI\_NOE 0. 0.**

**NET: MAS1 7.30265E+06 9.45582E-02**

**NET: MAS2 1.25584E+07 1.62612E-01**

**NET: MAS3 1.92226E+07 2.48904E-01**

**----- ! a certain number of omitted lines -----**

**NET: E2001 6.75516E+06 8.74690E-02**

**NET: E2101 1.14260E+07 1.47949E-01**

**NET: E2201 6.75134E+06 8.74196E-02**

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**22/02/06**

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*22/02/06*

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*A. ASSIRE, E. LORENTZ, Key P. BADEL*

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## ***Tool for interactive postprocessing STANLEY***

### ***1 Goal***

***Application STANLEY is a tool for interactive postprocessing for Aster calculations. This interface graph gives access the list sizes, to calculate those which are not it yet, of to generate the exits for the tools of visualization gms (isovaleurs) and xmgrace (curved) and of launching those.***

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***matters***

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## **2 Introduction**

***Application STANLEY is a tool for interactive postprocessing for Aster calculations. This interface graph gives access the list sizes, to calculate those which are not it yet, of to generate the exits for the tools of visualization gms (isovaleurs) and xmgrace (curved) and of launching those.***

## **3**

### ***Launching of the interface***

***Stanley is usable by the users of Code\_Aster, who are in one of the following situations:***

.

***Working station under Linux/Unix and calculation locally***

.

***Working station under Linux/Unix and calculation on a distant waiter***

.

***Calculation and working station Windows on a distant waiter***

***Stanley must be used in interactive. It is thus advised to carry out its study in the first calculation (which can be launched in Batch mode), the following which one will safeguard a base post-to treat***

*in*

*interactive mode with Stanley, either on the same machine, or on a different machine. In it last case, you will have to use format HDF if the operating systems are different:*

*END (FORMAT\_HDF=' OUI')*

*There are two ways of launching STANLEY:*

*· In the interface ASTK, right button on a basis containing an Aster result, then To open with Stanley.*

*· At the end of the command file, to insert the line:*

*STANLEY ()*

*Stanley uses a file of configuration. The configuration is done directly in the interface by the intermediary of menus. The file of configuration is generated by the interface.*

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*First use:*

*When the file of configuration was not yet creates or is not available, Stanley launches out with default options. In these cases there, it is necessary necessarily that the variable of environment DISPLAY is correctly indicated. It is the case when one launches calculation in interactive in*

*notching the box followed interactive.*

*If the Stanley interface still does not appear, the variable DISPLAY can be overloaded in arguments of the order:*

*STANLEY (DISPLAY=' mon\_adresse.der.edf.fr: 0 ')*

*Or:*

*STANLEY (DISPLAY=' aaa.bbb.ccc.ddd: 0 ')*

**4**

### *Parameter setting of the Stanley interface*

*The parameter setting of Stanley was completely re-examined in this version of Stanley. There is no more files to manually publish nor of variables of environment to modify in the account of the user.*

*Henceforth, the parameter setting of Stanley is done directly since the interface. In the menu Parameters, to choose Visualization (parameters of GMSH) Waiter of calculation and Stanley (options bound to the waiter of calculation and to returned interface):*

### *Description of the parameters:*

- *VISUALIZATION (all parameters of GMSH)*
- *SHRINK: parameter for CREA\_MAILLAGE/CREA\_RESU key word ECLA\_PG.*
- *TAILLE\_MIN: parameter for CREA\_MAILLAGE/CREA\_RESU key word ECLA\_PG.*
- *version\_fichier\_gmsh (1. or 1.2): the version of file produced. Version = 1: QUAD are cut out SORTED some, the HEXA and PENTA in TETRA for postprocessing. Version 1.2 (to be visualized with GMSH more recent than 1.35): no the cutting of QUAD, HEXA and PENTA linear.*
- *SKIN (value YES or not): allows to engage mode SKIN in GMSH and thus of to charge that skin of the grid.*
- *WAITER OF CALCULATION AND STANLEY: gather parameters for the waiter (machine on which Aster is launched).*
- *cast iron: pig iron and cast iron used in the interface. Taking into account with next launching.*
- *gmsh: the way towards the achievable GMSH on the waiter of calculation (or “gmsh” if it is in the way). This GMSH is localised on the waiter of calculation and can be a version batch.*

*It is only used to generate points and lines of postprocessing.*

*- grace: the way towards XMGRACE on the waiter of calculation (XMGRACE is obligatorily on the waiter of calculation).*

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*- smbclient: the way towards the achievable one smbclient on the waiter of calculation (is not useful that for a working station under Windows when the shared repertory is used Windows).*

*· WORKING STATION: for the configuration of the working station (the local machine of the user).*

*See the paragraph [\[§5\]](#) for more details.*

*5*

*Parameter setting of the Working station*

*The configuration of the working station is also done since the interface. Each configuration being safeguarded on the waiter of calculation in a file, one can manage several configurations and rock directly in Stanley of worms others (for example the working station Windows, one waiter TX in an engine room, etc).*

*One can create a new configuration by choosing small Paramètres, then Nouvelle configuration. It is then necessary to choose the type of working station which one wants (local, distant, Windows).*

*For having chosen the type of configuration which one wishes to create, it is necessary to inform some numbers of parameters. The detail of the parameters to be informed according to the type of configuration is described on [Table 5-1].*

*The configuration could be safeguarded in a file on the waiter of Aster calculation while choosing small Parameters, then To safeguard a configuration.*

*One can thus manage several configuration and pass from the one to the other directly in a session of Stanley, by choosing small the Parameters, then To charge a configuration.*

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*Various possible cases of figure*

*Waiter of calculation Aster*

*Unix 1*

*Unix 1*

*Unix 1*

*Unix 1*

*Unix 1*

***Working station of the user Unix 1***

***Unix 2***

***Unix 2***

***Windows***

***Windows***

***Waiter of execution of GMSH Unix 1***

***Unix 2***

***Unix 3***

***Unix 2***

***Windows***

***Parameter settings corresponding to carry out in Stanley***

***Mode***

***DISTANT DISTANT ROOM DISTANT WINDOWS***

***machine\_gmsh***

***IP Unix 1***

***IP Unix 2***

***IP Unix 3***

***IP Unix 2***

***IP Windows***

***address machine on***

***which is carried out GMSH***

***machine\_gmsh\_exe***

***- Na***

***Way Way - Na***

***- Na***

***achievable of GMSH on***

***machine\_gmsh***

***machine\_gmsh\_login***

***- Na YES - Na YES YES,***

***if***

***identifying for connection to***

***need***

***the machine\_gmsh***

***machine\_gmsh\_pass***

***- Na - Na - Na - Na YES,***

***if***

*password for  
need  
connection to the machine\_gmsh*

*machine\_gmsh\_tmp  
YES YES YES YES,  
it  
reference mark  
YES, to put  
temporary repertory on  
must be  
the name of  
machine\_gmsh  
accessible  
divide*

*since  
Windows  
Windows  
machine\_visu  
- Na  
Unix2: 0 Unix2: 0 - Na  
- Na  
machine + display where to return  
the display of GMSH (the station  
room)*

*Remarks All  
room  
Calculation  
Terminal X  
Windows,  
Windows,  
distant,  
need  
need  
Local GMSH  
to open  
to open  
GMSH with the GMSH with  
hand on the hand on  
file .pos, file .pos  
who is  
in network*

**Table 5-1: Various parameter settings according to the type of configuration**

**Explanation:**

- **Unix 1: a machine Unix/Linux**
- **Unix 2: one 2nd machine Unix/Linux**
- **Unix 3: one 3rd machine Unix/Linux**
- **Windows: a machine under Windows**

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**Some examples of use:**

- **Configuration 1: All locally.**
- **Configuration 2: Calculation on distant Waiter + GMSH locally.**
- **Configuration 3: Calculation on distant Waiter + distant GMSH + local posting (for example Terminal X or Windows with Exceed 3D).**
- **Configuration 5: Calculation on distant Waiter + storage of the files .pos in a repertory accessible by network since Windows**
- **Configuration 4: Calculation on distant Waiter + GMSH locally under Windows (including station Portalis). Require a repertory shared under Windows).**

**Thereafter, a configuration can be modified by choosing small Paramètres then Poste of work.**



## ***Additional explanations for the Windows users at EDF***

***For the mode WINDOWS de Stanley, one can put under repertory of the repertory of division: in the WINDOWS configuration, for the variable “machine\_gmsh\_tmp”, it is necessary to add under repertory with a \.***

***For example “DIVISION \ louse” means that the name of Windows division is DIVISION and that inside one uses under repertory louse.***

***One can thus use this Windows configuration with any Samba waiters (under Unix or Linux) or Microsoft waiters (for which the name of division led in a repertory of which the user does not have the rights of writing).***

***One presents below two examples which function with EDF R & D/AMA, and other units EDF in changing the name of the waiters.***

***· Exemple 1: Portalis machine (for EDF) with an access samba to a machine Unix (it be-with to say a letter of reader gone up automatically towards an account Unix)***

***Example for EDF/AMA, user “assire”:***

***. waiter samba Unix: clayrd02.der.edf.fr***

***. login Unix: assire***

***. under Samba, the name of division is the name of user***

***--> In Stanley, to put:***

***mode = WINDOWS***

***machine\_gmsh = clayrd02.der.edf.fr***

***machine\_gmsh\_login = assire***

***machine\_gmsh\_pass = mot\_de\_passe***

***machine\_gmsh\_tmp = assire \ tmp***

***Not to forget to create the /home/assire/tmp repertory!***

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**· Exemple 2: machine under Microsoft waiter. Example for EDF/AMA:**

**Example for EDF/AMA, Portalis user “assire-aim”:**

**. Microsoft waiter: clas0003.cla.edfgdf.fr**

**. login Microsoft: assire-aim**

**. the name of division is in this case: USERS**

**It is necessary to define under repertory because the home of the user is not directly the repertory divided, it is: clas0003.cla.edfgdf.fr | USERS | assire-aim**

**Note: it is necessary to be based on the configuration under Windows “to guess” the configuration samba has to use...**

**--> In Stanley, to put:**

**mode = WINDOWS**

**machine\_gmsh = clas0003.cla.edfgdf.fr**

**machine\_gmsh\_login = assire-aim**

**machine\_gmsh\_pass = mot\_de\_passe**

**machine\_gmsh\_tmp = USERS | ASSIRE-AIM | tmp**

**Not to forget to create the repertory tmp in its shared repertory!**

**Note: in order to determine the configurations which function, it can be useful to simulate with the hand**

**the operation with the order smbclient since the Aster waiter:**

**//serveur/nom\_de\_partage password smbclient - U to use**

**As long as this order does not function, Stanley will not be able to function!**

**6 Use**

**The use itself of the graphic interface does not pose a problem: the term is that of CALC\_ELEM and of IMPR\_RESU.**

**Concerning ergonomics:**

.

*On the right side, tricolour fire indicates the state of the concepts: green: calculated concept and displayable, orange: concept which one can calculate to pass to the green light, red: concept that one cannot calculate within the framework of calculation.*

*While clicking on **Ordre** one rocks between the **NUME\_ORDRE** and the **INST**.*

*While clicking on **Geometrical Entités** one rocks between the layout of **isovaleurs** (with **GMSH**) or of **curves** (with **XMGRACE**).*

*One can add points and lines which will be used like place for postprocessing, in choosing small the **Geometry and Addition Not or Addition Way**.*

*The geometries added by this intermediary will appear directly in the interface under **Entités Geometrical**. One thus can, for example, to add a point and to look at the temporal evolution of one variable in this point.*

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*Remarks concerning the layout on the deformed grid*

*Since **STANLEY**, one can notch a button to print the field as well as the field of displacements (except for fields **ELGA**).*

*Once in **GMSH**, the user can post the field on the deformed grid.*

***It has three solutions to visualize the field on the deformation in GMSH (v1.60.1):***

***· Solution 1 (most general):***

***To strip field XXX\_DEPL\_VECTEUR***

***To go in Tools/Options then “View [0]” (or that corresponding to the field to trace)***

***Mitre Offset, to click on “Uses general transformation expressions”, then to choose Data Source = “View [1]” (or that corresponding to the deformed field)***

***· Solution 2 (the two fields must be compatible, e.g. field NOEU):***

***To strip the field (to leave only field XXX\_DEPL\_VECTEUR)***

***To go in Tools/Options then “View [1]” (or that corresponding to the field XXX\_DEPL\_VECTEUR)***

***Mitre Aspect, to choose Dated Source = “View [0]” (or that corresponding to the field has to visualize)***

***In this same mitre Aspect, to put Vector Display = Displacement***

***· Solution 3 (walk for fields NOEU and ELNO):***

***To strip field XXX\_DEPL\_VECTEUR***

***To click on the box on the right field? to visualize then to choose “Plugins” and 'Displacement Raise'.***

***In the window of the plugin: Factor is the factor of amplification, dTimeStep is the moment used in the field deformed to build the grid deformed (one definite only one deformed grid which will be used for all the steps of time of the field? to visualize).***

***To click on Butt to have the details concerning this Plugin.***

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***In the event of problem or to make go up requests***

***Current problems:***

.

***GMSH does not launch out.***

***If the .mess contains the error message “Can' T open display”, check that you notched the interactive follow-up in ASTK well. Check that the files .rhost on various machines are quite indicated.***

.

***I am in configuration Windows and the file fort.37.pos is not deposited in my temporary repertory Windows.***

***If the message “putting file fort.37.pos have \ fort.37.pos (xxx kb/s)” appears, it is that Stanley posed the file well. Check in env.py that machine\_gmsh is well the maid and that the shared repertory is well that in which you look at...***

***If the preceding message does not appear, check the rights of writing on your repertory divided while manually launching one of the two following orders (since the waiter of calculation):***

***smbclient “\ | my-machine.der.edf.fr | my-reference mark-temp” (repertory in complete access)***

***smbclient “\ | my-machine.der.edf.fr | my-reference mark-temp” - U my-log win (if not)***

***and check that you have prompt “the smb well: \ >”. If it is not the case, check them rights of access on the repertory shared Windows.***

***To make go up bugs or requests for evolution of the product, use the AREX Aster while opening cards of Anomaly or Evolution Tool.***

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***Operator DEFI\_FOND\_FISS***

***Date:***  
***31/01/06***  
***Author (S):***  
***E. GALENNE, C. REZETTE Key***

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***Organization (S): EDF-R & D /AMA, DeltaCAD***

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***Document: U4.82.01***

***Operator DEFI\_FOND\_FISS***

***1 Goal***

***To define a bottom of crack of a grid 3D and upper lips and lower of this crack.***

*The definition of the bottom of the crack can be done starting from entities (nodes or meshes) or from groups of entities. The nodes can be ordered in the direction of the curvilinear X-coordinates increasing. If it is not the case and if the bottom of crack is given by a list of meshes or of groups of meshes, the operator will order the nodes with the help of the definition of a node origin.*

*The definition of the upper lips and lower is given by two lists of meshes or groups of meshes.*

*This operator creates a concept of the `fond_fiss` type which is usable in 3D by the operators `CALC_THETA` [U4.82.02], `CALC_G_LOCAL_T` [U4.82.04].*

*In 2D, the bottom of crack is tiny room to a point and this operator is necessary only for the option “`CALC_K_G`” of operator `CALC_G_THETA_T` [U4.82.03] (calculation of the coefficients of intensity of constraints `K1` and `K2`). It makes it possible to recover the basic node of crack and the normal with the crack.*

*This operator generates a concept of the `fond_fiss` type.*

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*2 Syntax*

*`FF` [`fond_fiss`] = `DEFI_FOND_FISS`*

*(*

**GRID = my, [grid]**

**/FOND\_FISS**

**=\_F**

**(**

***# Is one defines a list of already ordered nodes***

**//GROUP\_NO = lgrno,**

**[l\_gr\_noeud]**

**/**

**NODE**

**=**

**lno**

**,**

**[l\_noeud]**

***# Is one defines a list of meshes whose nodes can be already ordered or not, in this last case it is then necessary to define an origin X-coordinates by NOEUD\_ORIG or GROUP\_NO\_ORIG:***

**//GROUP\_MA = lgrma,**

**[l\_gr\_maille]**

**/**

**NET**

**=**

**lma**

**,**

**[l\_maille]**



```
/
/NOEUD_ORIG =no
, [l_noeud]
/
GROUP_NO_ORIG
=grno, [l_gr_noeud]
```

```
/
/
NOEUD_EXTR =no
, [l_noeud]
/
GROUP_NO_EXTR
=grno [l_gr_noeud]
```

),

```
/
FOND_FERME=_F (
```

*# Is one defines a list of already ordered nodes*

```
//GROUP_NO = lgrno,
[l_gr_noeud]
```

```
/
NODE
=
lno
```

,

**[l\_noeud]**

**# Is one defines a list of meshes whose nodes can be already ordered or not, in this last case it is then necessary to define an origin X-coordinates by NOEUD\_ORIG or GROUP\_NO\_ORIG and a first mesh by MAILLE\_ORIG or GROUP\_MA\_ORIG which will give the direction of course on closed curve:**

```
//GROUP_MA = lgrma,  
[l_gr_maille]  
/  
NET  
=  
lma  
,  
[l_maille]
```

```
//NOEUD_ORIG =no  
, [l_noeud]  
/  
GROUP_NO_ORIG  
=grno, [l_gr_noeud]
```

```
/MAILLE_ORIG =ma  
, [l_maille]  
/  
GROUP_MA_ORIG  
=grma, [l_gr_maille]
```

),

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/  
*FOND\_INF = \_F (/GROUP\_NO = lgrno,  
[l\_gr\_noeud]*

/  
*NODE*

=  
*lno*

,  
*[l\_noeud]*

*/GROUP\_MA = lgrma,  
[l\_gr\_maille]*

/  
*NET*

=  
*lma*

,  
*[l\_maille]*

//NOEUD\_ORIG =no  
, [l\_noeud]  
/  
GROUP\_NO\_ORIG  
=grno, [l\_gr\_noeud]

/MAILLE\_ORIG =ma  
, [l\_maille]  
/  
GROUP\_MA\_ORIG  
=grma, [l\_gr\_maille]

),

FOND\_SUP = \_ F (/GROUP\_NO = lgrno,  
[l\_gr\_noeud]  
/  
NODE  
=  
lno  
,  
[l\_noeud]

*/GROUP\_MA = lgrma,  
[l\_gr\_maille]  
/  
NET  
=  
lma  
,  
[l\_maille]*

*//NOEUD\_ORIG =no  
, [l\_noeud]  
/  
GROUP\_NO\_ORIG  
=grno, [l\_gr\_noeud]*

*/MAILLE\_ORIG =ma  
, [l\_maille]  
/  
GROUP\_MA\_ORIG  
=grma, [l\_gr\_maille]*

),

*/LEVRE\_SUP = \_F (*  
*/GROUP\_MA = lgrma,*  
*[l\_gr\_maille]*  
*/*  
*NET*  
*=*  
*lma*  
*, [l\_maille]*  
*),*

*LEVRE\_INF = \_F (*  
*/GROUP\_MA = lgrma,*  
*[l\_gr\_maille]*  
*/*  
*NET*  
*=*  
*lma*  
*, [l\_maille]*

),

*/NORMAL = (Nx, Ny, Nz)*

*[l\_R]*

*/DTAN\_ORIG*

*= (Tox, Toy, Toz),*

*[l\_R]*

*DTAN\_EXTR*

*= (Tex, Tey, Tez),*

*[l\_R]*

*/*  
*VECT\_GRNO\_ORIG*

*=*

*lgrno,*

*[l\_gr\_noeud]*

*VECT\_GRNO\_EXTR*

*=*

*lgrno,*

*[l\_gr\_noeud]*

)

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### **3 Operands**

#### **3.1 Operand**

##### **GRID**

**GRID = my**

*my: name of the grid on which one will define the bottom of crack and the lips.*

#### **3.2 Word**

*key*

**FOND\_FISS**

**FOND\_FISS**

=

*The whole of the ordered nodes of the bottom of crack defines. If none key words **NOEUD\_ORIG** or **GROUP\_NO\_ORIG** is not defined, the order of declaration of these nodes, via list nodes or meshes segments, will define the direction of course of the curvilinear X-coordinate of the bottom*

*of crack. Load is thus left with the user compose an ordered list, within the meaning of connectivity of the grid, by increasing curvilinear X-coordinate.*

*It is also possible to provide a list of meshes segments without worrying about the order. Then the data of a node origin, provided that it corresponds well at an end of the way defined by the meshes segments, makes it possible to order the list of nodes.*

*The whole of the nodes composing the bottom of crack is specified by the operands:*

/

**/GROUP\_NO = lgrno**

*with lgrno list of groups of nodes obligatorily ordered compared to melts of crack with the last node of lgrno (I) which must be identical to first node of lgrno (I + 1).*

/  
**NODE = lno**

*with lno list of nodes obligatorily ordered compared to the bottom of crack.*

/  
**/GROUP\_MA = lgrma**

*with lgrma list of groups of meshes, ordinates or not, compared to the bottom of fissure of type SEG2 or SEG3.*

/  
**NET**  
=  
**lma**

*with lma list of meshes, ordinates or not, of type SEG2 or SEG3.*

**//NOEUD\_ORIG = No**

*with single No node defining the origin. To be an end of way defining the bottom of crack, it must belong to one and only one net lgrma or lma.*

/  
**GROUP\_NO\_ORIG**  
=  
**grno**

*with grno single group of node, containing a single node. To be an end of the way defining the bottom of crack, it must belong to one and only one mesh of lgrma or lma.*

**/NOEUD\_EXTR = No**

*with single No node defining the end. This data is optional and is only used to check that the node end obtained by the operator is well that of which the user thinks. The code will stop in error if it is not*

*the case.*

/  
**GROUP\_NO\_EXTR**  
=  
**grno**

*with grno single group of node, containing a single node.*

*The key words GROUP\_MA and MESH and by consequence NOEUD\_ORIG and GROUP\_NO\_ORIG can be used that in 3D.*

*In 2D the bottom of crack is reduced to a point defined by GROUP\_NO or NODE.*

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### **3.3 Word**

*key*

**FOND\_FERME**

**FOND\_FERME**

=

*This key word treats the case of the funds of crack defined by a closed curve, for example one elliptic crack within a massive part (penny-shaped ace). The principle is the same one as for a bottom of crack not closed. If the user wishes to leave the care to the operator to order the nodes, it is then necessary to define in more one mesh of origin, carrying the node of origin, which*

*defines it  
feel course of the closed curve.*

*If the user chooses to give nodes, it must stop with before the last for  
not to repeat the first node twice.*

*/  
/GROUP\_NO = lgrno*

*with lgrno list of groups of nodes obligatorily ordered compared to  
melts of crack with the last node of lgrno (I) which must be identical to  
first node of lgrno (I + 1).*

*/  
NODE = lno*

*with lno list of nodes obligatorily ordered compared to the bottom of crack.*

*/  
/GROUP\_MA = lgrma*

*with lgrma list of groups of meshes, ordinates or not, compared to the bottom of  
fissure of type SEG2 or SEG3.*

*/  
NET  
=  
lma*

*with lma list of meshes, ordinates or not, of type SEG2 or SEG3.*

*//NOEUD\_ORIG = No*

*with single No node defining the origin. To be an end of  
way defining the bottom of crack, it must belong to one and only one  
net lgrma or lma.*

*/  
GROUP\_NO\_ORIG  
=  
grno*

*with grno single group of node, containing a single node. To be an end of the way defining the bottom of crack, it must belong to one and only one mesh of lgrma or lma.*

*/MAILLE\_ORIG = my*

*with my single mesh containing the already definite node origin. It allows to choose between the two directions of possible courses of the closed curve.*

*/  
GROUP\_MA\_ORIG  
=  
grma*

*with grma single group of mesh, containing a single mesh. It allows to choose between the two directions of possible courses of the curve closed.*

*Key word FOND\_FERME has direction only in 3D. To declare the node single defining the bottom of fissure in 2D, to use key word FOND\_FISS.*

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### 3.4 Words

*keys*

#### **FOND\_INF/FOND\_SUP**

*These key words make it possible to define a bottom of crack by two entities (NODE, MESH, GROUP\_NO, GROUP\_MA) coincidentes whose elements of the one belong to the lower lip and the elements other with the upper lip.*

**FOND\_INF =**

*This key word treats the case of a bottom of crack defined by geometrical entities (nodes, meshes) pertaining to the lower lip.*

**FOND\_SUP =**

*This key word with the same functionality as FOND\_INF for the upper lip. It is necessary to take care of it that the entities of FOND\_SUP coincide geometrically with those of FOND\_INF.*

*Key words NODE, GROUP\_NO, MESH, GROUP\_MA, NOEUD\_ORIG, GROUP\_NO\_ORIG, MAILLE\_ORIG, GROUP\_MA\_ORIG have the same significance as for key word FOND\_FISS.*

### 3.5

#### **Description of the lips for a nonplane crack in 3D**

*In operators CALC\_THETA [U4.82.02] and CALC\_G\_LOCAL\_T [U4.82.04], the direction of propagation of the crack in any point of the bottom of crack will be obtained by vector product between tangent vector at the bottom of crack and the normal vector with the lip in this point.*

#### **3.5.1 Word**

*key*

#### **LEVRE\_SUP**

/

**LEVRE\_SUP =**

*The whole of the faces of the elements 3D defines which are pressed on the upper lip of fissure. The whole of these faces is specified by the operands:*

/

**GROUP\_MA =**

*lgrma with lgrma list of groups of meshes.*

/  
*NET*  
*= lma with lma list of meshes.*

### **3.5.2 Word**

**key**  
***LEVRE\_INF***

*LEVRE\_INF =*

*The whole of the faces of the elements 3D defines which are pressed on the lower lip of fissure (if the crack is on a symmetry plane, this key word does not have to be informed).*

*The whole of these faces is specified by the operands:*

/  
*GROUP\_MA =*  
*lgrma with lgrma list of groups of meshes.*

/  
*NET*  
*= lma with lma list of meshes.*  
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*Operator DEFI\_FOND\_FISS*

*Date:*

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### **3.6 Operand**

#### ***NORMAL for a crack planes in 3D or a crack in 2D***

*When the lips of the crack were not defined, the key word **NORMAL** is used to specify the normal vector in the plan of these lips, therefore with the crack itself. This vector is used in any point of the bottom of fissure to determine the direction of propagation and thus supposes that the crack is plane.*

/

**NORMAL** = ( $N_x$ ,  $N_y$ ,  $N_z$ )

*The key word **NORMAL** makes it possible to introduce the components  $N_x$ ,  $N_y$ ,  $N_z$  in the total reference mark*

*of a normal **NR** in the plan of the crack with the following convention of direction:*

.

*In 3D, **N** = **NR***

*0*

*, where **N** is the normal external with the crack in the plan of lips, 0 are the directed bottom of crack (defined by key word **FOND\_FISS**),*

.

*in 2D, the normal **NR** is defined such that the reference mark (**N0**, **T**, **NR**) is direct, with:*

***N0** the node of the bottom of crack,*

***T** direction of propagation of the crack.*

**T**

**NR**

**N0**

*In all the cases **NR** is normalized automatically.*

### **3.7**

#### ***Directions of propagation of the bottom of crack at the ends in***



## ***plan of the lips in 3D***

*Key words DTAN\_ORIG and DTAN\_EXTR are optional and must be defined only in 3D. They do not have*

*no direction in the case of a FOND\_FERME and is then prohibited. Indeed, any node has then a mesh segment on its left and its right-hand side; nothing distinguishes the node origin and the direction from*

*propagation in this point of a current node of the bottom of crack.*

*/DTAN\_ORIG*

*= (Tox, Toy, Toz),*

*[l\_R]*

*DTAN\_EXTR*

*= (Tex, Tey, Tez),*

*[l\_R]*

*/*  
*VECT\_GRNO\_ORIG*

*=*

*lgrno*

*,*  
*[l\_gr\_noeud]*

*VECT\_GRNO\_EXTR*

*=*

*lgrno*

*,*  
*[l\_gr\_noeud]*

### ***3.7.1 Operand***

***DTAN\_ORIG***

*/DTAN\_ORIG = vector (Tox, Toy, Toz)*

*Tor direction at the origin of the bottom of crack directed in the direction of the propagation of fissure.*

### ***3.7.2 Operand***

***VECT\_GRNO\_ORIG***

/

*VECT\_GRNO\_ORIG = lgrno with lgrno list of two nodes.*

*Tor direction deduced from the data of two nodes.*

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### **3.7.3 Operand**

**DTAN\_EXTR**

/

*DTAN\_EXTR = vector (Tex, Tey, Tez)*

*Tex direction at the end of the bottom of crack in the direction of the propagation of the crack.*

### **3.7.4 Operand**

**VECT\_GRNO\_EXTR**

/

*VECT\_GRNO\_EXTR = lgrno with lgrno list of two nodes.*

*Tex direction deduced from the data of two nodes.*

*Example 1: case of a rectilinear plane crack:*

*Nn*  
*X*  
***Tex***  
*X*  
*0 X*  
*X*  
*X*  
*N1*  
***Tor***

*Example 2: case of a crack planes curve:*

***Tex***  
*Nn*  
*N1*  
***Tor***

***Note:***

***T***  
*and T*  
***however***  
*ex is normalized automatically.*

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## 4

### **Phase of checks**

*With the execution:*

.

*checking of the membership of the entities (nodes and meshes) to the grid,*

.

*when the bottom of crack is defined by GROUP\_NO it is checked that the last node of group\_no (I) is identical to the first node of the group\_no (I + 1),*

.

*checking that the bottom of crack defined by the data of a list of mesh constitutes one well related way,*

.

*checking which the NOEUD\_ORIG belongs well to one of the meshes and which it is well one of two ends of the way defined by these meshes,*

.

*in the case of a crack planes where the key word NORMAL was used, one checks orthogonality of this normal with the 2 tangent vectors given by operands DTAN\_ORIG and DTAN\_EXTR.*

## 5 Examples

### 5.1

**Whole crack defined by various types of entities in 3D**

**The bottom of crack is defined by a list of group\_no, the upper lip by a list of meshes, the lower lip by a list of group\_ma.**

**Fiss1 = DEFI\_FOND\_FISS**

**(GRID = my,**

**FOND\_FISS**

**=**

**\_F**

**(GROUP\_NO**

**=**

**(“GRN1”, “GRN2”, “GRN3”),),**

**LEVRE\_SUP**

=

**\_F**

**(MESH**

= (“MA5”, “MA13”, “MA4”, “MA12”),

**LEVRE\_INF**

=

**\_F**

**(GROUP\_MA**

=

(“GRM1”,

“GRM2”),

**DTAN\_ORIG**

=

(

1.,0.,0.),

**DTAN\_EXTR**

=

(

1.,0.,0.),

)

*with the following groups defined in the grid my:*

**GRN1: {N010 N018}**

**GRN2: {N018 N016 N017}**

**GRN3: {N017 N015}**

**GRM1: {MA17 MA15 MA6}**

**GRM2: {MA40}**

***The bottom of crack is consisted here of the nodes N010, N018, N016, N017, N015 in an ordered way.***

***upper lip***

***NO10***

***melts of crack***

***MA5***

***T gold NO18***

***MA17***

***MA13***

***NO16***

***MA15***

***MA4***

***NO17***

***MA6***

***MA12***

***NO15***

***Z***

***MA40***

***y***

***T ex***

***lower lip***

***X***

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## 5.2

### *Symmetry of the lips in 3D*

*The bottom of crack is defined by a list of nodes, the upper lip by a list of group\_ma, lower lip is not defined due to symmetry of the problem.*

*Fiss2*

=

*DEFI\_FOND\_FISS*

*(GRID*

=

*my,*

*FOND\_FISS*

=

*\_F*  
*(NOEUD= ("N014 " N019 " N017 " N015"),),*

*LEVRE\_SUP*

=

*\_F*

*(GROUP\_MA*

*= ("GRMA", "GRMB", "GRMC"),),*

*DTAN\_ORIG*

=

*(*  
*1.,0.,0.),*

*DTAN\_EXTR*

=

*(*  
*1.,0.,0.),*

)

*With the following groups defined in the grid:*

**GRMA: (MA5 MA13 MA4), GRMB: (MA12 MA58) GRMC: (MA1)**

*The bottom of crack is consisted here of the nodes N014, N019, N017, N015 in an ordered way.*

*upper lip*

*melts of crack*

**N014**

**T gold**

**MA5**

**MA13**

**N019**

**MA4**

**MA12**

**N017**

**Z**

**y**

**MA58**

**MA1**

**N015**

**X**

**T ex**

**5.3**

*Two cracks in a grid in 3D*

*Sequence of two operators **DEFI\_FOND\_FISS**:*

.

*the bottom of crack 1 is defined by an ordered list of group\_no, its upper lip by a list of meshes, its lower lip by a list of group\_ma.*

.

*the bottom of crack 2 is defined by a list of ordered nodes, its upper lip by one list group\_ma, its lower lip by a list of meshes.*

*fissa*

=

**DEFI\_FOND\_FISS**

**(GRID**

=

**my,**

**FOND\_FISS**



=  
\_F  
(GROUP\_NO  
=  
"GRN1")  
LEVRE\_SUP  
=  
\_F  
(MAILLE= ("MA10", "MA40", "MA6", "MA7", "MAI"),),  
LEVRE\_INF  
=  
\_F  
(GROUP\_MA  
=  
("GRM1", "GRM2"),),  
DTAN\_ORIG  
=  
(1,1,1.),  
DTAN\_EXTR  
=  
(1,0,1.),

)  
  
*fissb*  
=  
DEFI\_FOND\_FISS  
(GRID  
=  
*my*,  
FOND\_FISS

=  
\_F  
(NOEUD= ("N037", "N038", "N039", "N043", "N051",  
"N060"),),

**LEVRE\_SUP**

**=\_F**

**(GROUP\_MA**

**=**

**(“GRM3”),),**

**LEVRE\_INF**

**=\_F**

**(MAILLE= (“MA44”, “MA54”, “MA60”, “MA55”, “MA80”),),**

**DTAN\_ORIG**

**=**

**(**

**1.,0.,0.),**

**DTAN\_EXTR**

**=**

**(**

**0.,1.,0.),**

**)**

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**with the my concept grid produced by order LIRE\_MAILLAGE:**

**GRN1: (NO3 NO7 NO8),**  
**GRM1: (MA73 MA19) GRM2: (MA74 MA5)**

**GRM3: (MA6 MA10 MA8 MA7 MA12 MA13 MA14)**

**5.4**  
**Use of the NORMAL operand (crack planes in 3D)**

**fiss = DEFI\_FOND\_FISS (GRID = my,**  
**FOND\_FISS**  
**=\_F**  
**(NODE**  
**=**  
**(“NO1”, “NO2”, “NO3”),,**  
**DTAN\_ORIG**

**=**  
**(**  
**1.,0.,0.),**  
**DTAN\_EXTR**

**=**

(  
***1.,0.,0.***),

***NORMAL = (0. , 0. , - 1.),***

)

***One defines the normal NR in the plan of the crack.***

***Direction N of the normal at the bottom of crack in the plan of the lips of the crack is given by  $N = 0 NR$***

***Z***

***y***

***T***

***NR O 1***

***however***

***X***

***N***

***NR O 2***

***0***

***T ex***

***NR***

***NR O 3***

***5.5***

***Fissure in 2D***

***The bottom of crack is defined by the N10 node of the grid my:***

*fiss*  
=  
**DEFI\_FOND\_FISS**  
(  
**GRID**  
=  
*my*,  
**FOND\_FISS**  
=  
**\_F (NODE**  
=  
"N10"),  
**NORMAL =**  
**(-1.,1.,0.),**  
  
)

**T**  
**NR**  
**N0**

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**5.6**  
***Melts of crack closed with scheduling of the nodes***

***fiss = DEFI\_FOND\_FISS (GRID =***  
***my,***  
***FOND\_FERME=\_F (***  
***MAILLE= (“MA3”, “MA1”, “MA2”...),***  
***GROUP\_NO\_ORIG***  
***= “NO”,***  
***MAILLE\_ORIG***  
***=***  
***“MA2”***  
***),***  
***NORMAL***

***=***  
***(***  
***0.,0.,-1.),***

***)***  
***One defines the normal NR in the plan of the crack.***

***Direction N of the normal at the bottom of crack in the plan of the lips of the crack is given by  $N = 0 NR$***

***The order of declaration of the meshes in the list does not have any importance. The operator checks that the node***

*NO belongs well to mesh MA2 and that the whole of the meshes segments provided form well one closed related curve.*

*MA2*

*NO*

*MA4*

*MA1*

*MA3*

*MA<sub>n</sub>*

*NR*

*Z*

*X*

*y*

*The order of the nodes in the produced concept will be that given by the arrow of the drawing above, therefore*

*NO.*

*5.7*

*Melts of crack defines by two groups of nodes coïncidents*

*The bottom of crack of the grid my is defined by 2 groups of nodes:*

-

*“FONDINF”*: group nodes belonging to the lower lip.

-

*“FONDSUP”*: group nodes belonging to the upper lip whose nodes coincide geometrically with those of group “FONDINF”

```
fiss = DEFI_FOND_FISS (GRID = my,  
FOND_INF  
=  
_F (GROUP_NO=' FONDINF'),  
FOND_SUP=_F (GROUP_NO=' FONDSUP'),  
LEVRE_INF=_F (GROUP_MA=' LEVINF'),  
LEVRE_SUP=_F (GROUP_MA=' LEVSUP'),  
DTAN_ORIG= (0. , 1. , 0.),
```

***DTAN\_EXTR= (1. , 0. , 0.),)***

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*Operator* CALC\_THETA

*Date:*

27/01/05

*Author (S):*

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*Organization (S):* EDF-R & D /AMA

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***Document: U4.82.02***

***Operator*** CALC\_THETA

***1 Goal***

***To define a field theta for the calculation of the rate of refund of energy or the factors of intensity of constraints.***

*The field theta is used within the framework of the breaking process in the orders  
CALC\_G\_THETA\_T [U4.82.03] and CALC\_G\_LOCAL\_T [U4.82.04].*

*This operator allows to define on all the nodes of the grid:*

*.  
the module of the field theta,*

*.  
in 2D direction of propagation of the bottom of crack (equalizes with that of the field theta) with  
key word DIRECTION,*

*.  
in 3D direction of the field theta calculated automatically starting from the directions of  
propagation of the nodes in bottom of crack. These directions are recovered by the concept of  
fond\_fiss type (produced by operator DEFI\_FOND\_FISS), or by the key words  
DIRE\_THETA or DIRECTION,*

*.  
the Rinf rays and Rsup of the crowns surrounding the bottom of crack and used in  
method theta.*

*In 2D the bottom of crack is tiny room to a node and the crowns are circular. In 3D rays  
can be variable with the curvilinear X-coordinate of the bottom of crack and Rinf, Rsup define then  
two deformed and variable cylinders surrounding the bottom of crack.*

*The rule of overload applies at the time of the assignment to the bottom of crack.*

*This field theta is also used to represent the movement of a rectilinear border in  
calculations 2D of sensitivity to the variations of field in linear thermics or mechanics.*

*The produced concept is of cham\_no\_DEPL\_R type.*

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## **2 Syntax**

***theta [cham\_no\_DEPL\_R] = CALC\_THETA***

**(  
OPTION**

**=**

**/**

**“CROWN”,  
[DEFECT]**

**/**

**“BAND”,**

**MODEL**

**=**

**Mo,**

**[model]**

**/FOND\_FISS**

**=**

**FF,**

**[fond\_fiss]**

**THETA\_3D =\_F**

**(**

**/ALL = "YES",**

**/**

**GROUP\_NO**

**=**

**lgrno**

**,**

**[l\_gr\_noeud]**

**/**

**NODE**

**=**

**lno**

**,**

**[l\_noeud])**

**/MODULE =, [R]**

**R\_INF = R, [R]**

**$R_{SUP} = R, [R]$**

/  
 **$MODULE_{FO} = Z, [function]$**

**$R_{INF_{FO}} = rz, [function]$**

**$R_{SUP_{FO}} = Rz, [function]$**

),

/  
**THETA\_2D**  
**=\_F**  
(  
**/GROUP\_NO = gno,**  
**[l\_gr\_noeud]**  
/  
**NODE**

=  
**No**  
**, [l\_noeud])**

**MODULATE = module, [R]**

**R\_INF = rinf,**

**[R]**

***R\_SUP = rsup,***

***[R]***

***),***

***/***  
***THETA\_BANDE=\_F (***  
***MODULATE = module, [R]***

***R\_INF = rinf,***

***[R]***

***R\_SUP = rsup,***

***[R]***

),

***/DIRECTION***

=

***(d1, d2, d3),***

***[l\_R]***

/

***DIRE\_THETA =***

***chamno***

,

***[cham\_no\_DEPL\_R]***

***GRAD\_NOEU\_THETA***

=

/

***“NOT”,***

***[DEFECT]***

***/“YES”,***

***IMPRESSION=\_F***

***(FORMAT***

***=/“EXCEL”, [DEFECT]***

/

***“AGRAF”,***



**UNIT**

=

/

8,

**[DEFECT]**

/

**links,**

**[I]**

)

)

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**3 Operands****3.1 Operand****OPTION**

*OPTION* = /“CROWN”,  
 [DEFECT]  
 “BAND”,

**3.1.1 OPTION = “CROWN”**

*This manner of introducing the field is geometrical [R7.02.01 §20]. It amounts being given two rays  $R_{inf}$ ,  $R_{sup}$ , and in each node of the bottom of crack by the key word factor  $THETA\_3D$  or  $THETA\_2D$ . One carries out calculations of distance from a knot slip at the bottom of crack for to determine the value of in this node.*

*More precisely, in any node of the bottom of crack 0, located by its curvilinear X-coordinate  $S$ , one a normal plan  $P$  can define into which the field is introduced in such way that after being given 2 volumes  $T$  and  $S$  (deformed cylinders) surrounding the bottom of crack, one a:*

·  
 $= O(S) = cte$  in  $T(R_{inf})$

·  
*linearly vary compared to the ray in the crown  $S(R_{sup}) / T(R_{inf})$*

·  
*is continuous in  $S(R_{sup})$*

·  
 $= 0$  outside  $S(R_{sup})$

 $P$  $S(R_{sup})$  $T(R_{inf})$  $R_{inf}$ 

0

 $R$  $R$  $sup$  $= cte$ *décroit linearly*

= 0

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### **3.1.2 OPTION = "BAND"**

*This manner of introducing the field is used to simulate the movement of a border in calculations of sensitivity to the variations of field in linear thermics [U4.54.01] or in linear mechanics [U4.51.01]. That is possible for the following configurations:*

.

*calculations in 2D or axisymmetric 2D,*

.

*rectilinear border, parallel with axis OY,*

.

*field of calculation on the right of the border.*

**R**

*One aims at obtaining a field being worth  $K E$  on the border and being cancelled at a certain distance to  $X$*

*interior; the module  $K$  is given in key word THETA\_BANDE. Between these two situations, field normalizes decrease linearly with the  $X$ -coordinate.*

*One must thus give successively:*

.

*the module of the field on the border,*

.

*the Rinf X-coordinate corresponding to the right-hand side border,*

.

*the Rsup X-coordinate corresponding to the right-hand side where the field is cancelled. There is Rsup > Rinf.*

*= K er*

*decrease linearly*

*= 0 Re*

*X*

*X*

*X*

*Rinf*

*Rsup*

### **3.2 Operand**

#### **MODEL**

*MODEL = Mo*

*Name of the concept models which defines the elements on which the field is calculated.*

### **3.3**

#### **Breaking process - 3D problem**

##### **3.3.1 Operand**

###### **FOND\_FISS**

/

*FOND\_FISS = FF*

*Name of the concept FF of the type fond\_fiss container:*

.

*the ordered list of the nodes describing the bottom of crack,*

.

*the list of the meshes describing the upper lip of the crack,*

.

*the list of the meshes of the lower lip of the crack if this one exists (case of one nonsymmetrical problem).*

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### **3.3.2 Operand**

#### ***THETA\_3D***

*THETA\_3D* =

*Defines the nodes or the groups of nodes entirely describing the bottom of crack where one affect the rays of the crown and the module of.*

*The whole of the nodes of the bottom of crack is specified by the operands:*

/

**ALL** =

*taking into account of the totality of the nodes of the bottom of crack.*

/

**GROUP\_NO** =

*taking into account of a under-part of the bottom of crack made up of list groups of nodes specified.*

/

**NODE** =

*taking into account of a under-part of the bottom of crack made up of list nodes specified.*

*The two rays defining the crown and the module can be introduced either by constant actual values which are arguments of single-ended spanner words *R\_INF*, *R\_SUP* and*

*MODULATE* or is by functions of the curvilinear X-coordinate on the directed bottom of crack, which are arguments of single-ended spanner words *R\_INF\_FO*, *R\_SUP\_FO* and *MODULE\_FO*.

### **3.3.3 Operands**

#### ***DIRE\_THETA* and *DIRECTION***

The operand *DIRECTION* makes it possible to define the three components (*d1*, *d2*, *d3*) of the field on the bottom of crack.

Operand *DIRE\_THETA* makes it possible to introduce in 3D the direction of the field theta on all the nodes of melts of crack by a field with the nodes defined at the time of a *AFFE\_CHAM\_NO* [U4.44.11] preliminary.

These options are optional: by defect these directions are calculated automatically from concept *FF* resulting from order *DEFI\_FOND\_FISS* [U4.82.01].

## **3.4**

### ***Breaking process - problem 2D***

#### **3.4.1 Operand**

##### ***THETA\_2D***

/  
*THETA\_2D* =

Key word factor defining the node of the bottom of crack is by *GROUP\_NO* (if this node belongs to a group of node which must be limited to this node) is by *NODE* followed by the name this node.

The module of and the two rays are arguments of the single-ended spanner words *MODULATES*, *R\_INF*, *R\_SUP*.

## **3.5**

### ***Sensitivity to the variations of field - problem 2D***

#### **3.5.1 Operand**

##### ***THETA\_BANDE***

/  
*THETA\_BANDE* =

Key word factor defining the field if the option *BANDAGES* was retained. The 3 then are found following single-ended spanner words:

## **MODULATE**

=  
*modulate*

*It is the value of the module of the field theta on the line border.*

$R\_INF = rinf$

*X-coordinate of the right-hand side border. Attention, it has no checking of the coherence there of this value rinf with the grid used.*

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$R\_SUP = rsup$

*X-coordinate of the right-hand side where the field is cancelled. This value must be strictly higher than rinf. It must be lower than the maximum X-coordinate of the field of calculation. In other words, the zone ranging between rinf and rsup must be completely included in the field of calculation. That is not controlled by the operator.*

### **3.6 Operand**

**GRAD\_NOEU\_THETA**

$GRAD\_NOEU\_THETA = / "YES",$

/

**“NOT”**,

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, the gradient of the field is calculated on all the nodes of the field. calculation is obligatory if the options of sensitivity were activated in the thermal resolution or mechanics.*

### **3.7 Operand**

#### **DIRECTION/DIRE\_THETA**

*DIRECTION = (d1, d2, d3),*

*List values of the three components of the direction of the field on the bottom of crack when this one is not calculated. In 2D this key word is obligatory: it is necessary to provide a vector of the form (d1 d2 0).*

*DIRE\_THETA = chamno,*

*Allows to introduce in 3D the direction of the field on all the nodes of the bottom of crack by skew of a preliminary AFFE\_CHAM\_NO. In the absence of DIRECTION and DIRE\_THETA, this one is calculated by the operator in each node of the bottom of crack (normal at the bottom of crack in plan of the lips).*

### **3.8 Operand**

#### **IMPRESSION**

*FORMAT*

*=/“EXCEL”, [DEFECT]*

*/*

*“AGRAF”,*

*UNIT =/8,*

*[DEFECT]*

*/*

*links*

*,*

*Key word factor making it possible to print on the logical file of unit links (para defect 8) for*



each node of the bottom of crack rinf, rsup, the module and direction of the field theta. The format "AGRAF" makes it possible post-to treat the impression by Agraf.

#### **4** **Phase of checking**

.  
checking of the membership of the nodes or groups of nodes to the grid,

.  
checking of the membership of the nodes or groups of nodes at the bottom of crack,

.  
checking which the bottom of crack is complete,

.  
checking that direction of the field on the bottom of crack (when it is given) contains only three components.

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#### **5 Examples**

##### **5.1**

**Assignment of a field in 2D by actual values**

**One affects on the node of the bottom of crack = 1 R\_INF = 1 and R\_SUP = 2**

**THET2 = CALC\_THETA (MODEL = Mo,**  
**THETA\_2D**  
**=\_F (**  
**NODE = ("NO29"),**  
**MODULATE**  
**=**  
**1.,**  
**R\_INF**  
**=**  
**1. , R\_SUP**  
**=**  
**2.),**  
**DIRECTION**  
  
**=(1.,1.,0.),**  
**IMPRESSION**  
**=\_F (UNIT**  
**=**  
**8),**

)

*with Mo the model concept produced by order AFFE\_MODELE.*

## 5.2 Assignment of a field in 3D by actual values

*On the bottom of crack one affects on all the nodes = 1. , R\_INF = 2. and R\_SUP = 5. by values real constants.*

*The direction of the field is given on each one of these nodes, it is worth (1. 0. 0.).*

**THET3 = CALC\_THETA (OPTION = ' COURONNE', MODELS =MO, FOND\_FISS =FF1,**  
**THETA\_3D**  
  
**=\_F (ALL**  
**=**

**“YES”,**  
**MODULATE**  
 =  
**1. , R\_INF**  
 =  
**2. , R\_SUP**  
 =  
**5.),**  
**DIRECTION**  
  
 =(  
**1.,0.,0.),**  
**IMPRESSION**  
 =\_F (UNIT  
 =  
**8),**

)

*with Mo the model concept produced by order AFFE\_MODELE,  
 ff1 the concept of the fond\_fiss type produces by order DEFI\_FOND\_FISS.*

### **5.3 Assignment of a field in 3D by actual values and function with rule of overload**

*On the bottom of crack one affects on the group of nodes GRN1, = 1. Rinf = 2. and Rsup = 5. by  
 constant actual values, and on the group of nodes GRN2, Rinf and Rsup by functions.*

*The direction of the field is calculated with the nodes of the bottom of crack.*

**THETA1 = CALC\_THETA (OPTION = “CROWN”, MODELS = Mo, FOND\_FISS =ff1,  
 THETA\_3D**  
 =  
 \_F (GROUP\_NO  
 =  
**GRN1,**

**MODULATE**

=

**1. , R\_INF**

=

**2. , R\_SUP**

=

**5.),**

**GROUP\_NO**

=

**GRN2,**

**MODULE\_FO=fo, R\_INF\_FO=f1, R\_SUP\_FO=f2),**

**IMPRESSION**

**=\_F**

**(**

**UNIT**

=

**8)**

**)**

**with:**

**Mo the model concept produced by order AFFE\_MODELE.**

**ff1 the concept of the fond\_fiss type produces by order DEFI\_FOND\_FISS.**

**GRN1 = {NO3 NO7 NO10}, GRN2 = {NO13 NO15}**

**The bottom of crack is consisted of the nodes: NO3, NO7, NO10, NO13, NO15 in an ordered way.**

**f0, f1, f2 are respectively the functions defining and the two rays of the crowns for GRN2 produced by order DEFI\_FONCTION.**

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**Note:**

**GRN1 and GRN2 must complètement describe the bottom of crack represented in the concept ff1.**

**On the bottom of crack one affects, Rinf and safe Rsup by function with nodes NO29 and NO15 where one**

**affect = 1. R\_INF = 2. R\_SUP = 3. by constant actual values.**

**The direction of the field is calculated with the nodes of the bottom of crack.**

**THETA2 = CALC\_THETA (OPTION = ' COURONNE', MODELS = Mo, FOND\_FISS =ff3,  
THETA\_3D  
= \_F (ALL  
= ' OUI'**

**MODULE\_FO=fa, R\_INF\_FO=fb, R\_SUP\_FO=fc),**

**(NODE  
=(  
"NO29",  
"NO15"),**

**MODULATE**

**=**

**1. , R\_INF**

**=**

**2. , R\_SUP**

=

3.

),

***IMPRESSION= \_F (***  
***UNIT***

=

8

)

)

***with:***

***Mo the model concept produced by order AFFE\_MODELE.***

***ff3 the concept fond\_fiss produces by order DEFI\_FOND\_FISS.***

***F, Bfrs, FC are respectively the functions defining II and the two rays of the crowns for all bottom of crack, produced by order DEFI\_FONCTION.***

***Note:***

***The rule of overload applies here for the nodes of the bottom of crack NO29 and NO15.***

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**Organization (S): EDF-R & D /AMA, SINETICS**

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**Operator CALC\_G\_THETA\_T**

**1 Goal**

**To calculate the rate of refund of energy in 2D or 3D and the stress intensity factors in 2D.**

**This operator calculates the following sizes of breaking process:**

**.**

**the rate of refund of energy G in 2D or 3D by the method in the case of a problem thermoelastic linear or not linear [R7.02.01] and [R7.02.03], in statics or in dynamics [R7.02.02]**

**.**

*the bilinear form  $G$ , function of a series of displacements, such as  $G(U, U) = G(U)$ ,*

*stress intensity factors  $K1$  and  $K2$  in 2D (plane or forced deformations plane) by the method of singular displacements in the case of a problem thermoelastic linear [R7.02.05].*

*For studies mechanic-reliability engineers of evaluation of probability of starting of the rupture, one calculates in more of the rate of refund of energy  $G$ , its derivative compared to a variation of field controlled by a suitable function  $\theta$  [R7.02.01] [R4.03.01]. This option is limited to the thermo problems linear rubber bands 2D being pressed on quadratic finite elements.*

*Before a first use, it is advised to refer to the council and reference documents of correspondents use, in particular the document [U2.05.01].*

*Functionalities concerning the rate of refund of energy with Lagrangian propagation (i.e. for an extension of the crack by using the same grid) in 2D or 3D in cases of a linear thermoelastic problem are described in the document [R7.02.04].*

*This operator generates a concept of the type counts.*

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*2 Syntax*

*[tabl\_\*] = CALC\_G\_THETA\_T*



(  
**MODEL**

=

**Mo,**  
**[model]**

**CHAM\_MATER = to subdue,**  
**[cham\_mater]**

**THETA**

=

**theta,**  
**[cham\_no\_DEPL\_R]**

**# recovery of the field of displacements**

/

**DEPL**

=

**depl,**  
**[cham\_no\_DEPL\_R]**

/

**QUICKLY = quickly,**  
**[cham\_no\_DEPL\_R]**

**ACCE = acce,**  
**[cham\_no\_DEPL\_R]**

/

**RESULT**

=

**resu,**  
**[evol\_elas]**

/

**[evol\_noli]**

/

**[dyna\_trans]**

/

**[mode\_meca]**

*# if RESULT of the evol\_elas type, evol\_noli or dyna\_trans*

*/TOUT\_ORDRE = "YES",*

*[DEFECT]*

*/*

*NUME\_ORDRE =*

*l\_ordre,*

*[l\_I]*

*/*

*LIST\_ORDRE =*

*read*

*,*

*[listis]*

*/*

*INST*

*=*

*l\_inst, [l\_R8]*

*/*

*LIST\_INST*

*=*

*l\_reel, [listr8]*

*# if RESULT of the mode\_meca type*

*/TOUT\_MODE*

*=*

*"YES",*

*[DEFECT]*

*/*

*NUME\_MODE*

*=*

*l\_ordre,*

**[l\_I]**

/

**LIST\_MODE**

**= read**

,

**[listis]**

/

**FREQ**

=

**l\_inst, [l\_R8]**

/

**LIST\_FREQ**

=

**l\_reel, [listr8]**

**/ PRECISION**

=

/

**prec,**

**[R]**

/

**1.0D-6, [DEFECT]**

**/ CRITERION =/"RELATIVE", [DEFECT]**

/

**"ABSOLUTE"**

,

**# loading**

**EXCIT = (\_F (LOAD**

=

*charge*

,

[*char\_meca*]

[*char\_cine\_meca*]

*FONC\_MULT = fmult,*  
[*function*]  
[*formula*]  
,)

*SYME\_CHAR*  
=  
/  
"WITHOUT"  
,  
[*DEFECT*]  
/  
"SYME"  
,  
/  
"ANTI"  
,

# *behavior*

*/COMP\_ELAS*

*=\_F*

*(*

*RELATION*

*=*

*/*

*“ELAS”, [DEFECT]*

*/*

*“ELAS\_VMIS\_LINE”,*

*/*

*“ELAS\_VMIS\_TRAC”,*

*DEFORMATION*

*=*

*/*

*“SMALL”,*

*[DEFECT]*

*/*

*“GREEN”,*

*/ALL = “YES”,*

*[DEFECT]*

*/*

*|*

*GROUP\_MA*

*=*

*lgrma,*

*[l\_gr\_maille]*

*|*

*NET*

*=*

*lma*

,

[l\_maille]

),

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/  
*COMP\_INCR*  
*=\_F*  
(

*RELATION*  
*=*  
/  
*“ELAS”, [DEFECT]*  
/  
*“VMIS\_ISOT\_TRAC”,*  
/  
*“VMIS\_ISOT\_LINE”,*

*DEFORMATION =/“SMALL”, [DEFECT]*  
/  
*“PETIT\_REAC”*  
,

*/ALL = “YES”*

,  
[DEFECT]  
/  
/  
GROUP\_MA  
=  
lgrma  
,  
[l\_gr\_maille]  
/  
NET  
=  
lma  
,  
[l\_maille]

),  
  
ETAT\_INIT  
=\_F  
(

/ / DEPL = EPD  
,  
[cham\_no\_DEPL\_R]

/ SIGM =  
sig  
,  
/  
[carte\_SIEF\_R]  
/  
/



[*cham\_elem\_SIEF\_R*]

),

# *option requested: - calculation of the rate of refund of energy G*

#

-

*calculation*

*coefficients*

*of intensity*

*of*

*constraints*

*K1*

*and*

*K2*

#

-

*calculation*

*of*

*G*

*with*

*propagation*

*Lagrangian*

#

-

*calculation*

*of*

*form*

*bilinear*

*G*

#

- *calculation of derived from G compared to one variation of field.*

*OPTION*

=

/

“*CALC\_G*”

,

[*DEFECT*]

#

/“*CALC\_K\_G*”

,

*FOND\_FISS*

= *fiss*, [*fond\_fiss*]

#

/

“*K\_G\_MODA*”

,

*FOND\_FISS*

= *fiss*, [*fond\_fiss*]

#

/

“*CALC\_G\_LAGR*”,

*PROPAGATION = alpha*

, [*l\_Kn*]

#

/

“*G\_BILINEAIRE*”

,

#

/

“*CALC\_G\_MAX*”,

*TERMINALS*

= *\_F*

(

*NUME\_ORDRE = num, [I]*

*VALE\_MIN*

= *qmin*  
, [R]

*VALE\_MAX*  
= *qmax*  
, [R]  
,

*SENSITIVITY*  
=  
(... to see [U4.50.02])

*TITRATE*  
=  
*titrate*  
, [l\_Kn]

# *impression*  
*information*

*INFORMATION* =/1, [DEFECT]

/ 2 ,

)

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### **3 Operands**

#### **3.1 Operand**

##### **MODEL**

**MODEL =**

**Mo**

*Mo is the name of the model on which G, K1 and K2 are calculated. It is generated by the order **AFFE\_MODELE** [U4.41.01].*

*The name of the model is:*

- *Facultatif if the field of displacement is given with the key word **RESULT** and if structure of data *resu* is of type **EVOL\_ELAS**, **EVOL\_NOLI**:*
  - *If the name of the model misses, the operator takes that which is present in structure of data *resu*;*
  - *If the name of the model is provided by the user, the operator checks if it is identical to that present in the structure of data *resu*, the contrary case an error fatal is emitted.*
- *Obligatoire in all the other cases.*

*The calculation of the rate of refund of energy G (option “**CALC\_G**”) is valid for modelings following:*

.  
**D\_PLAN,**

.  
**C\_PLAN,**

.  
**AXIS,**

.  
**3D.**

***These modelings correspond:***

.  
***for a two-dimensional medium with triangles with 3 or 6 nodes, quadrangles with 4, 8 or 9 nodes and of the segments with 2 or 3 nodes,***

.  
***for a three-dimensional medium with hexahedrons with 8, 20 or 27 nodes, pentahedrons with 6 or 15 nodes, of the tetrahedrons with 4 or 10 nodes, of the pyramids with 5 or 13 nodes, of faces with 3, 4, 8 or 9 nodes.***

***The calculation of the stress intensity factors K1, K2 (option "CALC\_K\_G") is possible for following modelings:***

.  
**D\_PLAN,**

.  
**C\_PLAN.**

***The calculation of the stress intensity factors in 3D starting from the rate of refund of energy is possible for linear elements with option "CALC\_K\_G" of the operator CALC\_G\_LOCAL\_T. To date, the option is not developed for axisymmetric modelings.***

***For a plane crack in an elastic, homogeneous and isotropic material, one also can to reach the values of K1, K2 and K3 by extrapolation of the jumps of displacements on the lips of this crack: order POST\_K1\_K2\_K3 [U4.82.05].***

***The calculation of derived from the rate of refund of energy compared to a variation of field is licit only for modelings 2D (D\_PLAN, AXIS and C\_PLAN) in linear thermoelasticity.***

***Caution:***

***With this option, the configuration forced plane is taken besides into account only in postprocessing of the calculation of mechanics, i.e. for the determination of the tensors of deformations and of the constraints starting from displacements. They should not appear at the time calculation of sensitivity of MECA\_STATIQUE which supports only modelings D\_PLAN and AXIS. In such a configuration the user is of course an only judge of the relevance of***

*its results.*

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### **3.2 Operand**

#### **CHAM\_MATER**

*CHAM\_MATER =*

*to subdue*

*to subdue is the field of material generated by order AFFE\_MATERIAU [U4.43.03].*

*The name of the material field is:*

- *Facultatif if the field of displacement is given with the key word RESULT and if structure of data resu is of type EVOL\_ELAS, EVOL\_NOLI:*

- *If the name of the material field misses, the operator takes that which is present in the structure of data resu;*

-

*If the name of the material field is provided by the user, the operator checks if it is identical to that present in the structure of data resu. In the contrary case, an alarm is emitted and calculation continues with the material field provided by the user.*

- *Obligatoire in all the other cases.*

*The material field makes it possible to recover the characteristics of material:*

.  
*YOUNG modulus E,*

.  
*NAKED Poisson's ratio,*

.  
*thermal dilation coefficient ALPHA (for a thermomechanical problem),*

.  
*elastic limit SY (for a nonlinear elastic problem),*

.  
*slope of the traction diagram D\_SIGM\_EPSI (for a nonlinear elastic problem with linear isotropic work hardening).*

*These characteristics can depend on the temperature only for option "CALC\_G". They must be independent of the temperature for the calculation of the factors of intensity of constraints (option "CALC\_K\_G").*

*The calculation of sensitivity was developed only for elastic materials independent of temperature. They can on the other hand be heterogeneous.*

*Characteristics SY and D\_SIGM\_EPSI are treated only for one elastic problem not linear with work hardening of von Mises and the option of calculation of the rate of refund of energy "CALC\_G". The calculation of the coefficients of intensity of constraints is treated only in elasticity linear.*

**Note:**

*For the calculation of the stress intensity factors (option "CALC\_K\_G"), them characteristics must be defined on all materials, including on the elements of edge, because of method of calculation [R7.02.05]. To be ensured so it is advised of to make AFFE = \_F (ALL = "YES") in order AFFE\_MATERIAU [U4.43.03], even if it means to use the rule of overload then.*

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***Problem of Bi-material:***

***1st case:*** *There is a Bi-material but the point of crack is in only one material, cf [Figure 3.2-a]. If one is assured that the crown, definite enters the rays inferior R and higher R (the order CALC\_THETA [U4.82.02]), has like support of the elements of same material, calculation is possible whatever the selected option. If not only option "CALC\_G" is possible.*

*material 1*

R

E

R

1, 1, 1

*material 2*

E2, 2, 2

***Appear 3.2-a: Bi-material: 1st case***

***2nd case:*** *There is a Bi-material where the point of crack is with the interface, cf [Figure 3.2-b]. To date,*

*only the option of calculation of the rate of refund of energy (option "CALC\_G") is available. The calculation of*

*coefficients of intensity of constraints K1 and K2 is not possible in this case.*

*material 1*

E1, 1, 1

R

R

*material 2*

E2, 2, 2

***Appear 3.2-b: Bi-material: 2nd case***

***3.3 Operand***

***THETA***

*THETA = theta*

*The field is a field of vector in each node of the grid. It is a concept of the type cham\_no\_DEPL\_R. It can be affected directly with order AFFE\_CHAM\_NO [U4.44.11].*

*In practice, it results generally from the specific order CALC\_THETA [U4.82.02] which allows to affect the module, the direction of the field theta and the rays of the crown surrounding it melts of crack.*

*For more precise details to refer to [R7.02.01 §3].*

### **The Councils:**

*To avoid using a field theta defined with a ray lower no one. Fields of displacements are singular in bottom of crack and introduce results vague in postprocessing of breaking process.*

*It is advised to use successively order CALC\_G\_THETA\_T with at least 3 fields theta of different crowns to ensure itself of the stability of the results. In case of important variation (higher than 5-10%) it is necessary to wonder about the good catch in count of all modeling.*

*In 2D, this field theta making it possible to determine the zone of calculation around the crack is completely independent of the field theta related to the calculation of sensitivity. The option takes in count their possible coverings of supports, even the displacement of the one by report/ratio with the other.*

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Author (S):

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### **3.4 Operands**

#### **DEPL/QUICKLY/ACCE/RESULT**

*These operands make it possible to recover the field of displacement (and speed and acceleration for a calculation in dynamics) starting from a field with the nodes or extract of a result.*

##### **3.4.1 Operand**

#### **DEPL**

*/DEPL = depl*

*depl is a field with the nodes solution of calculation on Mo.*

##### **3.4.2 Operand**

#### **QUICKLY/ACCE**

*/QUICKLY = quickly*

*ACCE = acce*

*quickly and acce is respectively a field speed and a field of acceleration. It is fields with the nodes solution of a dynamic calculation on Mo.*

*These two operands must be simultaneously present to calculate the rate of refund energy into elastodynamic [R7.02.02].*

##### **3.4.3 Operand**

#### **RESULT**

*/RESULT = resu*

*Name of a concept result of the evol\_elas type, evol\_noli, dyna\_trans or mode\_meca.*

#### **3.4.4 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/INST/ LIST\_INST/TOUT\_MODE/NUME\_MODE/LIST\_MODE/FREQ/ LIST\_FREQ /PRECISION/CRITERION**

*These operands are used with the operand RESULT. See [U4.71.00].*

### **3.5 Word**

#### **key**

#### **EXCIT and operands CHARGE/FONC\_MULT**

*EXCIT = \_F (LOAD*

= *load*

*FONC\_MULT = fmult)*

*Key word EXCIT makes it possible to recover a list of loadings charges, resulting from the orders Multiplying AFFE\_CHAR\_MECA or AFFE\_CHAR\_MECA\_F [U4.44.01], and coefficients fmult.*

*Key word EXCIT is optional.*

*If displacements are provided by the key word RESULT and that the structure of data resu is of type EVOL\_ELAS, EVOL\_NOLI, the loading taken into account is is that provided by the user, that is to say that extracted from resu if it misses order. If the loading provided in resu (coherence of the name and the number of loads is different from that present, of couples load-function), an alarm is emitted and calculation continues with the loading indicated by the user.*

*In all the cases, it should be taken care that the loads indicated here were indeed taken into account in the preceding mechanical calculation which produced the field of displacements.*

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*The loadings currently supported by various modelings are as follows:*

## ***Option Modeling***

### ***Loading***

***key word of AFFE\_CHAR\_MECA***

***or AFFE\_CHAR\_MECA\_F***

***CALC\_G C\_PLAN, D\_PLAN, AXIS***

***TEMP\_CALCULEE***

***FORCE\_CONTOUR***

***FORCE\_INTERNE***

***GRAVITY***

***PRES\_REP***

***ROTATION***

***EPSI\_INIT***

***CALC\_G,***

***3D TEMP\_CALCULEE***

***FORCE\_FACE***

***CALC\_G\_MAX,***

***FORCE\_INTERNE***

***GRAVITY***

***G\_BILINEAIRE PRES\_REP***

***ROTATION***

***EPSI\_INIT***

***CALC\_K\_G,***

***C\_PLAN, D\_PLAN***

***TEMP\_CALCULEE***

***GRAVITY***

***K\_G\_MODA***

***FORCE\_INTERNE***

***ROTATION***

***PRES\_REP***

***FORCE\_CONTOUR***

***EPSI\_INIT***

***CALC\_K\_G,***

***AXIS, 3D***

*Modelings nonavailable*

***K\_G\_MODA***

*(in 3D: to see operator CALC\_G\_LOCAL\_T)*

***Table 3.5-a: Perimeter, by modeling, of the licit loadings.***

***Note:***

*The loadings not supported by an option are ignored. To date, loadings following being able to have a direction in breaking process is not treated:*

*·*  
***FORCE\_NODALE***

*·*  
***FORCE\_ARETE***

*·*  
***DDL\_IMPO*** *on the lips of the crack*

*·*  
***FACE\_IMPO***

*It is important to note that the only loadings taken into account in a calculation of mechanics rupture with the method are those supported by the elements inside the crown, where the field of vectors theta is nonnull (between Rinf and Rsup [R7.02.01 §3.3]). **Only types of load likely to influence the calculation of G are thus the voluminal loadings (gravity, rotation), a nonuniform field of temperature or efforts applied to lips of the crack.***

***Caution:***

*·*  
*A loading of comparable nature (for example voluminal force) can appear only in only one load. In the contrary case, calculation finishes in error.*

*·*  
*One observes also a rule of exclusion at the time of the simultaneous presence of a field of deformations (via “EPSI\_INIT”) and of initial displacements (via “ETAT\_INIT/DEPL” cf [§3.9]). Only one of both must remain.*

*·*  
*It is not possible to date to associate a load defined as a function (AFFE\_CHAR\_MECA\_F) and a multiplying coefficient (FONC\_MULT). In this case, it calculation finishes in error.*

*·*  
*For option CALC\_K\_G, if a loading is imposed on the lips of the crack (PRES\_REP or FORCE\_CONTOUR), then it is obligatorily necessary to direct them correctly meshes of those (by using ORIE\_PEAU\_2D) before the calculation of K.*

*·*  
*If one makes a calculation in great transformations (key word DEFORMATION: “GREEN” under*

*the key word factor COMP\_ELAS or DEFORMATION = “PETIT\_REAC” under the key word factor COMP\_INCR) the supported loadings must be died loads, typically an imposed force and not a pressure [R7.02.03 §2.4]; these loads must be declared like nonfollowing in STAT\_NON\_LINE.*

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*During calculation of derived from G compared to a variation from field (calculation of sensitivity), only loadings PRES\_REP and TEMP\_CALCULEE are usable in the totality of process. This software restriction is due only to the limited development of the option SENSITIVITY in operator MECA\_STATIQUE. As for modeling C\_PLAN, them other types of loading are taken into account only in postprocessing of the calculation of mechanics. **They cannot and they should intervene** only for the assembly of the terms of derived. They are thus modelled by inserted AFFE\_CHAR\_MECA or AFFE\_CHAR\_MECA\_F between MECA\_STATIQUE and CALC\_G\_THETA\_T (cf [§3.10], [§5.3]). In addition one can, for the moment, only to handle loadings independent of variation of field, in their intrinsic definitions as in those their supports. In other words, their derivative eulériennes must be null.*

### **3.6 Operand**

**SYME\_CHAR**

*SYME\_CHAR*

*=/“WITHOUT”*

*, [DEFECT]*

*/*

“*SYME*”

,

/

“*ANTI*”

,

*Key word SYME\_CHAR makes it possible to indicate if the loading is symmetrical or antisymmetric in case where one models only half of the solid compared to the crack. This key word can be essential if one uses option “CALC\_K\_G” to calculate the stress intensity factors: it allows to assign K2 to 0. if the loading is symmetrical compared to the crack or K1 with 0. if it is antisymmetric.*

*This key word also makes it possible to multiply by 2, the values of the rate of refund of energy G and its possible derivative, if one models only half of the solid compared to the crack.*

“*WITHOUT*” “*SYME*”

“*ANTI*”

**G**

*G () 2.D0 \* G () 2.D0 \* G ()*

**K1**

*K1*

*K1 0.D0*

**K2**

*K2 0.D0*

*K2*

**Table 3.6-a: Taking into account of symmetry**

### **3.7 Word**

**key**

**COMP\_ELAS**

*COMP\_ELAS*

=

*This key word factor makes it possible to define the relation of behavior of material used for it postprocessing of breaking process.*

*By defect the relation of behavior is elastic linear in small deformations.*

*The calculation of derived from G compared to a variation of field is restricts with elasticity linear (into pre and postprocessing), on the other hand it was also extended to the deformations of Green-Lagrange.*

**Note:**



- *The calculation of the rate of refund of energy  $G$  or not has direction only in linear elasticity lineaire (COMP\_ELAS). It is however possible to calculate in elastoplasticity (COMP\_INCR) a parameter  $G$  then defined as the total flow of energy (plasticity and rupture) through the defect. In the case of elastoplasticity, the defect must be modelled by a notch.*
- *Nothing prohibits to affect a behavior different during calculation from displacements (by elastoplastic example) then to carry out this postprocessing with another relation (by non-linear elastic example). The user is responsible for interpretation for results obtained [R7.02.03].*
- *If the loading is perfectly radial monotonous, calculations in nonlinear elasticity and in elastoplasticity lead to the same results. For this type of loading (and only in this case), it is also possible to make an elastoplastic calculation on a crack.*

*For more precise details, to refer to [U2.05.01].*

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### **3.7.1 Operand RELATION**

RELATION =

/

“ELAS”

*Relation of elastic behavior linear i.e. the relation between the deformations*

and the constraints considered is linear [R7.02.01 §1.1].

/  
 “ELAS\_VMIS\_LINE”

*Relation of nonlinear elastic behavior, von Mises with isotropic work hardening linear. The data materials necessary of the field material are provided in operator DEFI\_MATERIAU (cf the operator STAT\_NON\_LINE [U4.51.03] and the key word VMIS\_ISOT\_LINE) [R7.02.03 §1.1] and [R5.03.20].*

/  
 “ELAS\_VMIS\_TRAC”

*Relation of nonlinear elastic behavior, von Mises with isotropic work hardening not linear. The data materials necessary of the field material are provided in operator DEFI\_MATERIAU (cf the operator STAT\_NON\_LINE [U4.51.03] and the key word VMIS\_ISOT\_TRAC) [R7.02.03 §1.1] and [R5.03.20].*

### **3.7.2 Operand DEFORMATION**

DEFORMATION =  
 /  
 “SMALL”

*The deformations used in the relation of behavior are the linearized relations:*

(  
 1  
 U)  
 ij  
 =  
 (iu J + uj I)  
 2  
 ,  
 ,

/  
 “GREEN”

*The deformations used in the relation of behavior are the deformations of Green-Lagrange [R7.02.03 §2.1]:*

(  
 $I$   
 $U$ )  
 $ij$   
 $=$   
 $(iu J + uj I + ku I ku J)$   
 $2$   
 $,$   
 $,$   
 $,$   
 $,$

**Caution:**

.  
*The supported loadings are those supported in linear rubber band provided that it are dead loads: charge imposed or nonfollowing pressure.*

.  
*Displacements and rotations can be large but it is preferable to be limited with small deformations if one wishes a coherence with actual material. For more precise details to refer to [R7.02.03 §2.5].*

**3.7.3 Operands**

***ALL/GROUP\_MA/MESH***

/  
 $ALL$   
 $=$   
 $“YES”$   
 $,$

/|  $GROUP\_MA = lgrma,$   
/  
 $NET$   
 $=$   
 $lma$   
 $,$

*Specify the meshes or the nodes on which the relation of behavior is used.*  
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### ***3.7.4 Relation of behavior available for each option***

**“CALC\_G”**

**“CALC\_K\_G”,**

**“K\_G\_MODA”**

**COMP\_ELAS “ELAS”**

**“SMALL”**

**“SMALL”**

**“GREEN”**

**“ELAS\_VMIS\_LINE”**

**“SMALL” not**

**disp.**

**“GREEN”**

**“ELAS\_VMIS\_TRAC”**

**“SMALL” not**

**disp.**

**“GREEN”**

**Table 3.7.4-a: Availability, by option, of the relations of behavior.**

*It is possible for these relations of behavior to calculate the rate of refund of energy G in great transformations [R7.02.03 §2] with the proviso of having only dead loads.*

**3.8 Word****key****COMP\_INCR****COMP\_INCR**

=

*The relation of behavior elastoplastic is associated a criterion of von Mises with isotropic or kinematic work hardening.*

**RELATION**

=

/

“ELAS”

*Relation of elastic behavior incremental [U4.51.03].*

/

“VMIS\_ISOT\_LINE”

*von Mises with linear isotropic work hardening ([U4.51.03] and [R5.03.20]).*

/

“VMIS\_ISOT\_TRAC”

*von Mises with isotropic work hardening given by a traction diagram [U4.51.03].*

**DEFORMATION**

=

/

“SMALL”

*Linearized deformations: = (U*

*) = 1 2 U*

*+ U*

*ij*  
*ij*  
*(I, J*  
*J, I)*  
  
*/*  
*“PETIT\_REAC”*

*U*  
*U*

*I*  
*J*

*ij = 1/2*  
*+*  
*(*  
*[U4.51.03].*  
*X + U)*  
*(X + U)*

*J*  
*I*

*ALL/GROUP\_MA/MESH*

*The meshes specify on which the incremental relation of behavior is used.*

### ***3.9 Word***

***key***  
***ETAT\_INIT***

*ETAT\_INIT*  
*=*

*Initial State of reference selected. By defect, all the fields are identically null. The data of an initial state does not have direction (and is not thus taken into account) only for the treated part of the field in incremental behavior (COMP\_INCR): if calculation is elastic (COMP\_ELAS) that does not have no incidence. Taking into account the formula established in the source of CALC\_G\_THETA\_T, it is not licit of*

*to cumulate an initial deformation (either directly in the load with EPSI\_INIT, or like below, in the form of displacement), with an initial stress field.*

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**Caution:**

- If one wants to take into account an initial state in elasticity, it is key word ELAS located under COMP\_INCR which should be used.*
- One observes a rule of exclusion at the time of the simultaneous presence of a field of displacements (via CHARGE/EPSI\_INIT cf [§3.5]) and of deformations initial (via ETAT\_INIT/DEPL). Only one of both must remain.*

*During calculation of derived as for the loadings, these initial states are not taken in count that in postprocessing calculation of mechanics. **They cannot and they do not have to intervene** that for the assembly of the terms of this derivative.*

*In addition one can, for the moment, only to handle states independent of the variation of field, in their intrinsic definitions as in those their supports. In others terms, their derivative eulériennes must be null (cf [§3.10] and [§5.3]).*

*/SIGM*

=

*sig*

,

*/DEPL*

=

*depl,*

*Respectively, displacement and stress fields taken in an initial state. They can be by being example resulting from order RECU\_CHAMP, or to be read in a file with the format I-DEAS by order LIRE\_RESU. Either one gives an initial displacement, or a constraint initial. Attention, if the load transmitted in the operand LOAD contains an initial deformation (key word EPSI\_INIT of AFFE\_CHAR\_MECA\_F), this one will be taken into account in the same way that depl displacement provided here; it is then illicit to give an initial state with the key word DEPL.*

### **3.10 Operand OPTION**

*OPTION  
=/"CALC\_G",*

*calculation of the rate of refund of energy G*

*/*  
*"CALC\_K\_G",*

*calculation of the coefficients of intensity of constraints K1, K2*

*/*  
*"K\_G\_MODAL",*

*calculation of the modal coefficients of intensity of constraints*

*/*  
*"CALC\_G\_LAGR",*

*calculation of G with Lagrangian propagation*

*/*  
*"G\_BILINEAIRE",*

*calculation of the bilinear matrix G*

*/*  
*"CALC\_G\_MAX",*

*maximization of G under constraints terminals.*

#### **3.10.1 OPTION = "CALC\_G" [R7.02.01] and [R7.02.03]**

*It is the default option. It allows the calculation of the rate of refund of energy G by the method theta in 2D or 3D for a linear thermoelastic problem or not linear. In 3D, it is necessary to divide gross amount of G given by Aster by the length of the crack. In the same way into axisymmetric, it is necessary to divide by the ray into bottom of crack.*

#### **3.10.2 OPTION = "CALC\_K\_G" [R7.02.05]**



*This option allows the calculation of the coefficients of intensity of K1 constraints and K2 in thermoelasticity*

*linear planes (modeling C\_PLAN or D\_PLAN) by the method of the singular fields (use of the bilinear form of G). It also calculates the rate of traditional refund of energy G is too calculated.*

*If option "CALC\_K\_G" is used it is necessary to provide information on the bottom of crack by the operand*

*FOND\_FISS (cf [§11]).*

### **3.10.3 OPTION = "K\_G\_MODAL" [R7.02.05]**

*This option allows the calculation of the modal coefficients of intensity of constraints K1 and K2, i.e them*

*factors of intensity of the constraints associated with the clean modes with vibration with the structure.*

*Calculations are carried out in linear thermoelasticity planes (modeling C\_PLAN or D\_PLAN) by method of the singular fields (use of the bilinear form of G), starting from a structure of data RESULT of the mode\_meca type only. The rate of refund of energy G is too calculated.*

*If option "K\_G\_MODAL" is used it is necessary to provide information on the bottom of crack by the operand*

*FOND\_FISS (cf [§11]).*

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### **3.10.4 OPTION = "CALC\_G\_LAGR" [R7.02.04]**

*This option relates to only the propagation Lagrangienne [R7.02.04]. It is necessary to provide the value of propagation behind the key word **PROPAGATION**.*

### **3.10.5 OPTION = "G\_BILINEAIRE" [R7.02.01]**

*For a series of displacements ( $U, \dots, U$ ), this option allows the calculation of the bilinear form*

*I*

*N*

*$G(U, U$  for  $I J$ ; if  $I = J$  then  $G(U, U) = G(U)$ . The results are stored in a table*

*I*

*J)*

*comprising two indices  $I$  and  $J$  in reference to displacements  $U$  and  $U$  ordered in the list*

*I*

*J*

*contained in the structure of data result under the key word **RESULT**.*

**Caution:**

*This option of calculation is valid only for linear elastic designs where superposition of loading by linear combination is possible.*

### **3.10.6 OPTION = "CALC\_G\_MAX" [R7.02.05]**

*This option relates to only the maximization of  $G$  in 3D under constraints terminals [R7.02.05]. It is necessary to provide the value of the constraints terminals behind the key word*

## **TERMINALS, cf paragraph**

3.14.

### **3.11 Operand SENSITIVITY**

**SENSITIVITY = theta**

**Name of the significant parameter by report/ratio to which one derives (see [U4.50.02]).**

**With this operand one has access, in addition to the value of the rate of refund of energy such as it is provided with “CALC\_G”, with its derivative compared to a variation of field described by the field theta sensitivity (cf [§3.10]).**

**Its perimeter of application limits to linear thermoelastic calculations 2D, resting on complete or incomplete quadratic finite elements (SEG3, TRIA6, QUAD8 and QUAD9). They support various modelings (cf [§3.1]), loadings (cf [§3.5]) and states initial (cf [§3.9]) in pre-or postprocessings of mechanical calculation. The materials can be heterogeneous but they must be independent of the temperature.**

**Note:**

**The field of investigation of this option is related among that of option “CALC\_G\_LAGR”. In both cases one avoids expensive parametric studies by using a fixed grid of reference and by modelling the virtual variations of field by functions theta adapted.**

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*The field  $S = \theta$  is a field of vector 2D in each node of the grid. It is directed according to the x-axis. It is a concept of the type CHAM\_NO\_DEPL\_R. It can be affected directly with order AFFE\_CHAM\_NO [U4.44.11].*

*In practice, it results generally from specific order CALC\_THETA [U4.82.02] with the option THETA\_BANDE which makes it possible to seize the module (key word MODULATES) and the X-coordinates  $x1$  and  $x2$*

*(key word R\_INF and R\_SUP) of the points delimiting its vertical support. It is pointed out that this field decrease*

*value MODULATES with the zero value between the X-coordinates  $x1$  and  $x2$ , and that it is null everywhere else. These*

*X-coordinates can be negative but one must have  $x1 < x2$ .*

*y*

*Field S*

*sensitivity*

*Field F*

*fissure*

*X*

*$x1$*

*XX*

*2*

*2*

*Appear 3.11-a: Derived from G (F) compared to a variation of field controlled by S*

*Note:*

- Contrairement to the field  $\theta$  fissures which is just continuous and defined in the form of one first order polynomial, this field  $\theta$  is a combination of students'rag processions of third order and it are of safe C2 class in the middle of its support (where it is right C1).*
- Indeed, during the calculation of G one calls only upon the derived first of the field  $\theta$  fissure, whereas for obtaining his derivative one uses the derivative second  $\theta$  sensitivity. A compromise was thus found between the theoretical order required by derivations and precision of the finite elements modelling calculation. Thus it is necessary to have recourse with quadratic elements to estimate this derivative.*

### *3.12 Operand*

*FOND\_FISS*

*FOND\_FISS = fiss,*

*This key word is obligatory if one uses option "CALC\_K\_G". If not it is not used.*

*fiss is a concept of the fond\_fiss type resulting from order DEFI\_FOND\_FISS. It allows to recover the basic node of crack and the normal with the crack [U4.82.01].*

### **3.13 Operand PROPAGATION**

**PROPAGATION = alpha**

*This key word is obligatory if one uses option "CALC\_G\_LAGR". If not it is not used.*

*alpha is the value of the propagation [R7.02.04].*

### **3.14 Key word TERMINALS**

**TERMINALS**

=

*This key word factor is obligatory if one uses option "CALC\_G\_MAX". If not it is not used. It allows to define couples of constraints terminals (Q, q+*

*I*

*I) for each sequence number of structure of data result. One then seeks to define the combination of loading more penalizing in term of rate of refund D`energy:*

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**NR** **$\max_{I, j} G_{ij} = \max_{I, j} Q_{ij}$**  **$I, j$**  **$ij$**  **$G_{ij}$  where  $Q_{ij}$  are the NR associated unit loadings** **$Q_{ij}$**  **$I$**  **$I$**  **$I$**  **$I$**  **$I, j=1$** **with the various  $U_i$  displacements contained in the structure of data result, and** **$G = G(U, U$**  **$ij$**  **$I$**  **$J$ ) bilinear form of  $G$ .** **$NUME\_ORDRE = num$** **Sequence number in the structure of data result associated with the values of constraints terminals.** **$VALE\_MIN = qmin$** **Value minimal of the coefficient applied to the loading associated with the result stored in sequence number  $num$  of the structure of data resu.** **$VALE\_MAX = qmax$** **Value maximum of the coefficient applied to the loading associated with the result stored in sequence number  $num$  of the structure of data resu.****Note:****.****The user must as many give couples of terminals of sequence numbers contained in the structure of data result under penalty of fatal error.****.****This option of calculation is valid only for elastic designs linear where**

*superposition of loading by linear combination is possible.*

*An example of use of this option to maximize G in the presence of constraints signed and not signed is given in the 5.4.*

### **3.15 Operand**

**TITRATE**

**TITRATE = title**

**[U4.03.01].**

### **3.16 Operand**

**INFORMATION**

**INFORMATION**

**=  
/1,**

**[DEFECT]**

**/2,**

*Level of messages in the file "MESSAGE".*

*Note:*

*For option "CALC\_K\_G", if INFORMATION is worth 2, one generates calculation and the impression (in the file MESSAGE) of the angle of propagation of the crack. This angle, calculated according to 3 criteria (K1 or G maximum, minimal K2) according to the formulas of AMESTOY, BUI and DANG-VAN [R7.02.05 §2.5], is given with a margin of 10 degrees.*

### **3.17 Count**

**produced**

*Order CALC\_G\_THETA\_T generates a concept of the type counts. This one contains the rate of restitution of energy then possibly, according to the options, its derivative or factors of intensity of constraints.*

*Order IMPR\_TABLE [U4.91.03] makes it possible to print the results with the desired format.*

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***Date:***

***31/01/06***

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***4***

***Standardization of the total rate of refund G***

***4.1***

***2D forced plane and plane deformations***

***In dimension 2 (plane constraints and plane deformations), the bottom of crack is tiny room to a point and***

***the value G () resulting from order CALC\_G\_THETA\_T is independent of the choice of the field:***

***G = G (),***

***4.2 Axisymetry***

***Into axisymmetric it is necessary to standardize the value G () obtained with Aster:***

***l***

***G =***

***G ()***

***R***

***where R is the distance from the bottom of crack to the axis of symmetry [R7.02.01 §2.4.4].***

***4.3 3D***



*In dimension 3, the value of  $G()$  for a given field is such as:*

$G() =$   
 $( ) m ( )$   
 $G S S$   
 $S ds$   
 $O$

*In order CALC\_THETA [U4.82.02], the user defines the direction of the field in bottom of fissure. By defect, it is the normal at the bottom of crack in the plan of the lips. By choosing one unit field in the vicinity of the bottom of crack, one a:*

$(S) m (S) = 1$

*and:*  
 $G() =$   
 $( )$   
 $G S D$   
 $O$

*Either  $G$  the total rate of refund of energy, to have the value of  $G$  per unit of length, it is necessary to divide the value obtained by the length of the crack  $L$ :*

$I$   
 $G = G() \text{ in}$   
 $3D$   
 $L$

4.4

*Symmetry of the model*

*Not to forget to multiply by 2, values of the rate of refund of energy  $G$  or  $G(S)$  if one model that half of the solid compared to the crack (or to specify the key word SYME\_CHAR = "SYME" or "ANTI" in the orders concerned).*

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## ***5 Examples***

### ***5.1 Example of calculation of the rate of refund of energy (option “CALC\_G”) in 2D***

#### ***5.1.1 Calculation of G in linear elasticity***

***G1***  
***=***  
***CALC\_G\_THETA\_T***  
***(***  
***MODEL***  
***=***  
***Mo,***  
***CHAM\_MATER =***  
***chma,***  
***THETA***  
***=***  
***theta,***  
***DEPL***  
***=***  
***depl,***  
***EXCIT***  
***=***  
***\_F (LOAD***  
***=***  
***CH),)***

***One calculates the rate of refund of energy G on the model Mo, with the field of depl displacement solution of the elastic problem with:***

•  
*the material chma field produces by AFFE\_MATERIAU,*

•  
*the field theta produced by CALC\_THETA or AFFE\_CHAM\_NO,*

•  
*the CH load produced by order AFFE\_CHAR\_MECA or AFFE\_CHAR\_MECA\_F.*

*This example results from test SSLP101 [V3.02.101]. It is about a plate fissured in traction.*

*Appear 5.1.1-a: Plate fissured in traction*

*Appear 5.1.1-b: Half-plate fissured in traction*

*If one models only half of the plate as on [Figure 5.1.1-b] it should be added the key word:*

**SYME\_CHAR**

=

**“SYME”**

*to specify the symmetry of the loading compared to the crack. The values of G are thus multiplied automatically by 2.*

*To note that in this case key word EXCIT is not essential: indeed the loading of traction CH does not apply between the crowns Rinf and Rsup. On the other hand if there is a pressure on the lips of*

*the crack or a voluminal loading, it should be taken into account in the calculation of G.*

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### ***5.1.2 Calculation of G in nonlinear elasticity in 3D***

***G2***  
***= CALC\_G\_THETA\_T (RESULT = resu,***  
***TOUT\_ORDRE=***  
***“YES”,***  
***THETA***  
***=***  
***theta,***  
***COMP\_ELAS***  
***=***  
***\_F (RELATION=' ELAS\_VMIS\_TRAC'),)***

***One calculates the rate of refund of energy G. The model, the field material and the loads are recovered in the structure of data resu, resulting from STAT\_NON\_LINE. The rate of refund of energy is calculated at every moment of calculation of the nonlinear elastic problem.***

***The relation of behavior is elastic nonlinear of von Mises with isotropic work hardening.***

***For other examples in 3D one will be able to refer to the tests:***

***SSLV110 [V3.04.110] semi-elliptic Crack in infinite medium***  
***SSLV112 [V3.04.112] circular Crack in infinite medium***  
***HPLV103 [V7.03.103] Thermoelasticity with circular crack in infinite medium***

### ***5.1.3 Calculation of G in great transformations***

***G3***  
***= CALC\_G\_THETA\_T (MODEL***  
***= Mo,***  
***RESULT***  
***=***  
***resu,***  
***INST***  
***=***  
***(1.,***  
***2.,***  
***3.),***  
***CHAM\_MATER=***  
***chma,***

**THETA**  
=  
**theta,**  
**EXCIT**

=  
  
\_F (  
**CHARGE**

=  
**CH,**  
**FONC\_MULT**  
= *fmult*,)  
**COMP\_ELAS**

=  
\_F (  
**RELATION**  
= "ELAS"  
),  
**DEFORMATION**  
=  
"GREEN"),)

*One calculates the rate of refund of energy G for 3 moments of a nonlinear calculation into large transformations starting from a concept resu resulting from STAT\_NON\_LINE. The coherence of the model Mo, of field of material chma and the excitation ch/fmult with the information contained in structure of data resu is checked.*

*The relation of behavior is elastic "linear" (the relation between the deformations and them constraints is linear) but the behavior of the solid is hyperelastic (DEFORMATION = "GREEN"). For more precise details to refer to [R7.02.03 §2.1].*

## 5.2

*Example of use of option "CALC\_K\_G"*

**y**  
**N**  
**N01**  
**X**

*Appear 5.2-a: Calculation of the stress intensity factors.*

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**my**

**=  
LIRE\_MAILLAGE**

**( )**

**Mo**

**=  
AFFE\_MODELE**

**(  
GRID = my,**

**AFFE**

**=\_F (**

**ALL**

**=**

**“YES”,**

**PHENOMENON**

**= ' MECANIQUE',**

**MODELING**

**=**

**“D\_PLAN”))**

**theta**

**= CALC\_THETA (MODEL**

**=**

**Mo,**

**THETA\_2D**

**=\_F (**

**NODE**

= "NOI",  
**MODULATE**  
=  
**1.**,  
**R\_INF**  
=  
**2.0**,  
**R\_SUP**  
=  
**3.0**),  
**DIRECTION**  
=  
**(1.**  
**0.)**),  
  
**FF**  
=  
**DEFI\_FOND\_FISS**  
(  
**NODE**  
=  
**"N01"**,  
**NORMAL =**  
**(0.**  
**1.)**),  
  
**G4**  
=  
**CALC\_G\_THETA\_T**  
(  
**MODEL**  
=  
**Mo**,  
**DEPL**  
=  
**depl**,  
**CHAM\_MATER =**  
**chma**,  
**THETA**  
=  
**theta**,  
**EXCIT**  
=  
=

```

_F (LOAD
=
CH),
SYME_CHAR
=
"SYME",
FOND_FISS
=
FF,
OPTION
=
"CALC_K_G"
INFORMATION = 2,)

IMPR_TABLE (TABLE
= G4)

```

*One calculates the stress intensity factors  $K1$  and  $K2$  on the model  $M_0$ , with displacement depl solution of the elastic problem with:*

- .  
*the material chma field produces by  $AFFE\_MATERIAU$ ,*
- .  
*the CH load produced by order  $AFFE\_CHAR\_MECA$ .*

*One recovers the basic node of  $N01$  crack and the normal with the crack by the concept  $fond\_fiss$ .  
One specify that the total loading is symmetrical compared to the crack thanks to the key word  $SYME\_CHAR$ .*

*Order  $IMPR\_TABLE$  makes it possible to print in the file  $RESULT$  the various sizes calculated with option  $CALC\_K\_G$ , namely the rate of refund of energy  $G$ , factors of intensity constraints  $K1$  and  $K2$ , and  $G\_IRWIN$ , rate of refund of energy obtained starting from the formula of Irwin:*

```

1
G _ IRWIN =
(2
2
K + K
1
2 )
plane

```



**S**  
**constraint**  
**in**  
**E**  
**2**  
**1-**

**G\_IRWIN =**  
**(2**  
**2**  
**K + K**  
**1**  
**2 )**  
**plane**

**NS**  
**déformatio**  
**in**  
**E**

*with E modulus Young and Poisson's ratio. The comparison between G and G\_IRWIN allows to ensure itself of the coherence of the results.*

*As INFORMATION is worth 2, the angle of propagation of the crack is also calculated, and the result is printed in the file MESSAGE with the following format:*

*Basic node of crack: N01*

*Co-ordinates of the basic node of crack: 0. 0.*

*Co-ordinates of the normal to the crack: 0. 1.*

**K1**  
**K2 G**  
**(IRWIN)**  
**2.14364E+01 0.0000E+00 1.14880E03**

**Rate of refund of energy G: 1.14907E03**

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**Direction of the deviation of the crack (in degrees):**

**According to the maximum K1 criterion**

**: 0 with K1 max**

**: 2.14364E+01**

**According to null the K2 criterion**

**: 0 with null K2**

**: 0.0000E+00**

**According to the maximum criterion G**

**: 0 with Gmax**

**: 1.1488E03**

**From the stress intensity factors K1 and K2, one can indeed calculate the K1\* coefficients and K2\* corresponding to a propagation of crack given (according to work of AMESTOY, BUI and DANG-VAN [R7.02.05 §2.5]).**

**The direction of the deviation of the crack is calculated according to these results and according to 3 K1\* criteria maximum, null K2\* and maximum G\*. The angle of propagation, given in degree, is calculated compared to prolongation of the crack.**

**y**

**X**

**Appear 5.2-b: Angle of propagation**

**Note:**

•  
*For a thermal loading, coefficients characteristic of the material (E,...) must be independent of the temperature.*

•  
*Attention with the orientation of the normal to the crack.*

*1*  
*+ 2*  
*N*  
*2*

*Appear 5.2-c: Orientation of the normal to the crack*

*For other examples one will be able to refer to the tests:*

*HPLP100 [V7.02.100] Plate fissured in thermoelasticity*

*SSLP103 [V3.02.103] fissured circular Plate*

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*5.3 Example of calculation of derived from the rate of refund of energy for a variation of field*

*Let us preserve the same configuration that at the preceding paragraph and calculate this time the derivative of*

*G (F) compared to the variation of field controlled by S.*

**y** *Field S*  
*sensitivity*  
**Field F**  
*fissure*  
**X**  
**NI**  
**xI**  
**X**  
**X**  
**2**  
**2**

*Appear 5.3-a: Derived from G (F) compared to a variation of field controlled by S*

*After having built the models Mo and moth in modeling “D\_PLAN” and the field theta sensitivity S (thetas), via key word THETA\_BANDE of CALC\_THETA, one affects loadings thermics of the temperatures type imposed on the flat rims and left of the structure. Then, one carry out the thermal calculation itself which uses thetas (provided via the key word SENSITIVITY) to calculate the field of temperature and its Lagrangian derivative.*

*Note:*

*The calculation of sensitivity in thermics is restricts with the linear 2D, stationary case or transient, with voluminal sources and conditions of imposed temperature, flow normal imposed and of convectif exchange. Conditions of exchange between wall and of radiation are not taken yet into account [R4.03.01] [U4.54.01].*

*The finite elements supporting the grid must be quadratic.*

**Mo**  
**=**  
**AFFE\_MODELE**  
**(**  
**GRID = my,**  
**AFFE**  
**=\_F (**  
**ALL**  
**=**  
**“YES”,**  
**PHENOMENON**  
**= ' MECANIQUE',**  
**MODELING**

=  
"D\_PLAN"),)

*moth*

=  
AFFE\_MODELE

(  
GRID = my,  
AFFE  
= \_F (  
ALL

=  
"YES",  
PHENOMENON  
= ' THERMIQUE',  
MODELING

=  
"PLANE"),)

*thetas*

= CALC\_THETA (MODEL

=  
Mo,  
OPTION

=  
"BAND",  
THETA\_BANDE

=  
\_F (  
MODULATE =

1.,  
R\_INF

=  
X1,  
R\_SUP

=  
X2),)

*chther* = AFFE\_CHAR\_THER (  
MODEL

=  
*moth*,  
TEMP\_IMPO

=

**\_F**  
**(GROUP\_NO**  
**=**  
**“bordd”,**  
**TEMP**  
**=-100)**  
**TEMP\_IMPO**

**\_F**  
**(GROUP\_NO**  
**=**  
**“bordg”,**  
**TEMP**  
**=**  
**100))**

**resth=**  
**THER\_LINEAIRE (**  
**MODEL**  
**=**  
**moth,**  
**SENSITIVITY**  
**=**  
**thetas,**  
**CHAM\_MATER**  
**=**  
**cmth,**  
**EXCIT**  
**=**  
**(LOAD**  
**=**  
**chther),)**

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***Before carrying out thermomechanical calculation, one affects a pressure distributed on the higher edge.***

***This loading, just like the calculated temperature, is used in the totality of the process of sensitivity, contrary to the loadings of gravity and the later initial deformations. These the last will intervene only in postprocessing of the calculation of mechanics.***

**Caution:**

***With such a taking into account of the loadings, the user is only responsible for the interpretation of the results.***

***To be fully usable, the calculation of the sensitivity of G will have to be extended to principal loadings for all the process.***

***The calculation of sensitivity in mechanics is restricted, for the moment, with linear case D\_PLAN or AXIS with conditions limit uniform imposed displacement types, connections and external pressure [R4.03.01] [U4.51.01].***

```
chmeca= AFFE_CHAR_MECA (  
MODEL  
=  
Mo,  
TEMP_CALCULEE  
=  
resth,  
DDL_IMPO  
=  
_F  
(GROUP_MA=' bordi', DY  
=  
0),  
PRES_REP  
=  
_F
```

(GROUP\_MA=' bords', NEAR  
=100),)

resme=  
MECA\_STATIQUE (  
MODEL  
=  
Mo,  
SENSITIVITY  
=  
thetas,  
CHAM\_MATER  
=  
cm,  
EXCIT  
=  
\_F  
(LOAD  
=  
chmeca))

a1  
=  
1.E-8  
a2  
=  
2.E-6  
a3  
=  
5.E-2

FONC1 = FORMULA (NOM\_PARA = ("X", "Y"), VALE = "a1\*(X \*\* 2) +a2\*Y+a3")

FONC2 = FORMULA (NOM\_PARA = ("X", "Y"), VALE = "a1\*(Y \*\* 2) +a2\*X+a3")

FONC3 = FORMULA (NOM\_PARA = ("X", "Y"), VALE = "a1\*(X\*Y) +a3")

f=  
AFFE\_CHAR\_MECA\_F (MODEL  
=  
Mo,  
GRAVITY  
=  
(10.



```

0.
-1.
0.),
EPSI_INIT
=
_F
(
ALL = "YES",
EPXX
=
fonc1,
EPYY
=
fonc2,
EPXY
=
fonc3))

```

*As in the preceding examples one builds the field theta fissures F (thetaf) which will play it role of a function test during the calculation of the integral of the rate of refund of energy G (F) while delimiting the zone of calculation centered around the N1 point.*

```

thetaf
= CALC_THETA (MODEL
=
Mo,
THETA_2D
= _F (
NODE
= "N1",
MODULATE
=
1.,
R_INF
=
r1,
R_SUP
=
r2,)
DIRECTION
=
(1.

```

0.  
0.),)  
  
G5  
=  
CALC\_G\_THETA\_T  
(  
MODEL  
=  
Mo,  
RESULT  
=  
resme,  
SENSITIVITY  
=  
thetas,  
CHAM\_MATER =  
chma,  
THETA  
=  
thetaf,  
EXCIT  
  
=  
(\_F (LOAD =  
chmeca),  
\_F (LOAD  
= F)),  
SYME\_CHAR  
=  
"SYME",  
COMP\_ELAS  
=  
\_F (RELATION  
=  
"ELAS",  
  
DEFORMATION  
=  
"SMALL"),

)

*For other examples in D\_PLAN one will be able to refer to case-test HPLP100B [V7.02.100]. One y will find in particular examples of sequences of CREA\_CHAMP allowing to build analytical stress fields and to relocate a grid (in order to simulate a difference finished in variation of field).*

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#### **5.4 Maximization of G in the presence of constraints not signed with option "CALC\_G\_MAX"**

*The purpose of this example is to specify how to maximize the rate of refund of energy for one linear problem with at the same time of the constraints signed (actual weight, internal pressure) and of constraints which one does not know the sign a priori (seism). The studied problem is in modeling 3D, with a linear elastic behavior. The contact on the lips of the crack is not made in count.*

*Let us suppose for example, that in addition to the boundary conditions of blocking CHCL, there is a loading of pressure signed not signed CHPRESS, and two loadings applying to groups of meshes distinct from the model, CH\_NS1 and CH\_NS2:*

```
CHCL=AFFE_CHAR_MECA (MODELE=MO,
DDL_IMPO= (_F (GROUP_NO = "SSUP_S", DZ = 0.),
_F (GROUP_NO = "SLAT_S", DX = 0.),
_F (GROUP_NO = "SAV_S", DY = 0.),),)
```

```
CHPRES=AFFE_CHAR_MECA (MODELE=MO,
PRES_REP=_F (GROUP_MA = "SINF", CLOSE = -1.E6),)
```

```
CH_NS1=AFFE_CHAR_MECA (MODELE=MO,
FORCE_NODALE=_F (GROUP_NO = "SLAT", FZ = 1540),)
```

```
CH_NS2=AFFE_CHAR_MECA (MODELE=MO,
FORCE_NODALE=_F (GROUP_NO = "SINF", FX = 2100),)
```

*One calculates the solution of the problem associated with each one of these loadings while defining multiplying functions:*

```
F0=DEFI_FONCTION (NOM_PARA=' INST',
PROL_GAUCHE=' LINEAIRE',
PROL_DROITE=' CONSTANT',
VALE= (1. , 1. , 2. , 0. ,
3., 0., ),)
```

```
F1=DEFI_FONCTION (NOM_PARA=' INST',
PROL_GAUCHE=' LINEAIRE',
PROL_DROITE=' CONSTANT',
VALE= (1. , 0. , 2. , 1. ,
3., 0., ),)
```

```
F2=DEFI_FONCTION (NOM_PARA=' INST',
PROL_GAUCHE=' LINEAIRE',
PROL_DROITE=' CONSTANT',
VALE= (1. , 0. , 2. , 0. ,
3., 1., ),)
```

```
LIST=DEFI_LIST_REEL (DEBUT=0.E+0,
INTERVALLE=_F (JUSQU_A = 3. , A NUMBER = 3),)
```

```
RESU=MECA_STATIQUE (MODELE=MO,
CHAM_MATER=CHMAT,
EXCIT= (_F (LOAD = CHCL),
_F (LOAD = CHPRES, FONC_MULT = F0),
_F (LOAD = CH_NS1, FONC_MULT = F1),
_F (LOAD = CH_NS2, FONC_MULT = F2)),)
```

```
LIST_INST
=
LIST,)
```

*One defines the bottom of crack and the crown  $\theta$  for the calculation of G:*

```
FOND=DEFI_FOND_FISS (MAILLAGE=MA,
FOND_FISS=_F (GROUP_MA = "LFF"),
NORMALE= (0. , 0. , 1. , ),)
```

*DTAN\_ORIG= (1. , 0. , 0. ),*

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*DTAN\_EXTR= (0. , 1. , 0. ),)*

*THETA=CALC\_THETA (MODELE=MO,*

*FOND\_FISS=FOND,*

*THETA\_3D=\_F (ALL = "YES",*

*MODULATE = 1. ,*

*R\_INF = 0.2,*

*R\_SUP = 0.5),)*

*The maximization of G is done by option CALC\_G\_MAX of CALC\_G\_THETA\_T (G total) or of CALC\_G\_LOCAL\_T (G local). The coefficient of the signed loading is worth 1, the coefficients of not signed loadings vary between 1 and 1:*

*G\_MAX=CALC\_G\_THETA\_T (THETA=THETA,*

*RESULTAT=RESU,*

*BORNES= (\_F (NUME\_ORDRE = 1,*

*VALE\_MIN = 1. , VALE\_MAX = 1.),*

*\_F (NUME\_ORDRE = 2,*

VALE\_MIN = -1. , VALE\_MAX = 1.),  
 \_F (NUME\_ORDRE = 3,  
 VALE\_MIN = -1. , VALE\_MAX = 1.),),  
 OPTION=' CALC\_G\_MAX',)

IMPR\_TABLE (TABLE = G\_MAX)

GL\_MAX=CALC\_G\_LOCAL\_T (RESULTAT=RESU,  
 FOND\_FISS=FOND,  
 R\_INF=0.2,  
 R\_SUP=0.5,  
 BORNES= (\_F (NUME\_ORDRE = 1,  
 VALE\_MIN = 1. , VALE\_MAX = 1.),  
 \_F (NUME\_ORDRE = 2,  
 VALE\_MIN = -1. , VALE\_MAX = 1.),  
 \_F (NUME\_ORDRE = 3,  
 VALE\_MIN = -1. , VALE\_MAX = 1.),),  
 OPTION=' CALC\_G\_MAX',)

IMPR\_TABLE (TABLE = GL\_MAX)

The table produced by CALC\_G\_THETA\_T is as follows:

#ASTER 8.02.01 CONCEPT GMAX CALCULATES THE 21/12/2005 A 15:49: 17 OF TYPE

#TABL\_CALC\_G\_TH

Q\_1 Q\_2 Q\_3 G G\_MAX

1.00000E+00	1.00000E+00	-1.00000E+00	3.91703E+03	3.91703E+03
1.00000E+00	1.00000E+00	-1.00000E+00	3.91703E+03	3.91703E+03
1.00000E+00	-1.00000E+00	-1.00000E+00	3.63507E+03	-
1.00000E+00	-1.00000E+00	-1.00000E+00	3.63507E+03	-
1.00000E+00	-1.00000E+00	1.00000E+00	2.92029E+03	-
1.00000E+00	-1.00000E+00	1.00000E+00	2.92029E+03	-
1.00000E+00	1.00000E+00	1.00000E+00	2.68007E+03	-
1.00000E+00	1.00000E+00	1.00000E+00	2.68007E+03	-

Thus, the maximum rate of refund is obtained for the combination of the loading of pressure with CH\_NS1 with a sign “+” and CH\_NS2 with a sign “-”.

For other examples, one can refer to the case test SSLV134E/F [V3.04.134].

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*Organization (S): EDF-R & D /AMA*

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***Document: U4.82.04***

***Operator CALC\_G\_LOCAL\_T***

***1 Goal***

***To calculate the rate of refund of energy room and - under certain conditions factors of intensity of constraints in 3D by the method théta.***



*This operator allows calculation in breaking process of the rate of refund of energy room function of the curvilinear X-coordinate on the bottom of crack G (S) in 3D by the method in the case of one linear thermoelastic problem or not linear [R7.02.01] and [R7.02.03]. The problem can be is statics, is dynamic [R7.02.02].*

*This operator also allows the extraction of the stress intensity factors function of the curvilinear X-coordinate of the bottom of crack K1 (S), K2 (S), K3 (S) in 3D by the method coupled with method XFEM in the case of a linear elastic problem [R7.02.12].*

*Before a first use, it is advised to refer to the council and reference documents of correspondents use, in particular the document [U2.05.01].*

*Functionalities concerning the rate of refund of energy room with Lagrangian propagation (i.e. for an extension of the crack by using the same grid) in 3D in the case of one linear thermoelastic problem are described in the document [R7.02.04].*

*The operator produces a concept of the type counts.*

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*2 Syntax*

*[tabl\_\*]*

*=*

**CALC\_G\_LOCAL\_T**

(  
**MODEL**  
=  
**Mo,**  
**[model]**

**CHAM\_MATER = to subdue,**  
**[cham\_mater]**

**/FOND\_FISS**  
**= FF,**  
**[fond\_fiss]**  
**/**  
**FISSURE =**  
**fiss,**  
**[fiss\_xfem]**

*# recovery of the field of displacements*

**/**  
**DEPL**  
**=**  
**depl,**  
**[cham\_no\_DEPL\_R]**  
**/**  
**QUICKLY = quickly,**  
**[cham\_no\_DEPL\_R]**  
**ACCE = acce,**  
**[cham\_no\_DEPL\_R]**

/  
*RESULT*  
=  
*resu,*  
/  
*[evol\_elas]*  
/  
*[evol\_noli]*  
/  
*[dyna\_trans]*  
  
/  
*[mode\_meca]*

*/TOUT\_ORDRE = "YES",*  
*[DEFECT]*  
/  
*NUME\_ORDRE =*  
*l\_ordre,*  
*[l\_I]*  
/  
*LIST\_ORDRE =*  
*read*  
  
*,*  
*[listis]*  
/  
*INST*  
=  
*l\_inst, [l\_R8]*  
/  
*LIST\_INST*  
=  
*l\_reel, [listr8]*

*/ PRECISION*

*=/prec*

/

*1.0D-6*

*[DEFECT]*

| *CRITERION =/"RELATIVE", [DEFECT]*

/

*"ABSOLUTE"*

,

*# loading*

*EXCIT = (\_F (LOAD = load*

*, [char\_meca]*

*[char\_cine\_meca]*

*FONC\_MULT = fmult,*

[function]

[formula]

),)

*SYME\_CHAR*

=

/

“WITHOUT”

,

[DEFECT]

/

“SYME”,

/

“ANTI”,

# *behavior*

*/COMP\_ELAS*

=\_F

(

*RELATION*

=

/

“ELAS”, [DEFECT]

/

“ELAS\_VMIS\_LINE”,

/

“ELAS\_VMIS\_TRAC”,

DEFORMATION =/“SMALL”, [DEFECT]

/

“GREEN”,

/ALL = “YES”,

[DEFECT]

/| GROUP\_MA

=

lgrma,

[l\_gr\_maille]

/ NET

= lma

,

[l\_maille]

),  
/  
*COMP\_INCR*  
=*\_F*  
(

*RELATION*  
=  
/  
“*ELAS*”, [*DEFECT*]  
/  
“*VMIS\_ISOT\_TRAC*”,  
/  
“*VMIS\_ISOT\_LINE*”,

*DEFORMATION* =/“*SMALL*”, [*DEFECT*]  
/  
“*PETIT\_REAC*”,

/ *ALL* = “*YES*”,  
[*DEFECT*]

/| *GROUP\_MA*  
=  
*lgrma*,  
[*l\_gr\_maille*]

/ *NET*  
= *lma*  
,  
[*l\_maille*]

),  
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***ETAT\_INIT***

= *\_F*

(



*/DEPL = depl,  
[cham\_no\_DEPL\_R]*

*/SIGM =  
sigm,  
/  
[carte\_SIEF\_R]  
/  
[cham\_elem\_SIEF\_R]*

*),  
# option requested: - calculation of G (S) traditional  
-  
calculation  
of  
G (S)  
with  
propagation  
Lagrangian*

*OPTION  
=  
/  
"CALC\_G",  
[DEFECT]  
#  
/"CALC\_K\_G",  
#  
/"K\_G\_MODAL"*

,  
#  
/  
"CALC\_G\_LGLO",

*PROPAGATION*

=  
*alpha*,  
[R]

*THETA*

=  
*theta*,  
[theta\_geom]

*DIRE\_THETA* = *dire\_theta*, [cham\_no\_DEPL\_R]

#  
/  
"G\_BILINEAIRE",  
#  
/  
"CALC\_G\_MAX"

,

*BORNES = \_F*  
(

*NUME\_ORDRE =*  
*num, [I]*

*VALE\_MIN*  
=  
*qmin*  
,  
*[R]*

*VALE\_MAX*  
=  
*qmax*

,

[R]

),

*# method used for the discretization of in bottom of crack*

*/LISSAGE\_THETA*

=

/

*“LEGENDRE”,*

*[DEFECT]*

/

*“LAGRANGE”,*

/

*LISSAGE\_G*

=

/

*“LEGENDRE”,*

*[DEFECT]*

/

*“LAGRANGE”,*

/

*“LAGRANGE\_NO\_NO”,*

*# degree of the polynomials of Legendre*

*DEGREE =/0,*

*/ 1,*

*/ 2,*

*/ 3,*

*/ 4,*

*/*

*5,*

*[DEFECT]*

*/ 6,*

/ 7,  
# lower rays and superiors defining the crowns

/  
 $R_{INF}$   
=  
 $R$   
, $[R]$

$R_{SUP}$   
=  
 $R$   
, $[R]$

/  
 $R_{INF\_FO}$   
=  
 $r_z$   
, $[function, formula]$

$R_{SUP\_FO}$   
=  
 $R_z$   
, $[function, formula]$

# *titrates*

*TITRATE*

=

*titrate,*

*[l\_Kn]*

# *impression*

*information*

*INFORMATION =/1,*

*[DEFECT]*

*/2,*

)

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### **3 Operands**

#### **3.1 Operand MODEL**

**MODEL =  
Mo**

**Mo is the name of the model on which the rate of refund of energy room G (S) is calculated. It is product by order AFFE\_MODELE [U4.41.01].**

**The name of the model is:**

- Facultatif if the field of displacement is given with the key word RESULT and if structure of data resu is of type EVOL\_ELAS, EVOL\_NOLI:**
  - if the name of the model misses, the operator takes that which is present in structure of data resu;**
  - if the name of the model is provided by the user, the operator checks if it is identical to that present in the structure of data resu, the contrary case an error fatal is emitted.**
- Obligatoire in all the other cases.**

**The calculation of the rate of refund of energy G (S) does not have a direction and is thus authorized only for modeling 3D.**

**This modeling corresponds to hexahedrons with 8, 20 or 27 nodes, pentahedrons with 6 or 15 nodes, of the tetrahedrons with 4 or 10 nodes, of the pyramids with 5 or 13 nodes, of the faces with 3, 4, 8 or 9 nodes.**

#### **3.2 Operand CHAM\_MATER**

**CHAM\_MATER =  
to subdue**

**to subdue is the field of material generated by order AFFE\_MATERIAU [U4.43.03].**

**The name of the material field is:**

- Facultatif if the field of displacement is given with the key word RESULT and if**



*structure of data resu is of type EVOL\_ELAS, EVOL\_NOLI:  
if the name of the material field misses, the operator takes that which is present  
in the structure of data resu;  
if the name of the material field is provided by the user, the operator checks if it is  
identical to that present in the structure of data resu. In the contrary case,  
an alarm is emitted and calculation continues with the material field provided by  
the user.  
· Obligatoire in all the other cases.*

*The material field makes it possible to recover the characteristics of material:*

*·  
YOUNG modulus E,*

*·  
NAKED Poisson's ratio,*

*·  
thermal dilation coefficient ALPHA (for a thermomechanical problem),*

*·  
elastic limit SY (for a nonlinear elastic problem),*

*·  
slope of the traction diagram D\_SIGM\_EPSI (for a nonlinear elastic problem  
with linear isotropic work hardening), or traction diagram.*

*These characteristics can depend on the geometry and the temperature for the option  
“CALC\_G” only.*

*Characteristics SY and D\_SIGM\_EPSI are treated only for one elastic problem not  
linear with work hardening of von Mises and the option of calculation “CALC\_G”.*

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***Problem of the bimatériau:***

***1st case: There is a bimatériau but the point of crack is in only one material.***

***material 1***

***R***

***E***

***R***

***1, 1, 1***

***material 2***

***E2, 2, 2***

***If one is assured that the crown, definite enters the rays inferior R and higher R (order CALC\_THETA [U4.82.02]), has like support of the elements of same material, calculation is possible some is the selected option. If not only option "CALC\_G" is possible.***

***2nd case: There is a bimatériau where the point of crack is with the interface.***

***material 1***

***E1, 1, 1***

***R***

***R***

***material 2***

***E2, 2, 2***

***To date, only the option of calculation of the rate of refund of energy (option "CALC\_G") is available.***

### ***3.3 Operands***

***FOND\_FISS/CRACK***

***/FOND\_FISS***

***= FF,***

***FF is the bottom of crack defined by order DEFI\_FOND\_FISS [U4.82.01]. It allows to recover:***

.

*the ordered list of the nodes of the bottom of crack,*  
.  
*meshes of the lips of the crack or the normal with the crack,*  
.  
*directions of propagation of the bottom of crack at the ends.*

*It is starting from these entities that are calculated automatically the curvilinear X-coordinates S and directions of propagation of the bottom of crack in each node [R7.02.01 §2.2]. This word key is obligatory, except if OPTION = "CALC\_K\_G" or "K\_G\_MODAL".*

*/CRACK = fiss,*

*fiss is the crack defined by order DEFI\_FISS\_XFEM [U4.82.08]. It allows to recover within the framework of method X-FEM:*

.  
*the ordered list of the points of the bottom of crack,*  
.  
*gradients of the level-sets,*  
.  
*the local base at the bottom of crack*  
.  
*the statute of the nodes (enrichment or not) and numbers of the enriched meshes.*

*These entities contain in particular the curvilinear X-coordinates S and the directions of propagation of the bottom of crack in each node. This word is obligatory only in case where OPTION = "CALC\_K\_G" or "K\_G\_MODAL".*

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### **3.4 Operands**

#### **DEPL/QUICKLY/ACCE/RESULT**

*These operands make it possible to recover the field of displacement (and speed and acceleration for a calculation in dynamics) starting from a field with the nodes or extract of a result.*

#### **3.4.1 Operand**

##### **DEPL**

*/DEPL = `depl`*

*depl is a field with the nodes solution of calculation on Mo.*

#### **3.4.2 Operand**

##### **QUICKLY/ACCE**

*/QUICKLY = `quickly`*

*ACCE = `acce`*

*quickly and acce is respectively a field speed and a field of acceleration. It is fields with the nodes solution of a dynamic calculation on Mo.*

*These two operands must be simultaneously present to calculate the rate of refund energy into elastodynamic [R7.02.02].*

#### **3.4.3 Operand**

##### **RESULT**

*/RESULT = `resu`*

*Name of a concept result of the `evol_elas` type, `evol_noli`, `mode_meca` or `dyna_trans`.*

#### **3.4.3.1 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/INST/LIST\_INST/PRECISION/CRITERION**

*See document [U4.71.00].*

### **3.5 Word**

**key**

## ***EXCIT and operands CHARGE/FONC\_MULT***

***EXCIT = \_F (LOAD  
= load***

***FONC\_MULT = fmult)***

***Key word EXCIT makes it possible to recover a list of loadings charges, resulting from the orders Multiplying AFFE\_CHAR\_MECA or AFFE\_CHAR\_MECA\_F [U4.44.01], and coefficients fmult.***

***Key word EXCIT is optional.***

***If displacements are provided by the key word RESULT and that the structure of data resu is of type EVOL\_ELAS, EVOL\_NOLI the loading taken into account is is that provided by the user, that is to say that extracted from resu if it misses order. If the loading provided in resu (coherence of the name and the number of loads is different from that present, of couples load-function), an alarm is emitted and calculation continues with the loading indicated by the user.***

***In all the cases, it should be taken care that the loads indicated here were indeed taken into account in the preceding mechanical calculation which produced the field of displacements.***

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*The loadings taken into account in the calculation of G are as follows:*

*Loading*  
*Options*  
*Modeling*  
*key word of*  
*AFFE\_CHAR\_MECA (\_F)*

*CALC\_G*  
*3D*  
*TEMP\_CALCULEE*  
*CALC\_K\_G*  
*FORCE\_INTERNE*  
*K\_G\_MODA*  
*PRES\_REP*  
*G\_BILINEAIRE*  
*FORCE\_FACE*  
*CALC\_G\_MAX*  
*GRAVITY*  
*ROTATION*  
*Note:*

*The loadings not supported by an option are ignored. To date, loadings following being able to have a direction in breaking process is not treated:*

*·*  
*FORCE\_NODALE*  
*·*  
*FORCE\_ARETE*  
*·*  
*EPSI\_INIT*  
*·*  
*DDL\_IMPO on the lips of the crack*  
*·*  
*FACE\_IMPO*

*It is important to note that the only loadings taken into account in a calculation of mechanics rupture with the method are those supported by the elements inside the crown (between Rinf and Rsup [R7.02.01 §3.3]). Only types of load likely to influence it calculation of G are thus the voluminal loadings (gravity, rotation), a field of*

*nonuniform temperature or of the efforts applied to the lips of the crack.*

**Caution:**

•  
*A loading of comparable nature (for example voluminal force) can appear only in only one load. In the contrary case, calculation finishes in error.*

•  
*It is not possible to date to associate a load defined as a function (AFFE\_CHAR\_MECA\_F) and a multiplying coefficient (FONC\_MULT). In this case, it calculation finishes in error.*

•  
*If one makes a calculation in great transformations (key word DEFORMATION = “GREEN” under the key word factor COMP\_ELAS) the supported loadings must be loads died, typically an imposed force and not a pressure [R7.02.03 §2.4].*

•  
*For option CALC\_K\_G, if a loading is imposed on the lips of the crack (PRES\_REP or FORCE\_CONTOUR), then it is obligatorily necessary to direct them correctly meshes of those (by using ORIE\_PEAU\_3D) before the calculation of K.*

### **3.6 Operand SYME\_CHAR**

**SYME\_CHAR**  
 =/“WITHOUT”  
 , [DEFECT]  
 /  
 “SYME”  
 ,  
 /  
 “ANTI”  
 ,

*This key word makes it possible to indicate if the loading is symmetrical or antisymmetric if one model that half of the solid compared to the crack. The values of G (S) are then automatically multiplied by 2.*

### **3.7 Word key COMP\_ELAS**

**COMP\_ELAS**  
 =

*This key word factor makes it possible to define the relation of behavior of material used for it postprocessing of breaking process.*

*By defect the relation of behavior is elastic linear in small deformations with characteristic defined in CHAM\_MATER.*

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*Note:*

- The calculation of the rate of refund of energy  $G$  or not has direction only in linear elasticity lineaire (COMP\_ELAS). It is however possible to calculate in elastoplasticity (COMP\_INCR) a parameter  $G$  then defined as the total flow of energy (plasticity and rupture) through the defect. In the case of elastoplasticity, the defect must be modelled by a notch.*
- Nothing prohibits to affect a behavior different during calculation from displacements (by elastoplastic example) then to carry out this postprocessing with another relation (by non-linear elastic example). The user is responsible for interpretation for results obtained [R7.02.03].*
- If the loading is perfectly radial monotonous, calculations in nonlinear elasticity and in elastoplasticity lead to the same results. For this type of loading (and only in this case), it is also possible to make an elastoplastic calculation on a crack.*

*For more precise details, to refer to [U2.05.01].*

### *3.7.1 Operand*



**RELATION****RELATION**

=

/

**“ELAS”**

*Relation of elastic behavior linear i.e. the relation between the deformations and the constraints considered is linear [R7.02.01 §1.1].*

/

**“ELAS\_VMIS\_LINE”**

*Relation of nonlinear elastic behavior, von Mises with isotropic work hardening linear. The data materials necessary of the field material are provided in operator **DEFI\_MATERIAU** (cf the operator **STAT\_NON\_LINE** [U4.51.03] and the key word **VMIS\_ISOT\_LINE**) [R7.02.03 §1.1] and [R5.03.20].*

/

**“ELAS\_VMIS\_TRAC”**

*Relation of nonlinear elastic behavior, von Mises with isotropic work hardening not linear. The data materials necessary of the field material are provided in operator **DEFI\_MATERIAU** (cf the operator **STAT\_NON\_LINE** [U4.51.03] and the key word **VMIS\_ISOT\_TRAC**) [R7.02.03 §1.1] and [R5.03.20].*

**3.7.2 Operand****DEFORMATION****DEFORMATION =**

/

**“SMALL”**

*The deformations used in the relation of behavior are the linearized relations:*

(

**1****U)****ij**

=

**(iu J + uj I)****2**

,

,

/  
“GREEN”

*The deformations used in the relation of behavior are the deformations of Green-Lagrange [R7.02.03 §2.1]:*

$$\begin{aligned} & ( \\ & \mathbf{1} \\ & \mathbf{U}) \\ & \mathbf{ij} \\ & = \\ & (\mathbf{iu J} + \mathbf{uj I} + \mathbf{ku I ku J}) \\ & \mathbf{2} \\ & , \\ & , \\ & , \\ & , \end{aligned}$$

**Caution:**

.  
*The supported loadings are those supported in linear rubber band provided that it are died loads, i.e independent of the configuration: an imposed load is a dead load whereas the pressure can be a following loading.*

.  
*Displacements and rotations can be large but it is preferable to limit to small deformations if one wishes a coherence with actual material. For more precise details to refer to [R7.02.03 §2.5].*

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### **3.7.3 Operands**

***ALL/GROUP\_MA/MESH***

/

*ALL*

=

“YES”,

/|

*GROUP\_MA = lgrma,*

|

*NET*

=

*lma,*

*Specify the meshes or the nodes on which the relation of behavior is used.*

### **3.7.4 Relation of behavior available for each option**

“***CALC\_G***”

“***CALC\_K\_G***”

***COMP\_ELAS*** “***ELAS***”

“SMALL”

“SMALL”

“GREEN”

“ELAS\_VMIS\_LINE”

“SMALL” not  
disp.

“GREEN”

“ELAS\_VMIS\_TRAC”

“SMALL” not  
disp.

“GREEN”

*It is possible for these relations of behavior to calculate the rate of refund of energy  $G$  in great transformations [R7.02.03 §2] with the proviso of having only dead loads.*

### **3.8 Word**

**key**

**COMP\_INCR**

COMP\_INCR

=

*The relation of behavior elastoplastic is associated a criterion of von Mises with isotropic or kinematic work hardening.*

RELATION

=

/“ELAS”:

*relation of elastic behavior incremental [U4.51.03]*

/“VMIS\_ISOT\_LINE”

*: von Mises with linear isotropic work hardening ([U4.51.03] and [R5.03.20])*

/“VMIS\_ISOT\_TRAC”

*: von Mises with isotropic work hardening given by a curve of traction [U4.32.01]*

DEFORMATION

=

*linearized deformations: = (U*  
*) = 1 2 U*

+ U

*ij*

*ij*

*(I, J*

*J, I)*

*/“SMALL”:*

*U*

*U*

*I*

*J*

*1 / 2*

*/“PETIT\_REAC”*

*:*

*ij =*

*+*

*(*

*[U4.32.01]*

*X + U)*

*(X + U)*

*J*

*I*

*ALL/GROUP\_MA/MESH*

*The meshes or the nodes specify on which the incremental relation of behavior is used.*

### **3.9 Word**

**key**

## ***ETAT\_INIT***

### ***ETAT\_INIT***

=

*Initial State of reference selected. By defect, all the fields are identically null. The data of an initial state does not have direction (and is not thus taken into account) only for the treated part of the field*

*in incremental behavior (COMP\_INCR): if calculation is elastic (COMP\_ELAS) that does not have no incidence.*

*If one wants to take into account an initial state in elasticity, it is key word ELAS located under COMP\_INCR which should be used.*

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### ***3.9.1 Operand***

#### ***SIGM/DEPL***

*/SIGM =*

*sig,*

*/DEPL*

=

*depl,*

*Respectively, displacement and stress fields taken in an initial state. They can be by being example resulting from order RECU\_CHAMP, or to be read in a file with*

*format I-DEAS by order LIRE\_RESU. Either one gives an initial displacement, or one initial deformation. Attention, if the load transmitted in the operand LOAD contains one initial deformation (key word EPSI\_INIT of AFFE\_CHAR\_MECA\_F), this one will be taken in count in the same way that depl displacement provided here; it is then illicit to give one initial state with key word DEPL.*

### **3.10 Operand OPTION**

OPTION

=

/

“CALC\_G”

,

[DEFECT]

/

“CALC\_K\_G”,

/

“K\_G\_MODA”,

/

“CALC\_G\_LGLO”

,

/

“G\_BILINEAIRE”,

/

“CALC\_G\_MAX”

,

#### **3.10.1 OPTION = “CALC\_G” [R7.02.01] and [R7.02.03]**

*It is the default option. It allows the calculation of the rate of refund of energy  $G(S)$  by the method  $\theta$  in 3D for a or not linear problem thermo elastic linear.  $G(S)$  is solution of the variational equation [R7.02.01 §2.2].*

$G(S)$  (

$S)$ .  $m(S) ds G()$ ,

=

O

where  $0$  are the bottom of crack and  $m$  the normal at the bottom of crack in the tangent plan of its lips.

### 3.10.2 OPTION = "CALC\_K\_G" [R7.02.12]

*This option allows calculation by the method  $\theta$  in 3D of the rate of refund of energy  $G$  (S) and of factors of intensity of the constraints  $K$  (*

*1 S),  $K$  (*

*2 S),  $K$  (*

*3 S) for a linear elastic problem. It is*

*a generalization of the case 2D [R7.02.05].*

*The factors of intensity of the constraints are calculated starting from the symmetrical bilinear form of the rate*

*of restitution. This formulation uses the explicit expressions of the fields of displacements*

*singular known for a plane crack at right bottom in an infinite medium. Singular displacements*

*are calculated while placing itself on the assumption of the plane deformations.*

**Caution:**

*For this option, only linear elastic designs (elements HEXA8, PENTA6 and TETRA4) without initial state are available to date. Moreover, narrower terms dependent with the mechanical loading on the lips of the crack are not calculated.*

*This formulation being recent in Code\_Aster, it is recommended to check, with each time that is possible, the coherence of the results with those of the operator POST\_K1\_K2\_K3.*

### 3.10.3 OPTION = "K\_G\_MODAL"

*This option allows the calculation of the modal coefficients of intensity of constraints, i.e the factors of intensity of the constraints associated with the clean modes with vibration with the structure.*

*Calculations are carried out in linear thermoelasticity by the method of the singular fields (use bilinear form of  $G$ ), starting from a structure of data RESULT of the mode\_meca type only. The rate of traditional refund of energy  $G$  is also calculated.*

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### **3.10.4 OPTION = "CALC\_G\_LGLO"**

**Also the calculation of the rate of refund of energy G allows (S) but with Lagrangian propagation [R7.02.04].**

### **3.10.5 OPTION = "G\_BILINEAIRE" [R7.02.01]**

**For a series of displacements (U,..., U), this option allows the calculation of the bilinear form**

**I**

**N**

**G (U, U for I J; if I = J then G (U, U) = G (U). The results are stored in a table**

**I**

**J)**

**comprising two indices I and J in reference to displacements U and U ordered in the list**

**I**

**J**

**contained in the structure of data result under the key word RESULT.**

**Caution:**

**Only combinations of discretization of G (S) and the field, cf [§3.12] and [§ 3.13]:**

**LEGENDRE-LEGENDRE or LAGRANGE-LAGRANGE are available for this option.**

### **3.10.6 OPTION = "CALC\_G\_MAX" [R7.02.05]**

**This option relates to only the maximization of G under constraints terminals [R7.02.05]. It**

**is necessary to provide the value of the constraints terminals behind the key word TERMINALS. The results are printed**

**in the structure of data result. The value of G\_MAX not being single one also determines the maximum value of G\_MAX.**

**Caution:**

**Only combinations of discretization of  $G(S)$  and the field, cf [§3.12] and [§3.13]:  
**LEGENDRE-LEGENDRE or LAGRANGE-LAGRANGE are available for this option.****

### **3.11 Key word **TERMINALS****

*TERMINALS*

=

*This key word factor is obligatory if one uses option "CALC\_G\_MAX". If not it is not used. It allows to define couples of constraints terminals ( $Q, q+$*

*I*

*I) for each sequence number of structure of data result. One then seeks to define the combination of loading more penalizing in term of rate of refund  $D$  `energy:*

*NR*

*max  $G Q Q = max$*

*I I*

*ij*

*$G qiq J$  where  $IQ$  are the NR associated unit loadings*

*$Q Q q+$*

*I*

*I*

*I*

*I*

*$I, j=1$*

*with the various  $U_i$  displacements contained in the structure of data result, and*

*$G = G(U, U$*

*ij*

*I*

*J) bilinear form of  $G$ .*

*NUME\_ORDRE = num*

*Sequence number in the structure of data result associated with the values of constraints terminals.*

*VALE\_MIN =  $qmin$*

*Value minimal of the coefficient applied to the loading associated with the result stored in sequence number num of the structure of data resu.*

*VALE\_MAX = qmax*

*Value maximum of the coefficient applied to the loading associated with the result stored in sequence number num of the structure of data resu.*

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**Note:**

.

*The user must as many give couples of terminals of sequence numbers contained in the structure of data result under penalty of fatal error.*

.

*This option of calculation is valid only for elastic designs linear where superposition of loading by linear combination is possible.*

.

*An example of use of this option is given in the document [U4.82.03] (CALC\_G\_THETA\_T).*

### **3.12 Operands**

**PROPAGATION/THETA/DIRE\_THETA**

***PROPAGATION = alpha,***

***THETA***

***=***

***theta,***

***DIRE\_THETA = dire\_theta***

***The operands PROPAGATION and THETA are obligatory if one uses option "CALC\_G\_LGLO" of Lagrangian propagation. If not they are not used. alpha is the value of propagation, defined by the field theta [R7.02.04].***

### ***3.13 Operand***

***LISSAGE\_THETA***

***/LISSAGE\_THETA***

***=***

***/***  
***"LEGENDRE" [DEFECT]***

***/***

***"LAGRANGE"***

***The trace of the field on the bottom of crack can be discretized either according to the base of NR first polynomials of Legendre ("LEGENDRE"), is according to the linear functions of form associated the discretization of the bottom of crack ("LAGRANGE") [R7.02.01].***

***LISSAGE\_THETA = ' LEGENDRE': (S) is discretized on a basis of polynomials of Legendre***

***()***

***J S of degree J (0 J Degmax) or Degmax is the maximum degree given under the key word DEGREE (between 0 and 7).***

***LISSAGE\_THETA = ' LAGRANGE': (S) is discretized on the functions of form of the node K of melts of crack: ()***

***K S.***

### ***3.14 Operand***

***LISSAGE\_G***

***/LISSAGE\_G***

***=***

/  
“**LEGENDRE**”,  
[**DEFECT**]  
/  
“**LAGRANGE**”,  
/  
“**LAGRANGE\_NO\_NO**”,

*G (S) can be discretized either according to the polynomials of Legendre (“**LEGENDRE**”), or according to functions of form of the nodes of the bottom of crack (“**LAGRANGE**”). Method “**LAGRANGE\_NO\_NO**” results from method **LAGRANGE-LAGRANGE** but it is simplified [R7.02.01].*

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*If the smoothing of  $\theta$  by polynomials of Legendre were retained with the preceding key word, then it*

*smoothing of  $G$  must also be to him of Legendre type. The options available in Aster are summarized in the following table:*

*Théta*

*Polynomials of **LEGENDRE***

*Functions of form*

*Polynomials of LISSAGE\_THETA= "LEGENDRE" LISSAGE\_THETA=' LAGRANGE'  
G (S) LEGENDRE  
LISSAGE\_G = "LEGENDRE"  
LISSAGE\_G= "LEGENDRE"*

*Functions of  
LISSAGE\_THETA = "LAGRANGE"  
form  
LISSAGE\_G = "LAGRANGE"  
or "LAGRANGE\_NO\_NO"*

### *3.15 Operand DEGREE*

*DEGREE = N*

*N is the maximum degree of the polynomials of Legendre used for the decomposition of the field in melts of crack [§3.12] (when LISSAGE\_THETA = ' LEGENDRE').*

*By defect N is assigned to 5. The value of N must lie between 0 and 7.*

*If one retains the discretizations LISSAGE\_THETA = ' LAGRANGE' and LISSAGE\_G = "LEGENDRE", one must have N NNO [R7.02.01 §2.3].*

*The Councils on smoothing:*

*•  
it is difficult to give a preference to one or the other method of smoothing. In theory both give equivalent numerical results. Nevertheless the Théta method:  
Lagrange is a little more expensive in time CPU than the Théta method: Legendre;*

*•  
the Théta method: Legendre is sensitive to the maximum degree of the selected polynomials. maximum degree must be defined according to the number of nodes in bottom of crack NNO. If N is too large taking into consideration NNO the results are poor [U2.05.01 §2.4];*

*•  
oscillations can appear with the Théta method: Lagrange, in particular if it grid comprises quadratic elements. If the grid is radiant in bottom of fissure, it is then recommended to define crowns R\_INF and coincidant R\_SUP*

*with the borders of the elements. A smoothing of the type “LAGRANGE\_NO\_NO” allows to limit these oscillations;*

*the use of the two methods with several crowns of integration and the comparison results makes it possible to consolidate the validity of the model.*

### **3.16 Operands**

***R\_INF/R\_SUP***

***/R\_INF = R***

***R\_SUP = R***

*R and R are the lower and higher rays, presumedly constant over the entire length crack, make it possible to determine the crown on which the fields will have one linear decrease.*

### **3.17 Operands**

***R\_INF\_FO/R\_SUP\_FO***

***/R\_INF\_FO = rz***

***R\_SUP\_FO = Rz***

*Functions defining the rays of the crowns varying according to the curvilinear X-coordinate on melts of crack.*

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**The Councils:**

**.**  
**To avoid using crowns with a ray lower no one. Fields of displacements are singular in bottom of crack and introduce results vague in postprocessing of breaking process.**

**.**  
**It is advised to use successively order CALC\_G\_LOCAL\_T with at least 3 different couples of crowns to ensure itself of the stability of the results. In the event of important variation (higher than 5-10%) it is necessary to wonder about the good taking into account of all modeling.**

**3.18 Operand**  
**INFORMATION**

**INFORMATION**

**=**  
**/1,**

**[DEFECT]**

**/2,**

**Level of messages in the file "MESSAGE". If INFORMATION is worth 2, one generates the impression of  $G_i$  coefficients of G (S) in the base of the polynomials of Legendre, the value of G elementary G (I) before smoothing, then G (S) on all the nodes of the bottom of crack.**

**3.19 Operand**  
**TITRATE**

**[U4.03.01].**



### **3.20 Count produced**

*Order CALC\_G\_LOCAL\_T produces a concept of the type counts.*

*This table contains, for each node of the bottom of crack:*

- *the name of the node,*
- *its curvilinear X-coordinate along the bottom of crack,*
- *the value of G local to the node.*

*For option CALC\_K\_G, the table contains:*

- the number of the point of the bottom of crack (see [U4.82.08]),*
- its curvilinear X-coordinate along the bottom of crack,*
- the value of the factors of intensity of the constraints K1, K2, K3 buildings and of G local in each not.*

*The table can be printed by IMPR\_TABLE [U4.91.03].*

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### **4 Examples**

#### **4.1 Calculation of**

***G (S) traditional in linear elasticity (option “CALC\_G”)***

```

GILOC
=
CALC_G_LOCAL_T
(
MODEL
=
Mo,
CHAM_MATER =
chma,
DEPL
=
depl,
FOND_FISS
=
FF,
R_INF
=
1.,
R_SUP
=
2.,
EXCIT
=
_F (LOAD
=
CH),
DEGREE
=
4.,
LISSAGE_THETA
= ' LAGRANGE')

```

***One calculates the rate of refund of energy room G (S) on the bottom of crack FF by approximating it by polynomials of Legendre of degree 4. The base of the fields of propagation corresponds to functions of form of the nodes of the bottom of crack (LISSAGE\_THETA=' LAGRANGE'). Rays of crown calculation are constant.***

***If one models only half of the solid compared to the bottom of crack, one can add the key word: SYME\_CHAR=' SYME' which makes it possible automatically to obtain the intrinsic values of G (S) (value***

*multiplied by 2.). To note that the CH load is taken into account only if it applies inside crown defined by R\_SUP.*

*One can find examples of use in the following tests:*

*SSLV110 [V3.04.110] semi-elliptic Crack in infinite medium*

*SSLV112 [V3.04.112] circular Crack in infinite medium*

*HPLV103 [V7.03.103] Thermoelasticity with circular crack in infinite medium*

#### *4.2 Calculation*

*of*

*G (S) in nonlinear elasticity in great transformations*

*(option "CALC\_G")*

**G2LOC**

**= CALC\_G\_LOCAL\_T (RESULT = resu,**

**NUME\_ORDRE=**

**(1,**

**10,**

**20),**

**FOND\_FISS**

**=**

**FF,**

**R\_INF\_FO**

**=**

**rinf,**

**R\_SUP\_FO**

**=**

**rsup,**

**LISSAGE\_THETA**

**= "LEGENDRE",**

**DEGREE**

**=**

**7.,**

**COMP\_ELAS**

**=\_F (RELATION=' ELAS\_VMIS\_LINE'**

**DEFORMATION=' GREEN'),**

)

*One calculates the rate of refund of energy room  $G(S)$ :*

*•  
on the bottom of crack  $FF$ ;*

*•  
starting from the model, field of material and loadings extracted the structure of data *resu*;*

*•  
the relation between the strains and the stresses is a nonlinear elastic relation of von Mises with linear isotropic work hardening;*

*•  
the deformations are those of Green-Lagrange (behavior hyperelastic), the large ones displacements and great rotations are authorized. In this case, the loadings are thus inevitably dead loads;*

*•  
 $G(S)$  is approximated by polynomials of Legendre of maximum degree 7;*

*•  
the base of the fields of propagation is the base of the polynomials of Legendre (*LISSAGE\_THETA='LEGENDRE'*);*

*•  
the rays defining the crown are functions of the curvilinear  $X$ -coordinate;*

*•  
calculation is carried out for 3 sequence numbers (one recovers displacements with the numbers of order 1, 10 and 20 starting from the concept *resu* resulting from a calculation with *STAT\_NON\_LINE*).*

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***Document: U4.82.05***

***Operator POST\_K1\_K2\_K3***

***1 Goal***

***To calculate the factors of intensity of the constraints in 2D and 3D for plane cracks.***

***This operator allows to calculate  $K_1$ ,  $K_2$  in 2D (plane and axisymmetric) and  $K_3$  in 3D by extrapolation***

***jumps of displacements on the lips of the crack. This method is applicable only to the case of plane cracks, in homogeneous and isotropic materials.***

***The method used is less precise than calculation starting from the bilinear form of the rate of refund***

*energy and singular displacements, usable in 2D with option CALC\_K\_G of the operator CALC\_G\_THETA\_T [U4.82.03]. It however makes it possible to easily obtain approximate values factors of intensity of the constraints, in particular in the case 3D, for which method of singular displacements is operational only with linear elements (option CALC\_K\_G of operator CALC\_G\_LOCAL\_T [U4.82.04]).*

*Product a concept of the type counts.*

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*2 Syntax*

*tk [table] = POST\_K1\_K2\_K3*

*(*

*MODELING =/"3D",*

*/*

*"AXIS",*

/  
**“D\_PLAN”**,

/  
**“C\_PLAN”**,

**MATER**  
**= chechmate**  
,  
**[material]**

/  
**RESULT**  
**= resu,**  
,  
**[evol\_elas]**  
,  
**[evol\_noli]**

/  
**TABL\_DEPL\_SUP**  
**=**  
**tdsup,**  
**[table]**



**TABL\_DEPL\_INF**

=

**tdinf,**  
**[table]**

**/TOUT\_ORDRE = "YES",**

**/**

**NUME\_ORDRE =**

**lnuor,**  
**[L\_I]**

**/**

**LIST\_ORDRE =**

**lnuor,**  
**[listis]**

**/**

**INST**

=

**l\_inst, [l\_R]**

**PRECISION**

=

**1.E-6,**  
**[DEFECT]**

**prec,**

**CRITERION =**  
**/**  
**“RELATIVE”, [DEFECT]**

**/**  
**“ABSOLUTE”**  
**,**

**/**  
**LIST\_INST**  
**=**  
**l\_inst, [listR8]**

**PRECISION**  
**=**  
**1.E-6,**  
**[DEFECT]**

**prec,**

**CRITERION =**

/  
“*RELATIVE*”, [*DEFECT*]

/  
“*ABSOLUTE*”  
,

*ABSC\_CURV\_MAXI*=  
*dmax*,  
[*R*]

*VECT\_K1* =  
(*y1*, *y2*, *y3*),  
[*R*]

*/FOND\_FISS*  
=  
*melts*,  
[*fond\_fiss*]

*/ALL* = “*YES*”,  
*/NODE*  
=  
*noeu*,  
[*l\_noeud*]

*/GROUP\_NO*  
=

**gr\_noeu,**  
**[l\_gr\_noeud]**

**/ SANS\_NOEUD = noeu,**  
**[l\_noeud]**

**/ SANS\_GROUP\_NO = gr\_noeu,**  
**[l\_gr\_noeud]**

**GRID = my,**  
**[grid]**

**PREC\_VIS\_A\_VIS =/1.E-1,**  
**[DEFECT]**

**/**  
**epsi,**  
**[R]**

**SYME\_CHAR**

**=**

**/**

**“WITHOUT”,**

**[DEFECT]**

**/**

**“SYME”,**

***TITRATE = title***

,  
***[l\_Kn]***

***INFORMATION***

=  
/  
***1,***  
***[DEFECT]***

***/ 2,***

)  
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### **3 Operands**

#### **3.1 Operand MODELING**

**MODELING =/"3D",**

**/"  
"AXIS",**

**/"  
"D\_PLAN",**

/

**“C\_PLAN”**,

*Allows to define the type of calculation to be carried out: 3D (in which case one K3 will calculate) or 2D.*

*This modeling must be coherent with the model used for the calculation of displacements.*

### **3.2 Operand**

#### **MATER**

**MATER = chechmate, [material]**

*Concept of the material type containing the elastic characteristics of fissured material  
The material must be homogeneous, isotropic and elastic linear.*

*If the properties materials depend on the temperature (key word ELAS\_FO  
DEFI\_MATERIAU), the treatment is different according to the type of modeling:*

*for a modeling 2D (“AXIS”, “D\_PLAN”, “C\_PLAN”), characteristics  
materials are obtained at the temperature of reference TEMP\_DEF\_ALPHA of  
DEFI\_MATERIAU;*

*for a modeling 3D (“3D”), if the key word RESULT is indicated, then them  
characteristics materials are calculated starting from the temperature of the nodes  
bottom of crack; if key words TABL\_DEPL\_SUP/TABL\_DEPL\_INF are  
informed, then the characteristics materials are calculated from  
temperature of reference TEMP\_DEF\_ALPHA of DEFI\_MATERIAU.*

**Note:**

*In 3D, it is thus recommended to inform the key word RESULT if the properties  
materials depend on the temperature.*

### **3.3 Operands**

#### **TABL\_DEPL\_SUP/TABL\_DEPL\_INF/RESULT**

**/RESULT = resu,**

/

**TABL\_DEPL\_SUP**

=

**tdsup,**

**[table]**

**TABL\_DEPL\_INF**

**=**

**tdinf,**

**[table]**

**Concepts of the type counts resulting from POST\_RELEVE\_T containing displacements from nodes of the upper lip (tdsup) and those of the lower lip (tdinf).**

**In 2D, these lips are segments of right-hand sides. tdsup and tdinf thus contain them values of the two components of displacement on each upper lip and lower. The nodes of the lips must be ordered (bottom of crack towards the lip crack).**

**In 3D, tdsup and tdinf contain displacements of all the nodes of the plans representing the upper lips and lower.**

**The two tables tdsup and tdinf must be present simultaneously safe if one model that half of the solid compared to the crack (SYME\_CHAR = `SYME'), to which case only the table of displacement of the upper lip is necessary.**

**To avoid extracting displacements by POST\_RELEVE\_T, it is possible to provide directly a concept result (key word RESULT).**

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### **3.4 Operands INST, LIST\_INST, TOUT\_ORDRE, NUME\_ORDRE, LIST\_ORDRE**

*Cf [U4.71.00].*

### **3.5 Operand ABSC\_CURV\_MAXI**

**ABSC\_CURV\_MAXI=**  
*dmax*  
**[R]**

*Outdistance maximum calculation of the factors of intensity of the constraints starting from the bottom of fissure. In practice, the precision of the results is worse if one is located very far from melts of crack [R7.02.08]. It is thus advised to choose dmax smallest possible (about 3 to 4 elements, or about the ray of the radiant grid, it case falling due).*

### **3.6 Operand VECT\_K1**

**VECT\_K1 = (y1, y2, y3)**

**[R]**

*POST\_KI\_K2\_K3 functions for a crack planes and carries out the calculation of the factors of intensity of the constraints in the normal plan with each node of the bottom of crack. For the calculation of the factors of intensity of the constraints, one defines a local reference mark for each node of the bottom of crack in the following way:*  
*center X1: normal vector in the plan of the crack;*  
*center X2: normal vector at the bottom of crack;*  
*center X3: tangent vector at the bottom of crack.*

*These axes are in the following way given:*

.

*the axis X2 is determined by the orientation of the vector connecting a node (NL) located on one of the faces of the crack towards the node of the bottom of crack, in the plan normal with this node (NF);*

*the axis X1 is deduced from the axis provided by the user by key word VECT\_K1. X1 must be the normal axis in the plan of the crack. The who can user not to very precisely know the normal in the plan of crack, the axis X1 is calculated in projecting vector VECT\_K1 on the orthogonal level with the axis X2:*

$$X1 = VECT\_K1 (VECT\_K1.X2) X2;$$

*the axis X3 is determined by the vector product (axis X1, axis X2).*

**VECT\_K1**

**X1**

**X2**

**NR**

**F**

**NL**

**X3**

**LEVRE\_SUP**

**LEVRE\_INF**

*Vector VECT\_K1 thus makes it possible to direct the axis X1, normal in the plan of the crack, in coherence with the definition of the lips of crack LEVRE\_INF and LEVRE\_SUP.*

*Displacements in this local reference mark enable us to calculate:*

*K1: mode I of opening, discontinuity of displacement following the axis X1;*

*K2: mode II of plane shearing, discontinuity of displacement following the axis X2;*

*K3: mode III of shearing antiplan, discontinuity of displacement following the axis X3.*

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***3.7 Operands***  
***FOND\_FISS/GRID/PREC\_VIS\_A\_VIS/NODE***  
***/GROUP\_NO/SANS\_NOEUD/SANS\_GROUP\_NO***

***/***  
***FOND\_FISS= melts,***  
***[fond\_fiss]***

***GRID =***  
***my,***  
***[grid]***

***PREC\_VIS\_A\_VIS***  
***=***  
***/***  
***1.D-1,***  
***[DEFECT]***

***/***

*epsi,*  
*[R]*

*/ALL*  
*= "YES",*  
*/*  
*/NODE = noeu,*  
*[l\_noeud]*

*/GROUP\_NO*  
*=*  
*gr\_noeu,*  
*[l\_gr\_noeud]*

*/*  
*/SANS\_NOEUD*  
*=*  
*noeu,*  
*[l\_noeud]*

*/SANS\_GROUP\_NO = gr\_noeu,*  
*[l\_gr\_noeud]*

*For a modeling 3D, it is possible to automate for each node of the bottom of fissure the research of the nodes located on normal segments at the bottom of crack and belonging to the upper lips and lower, then to carry out the calculation of the factors of intensity of the constraints.*

*It is necessary for that to provide a concept fond\_fiss created by the order DEF1\_FOND\_FISS, as well as a precision for the geometrical research of the nodes located on the normals at the various nodes of the bottom of crack. It is also necessary to provide the name of the grid on which one carries out the post treatment.*

*By defect, the calculation of the stress intensity factors is done only on nodes ends of the meshes composing the bottom of crack (thus all nodes for linear elements, and a node on two for the quadratic elements).*

*The user with the possibility of:*

- to select certain nodes ends of the bottom of crack (key words **NODE** and **GROUP\_NO**);*
- to exclude from the nodes of the bottom of crack (key words **SANS\_NOEUD** and **SANS\_GROUP\_NO**);*
- to make calculation on all the nodes mediums and ends of the bottom of crack (key word **ALL**).*

*At the time of automatic research for each node of the bottom of crack, the operator select the nodes checking the three following conditions:*

- outdistance  $D$  with the right-hand side perpendicular to the bottom of crack:  $D < \text{epsi} \cdot d$ , where  $D$  is the minimal distance between two successive nodes of the bottom of crack;*
- outdistance  $R$  compared to the bottom of crack:  $R < \text{ABSC\_CURV\_MAXI} (1 + \text{epsi} / 10)$  ;*
- outdistance  $L$  compared to its opposite on the other lip:  
 $L < \text{epsi} \cdot \text{ABSC\_CURV\_MAXI}$ .  
where  $\text{epsi}$  is the value of the provided precision (key word **PREC\_VIS\_A\_VIS**). By defect  $\text{epsi}$  is worth 0,1. To increase the value of  $\text{epsi}$  amounts increasing the number of nodes potentially retained for calculation.*

### **3.8 Operand SYME\_CHAR**

**SYME\_CHAR**  
=  
/  
“WITHOUT”, [DEFECT]  
/  
“SYME”,

*This key word makes it possible to indicate if the loading is symmetrical if one model that half of the solid compared to the crack. Normal displacements of lips are then supposed to be opposite ( $K1 = 0$ ) and equal tangent displacements (either  $K2 = K3 = 0$ ).*

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**3.9 Operand**

**INFORMATION**

**INFORMATION**

**=**

**/**

**1,**

**[DEFECT]**

**/ 2,**

**Level of messages in the file message: if INFORMATION is worth 2, one provides the list of all computed values for all the treated nodes.**

### **3.10 Operand**

#### **TITRATE**

**TITRATE = title,**

**Titrate that one wants to give to the result of the order.**

## **4 Precautions and councils of use**

### **4.1 Count produced**

**Three different methods are systematically used to carry out the calculation of K in each node of the bottom of crack [R7.02.08]:**

**Method 1: for each node of the segment of interpolation, one calculates the jump of the field of displacements squared and one divides it by R. Différentes values from K1 (resp. K2, K3) are obtained (with a multiplicative factor near) by extrapolation in  $R = 0$  of the segments of right-hand sides thus obtained.**

**Method 2: one traces the jump of the field of displacements squared according to R. Them approximations of K1 are (always except for a multiplicative factor) equal to the slope of segments connecting the origin to the various points of the curve.**

**Method 3: one identifies the stress intensity factor K1 (resp. K2, K3) starting from the jump of displacement by a method of least squares. One obtains a single value of K1, K2 and K3 for each node of the bottom of crack.**

**Order POST\_K1\_K2\_K3 produces a concept of the type counts. This table contains, for each node of the bottom of crack and for each of the 3 methods:**

**the maximum value K1\_MAX and minimal value K1\_MIN of the factors of intensity of constraints in mode I calculated for each node of the segment of interpolation;**

**K2\_MAX and K2\_MIN for mode II;**

**K3\_MAX and K3\_MIN for mode III in 3D;**

**The rate of refund of energy G (maximum value G\_MAX and minimal G\_MIN) calculated with**

*to leave the factors of intensity of the constraints by the formula of Irwin.*

*The table can be printed by IMPR\_TABLE [U4.91.03]. Method 3 produces only one value of K1, K2, K3 and G, the minimal and maximum values corresponding are thus equal in table result.*

*If INFORMATION is worth 2, all intermediate calculations are posted in the file message. It is announced that*

*column entitled SAUT\_DX (resp. SAUT\_DY and SAUT\_DZ) in the tables of the file message corresponds to the jump of displacement following the axis X1 (resp. X2 and X3), multiplied by a coefficient*

*depending on material (in 3D:  $E(2)/8(1^2)$ ), the whole squared.*

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*4.2*

*Precautions and councils*

*The assumptions necessary to the validity of this method are:*

- 1) the crack is plane,*
- 2) the behavior is elastic, linear, isotropic and homogeneous and the structure is isothermal,*
- 3) one places oneself in a normal plan at the bottom of crack, supposed sufficiently regular.*

*In practice, the grid will have to comprise sufficient nodes perpendicular to the bottom of fissure. In addition, the results are clearly improved if if the grid is made up quadratic elements, the nodes mediums are moved (edges which touch the bottom of crack), with the quarter of these edges by bringing them closer the bottom of crack. This is possible thanks to*



*the key word*

***MODI\_MAILLE*** (option “***NOEUD\_QUART***”) of order ***MODI\_MAILLAGE*** [U4.23.04].

*The method used is less precise than the method of singular displacements [R7.02.05]. One can however have an idea of the precision of the results by comparing the value of G (provided in the table result and calculated starting from K1, K2 and K3 by the formula of Irwin) with that obtained with*

***CALC\_G\_THETA\_T*** [U4.82.03].

*In 2D, the lips are segments of right-hand sides, and the nodes must be ordered (bottom of fissure towards the lip of crack).*

*Calculation by interpolation of the jumps of displacement requires to have at least 3 nodes on normal at the bottom of crack. If the number of nodes is not sufficient, an alarm is emitted and it calculation continues, if necessary, for the following node of the bottom of crack. One can in this case:*

.

*that is to say to increase curvilinear X-coordinate maximum ***ABSC\_CURV\_MAXI*** to go to seek nodes further away from the bottom of crack;*

.

*that is to say to increase parameter ***PREC\_VIS\_A\_VIS***, which returns to being less demanding in selection of the nodes for calculation.*

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***5 Example***

*Fissure circular in a block 3D (test SSLV134D).*

*MA = LIRE\_MAILLAGE ()*

*LEVINF1, LEVINFS are the groups containing the surface meshes located on the lips higher and lower of the crack. One creates the groups of associated nodes:*

*MA = DEFI\_GROUP (GRID = MA,  
CREA\_GROUP\_NO = \_F (GROUP\_MA= (“LEVINF1”, “LEVINFS”),))*

*Displacement of the nodes to the quarter of the edges:*

*MA = MODI\_MAILLAGE (GRID = MA, reuse = MA,  
MODI\_MAILLE = \_F (OPTION = “NOEUD\_QUART”,  
GROUP\_MA\_FOND = “LFF1”  
)*

*calculation with MECA\_STATIQUE....*

*FISS = DEFI\_FOND\_FISS (GRID = MA,  
FOND\_FISS = \_F (GROUP\_MA = “LFF1”,  
GROUP\_NO\_ORIG = “NFF1”,  
GROUP\_NO\_EXTR = “NFF2”,  
)  
LEVRE\_SUP = \_F (GROUP\_MA = “LEVINFS”),  
LEVRE\_INF = \_F (GROUP\_MA = “LEVINF1”),  
DTAN\_ORIG = (1. , 0. , 0. ),  
DTAN\_EXTR = (0. , 1. , 0. )  
)*

*DEP\_SUP = POST\_RELEVE\_T (ACTION = \_F (ENTITLES = “TAB\_SUP”,  
GROUP\_NO = “LEVINFS”,  
RESULT = RESU1,  
NOM\_CHAM = “DEPL”,  
NOM\_CMP = (“DX” “DY” “DZ”),  
OPERATION= “EXTRACTION”)*

*DEP\_INF = POST\_RELEVE\_T (ACTION = \_F (ENTITLES = “TAB\_INF”,  
GROUP\_NO = “LEVINF1”,  
RESULT = RESU1,  
NOM\_CHAM = “DEPL”,  
NOM\_CMP = (“DX” “DY” “DZ”),  
OPERATION= “EXTRACTION”  
)*

**TABK1K3 = POST\_K1\_K2\_K3 (MODELING = "3D", INFO=2,  
FOND\_FISS = FISS,  
GRID = MA,  
MATER = CHECHMATE,  
TABL\_DEPL\_SUP = DEP\_SUP,  
TABL\_DEPL\_INF = DEP\_INF,  
ABSC\_CURV\_MAXI = 0.539,  
LOCATE = "LOCAL",  
VECT\_Y = (0. 0. 1.)  
)**

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***Organization (S): EDF-R & D /MMC***

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***Operator RECA\_WEIBULL***

### ***1 Goal***

***To readjust the parameters of the model of WEIBULL on experimental data. These data are composed of one (or several) list of in experiments determined moments of rupture, associated one (or several) concept result of STAT\_NON\_LINE modelling the tests at these various moments. The module of WEIBULL, or the constraint of cleavage (possibly depending on the temperature), or still these two parameters, can be readjusted. One uses the method of maximum of probability or of linear regression [R7.02.09] for this retiming.***

***Product a structure of data of the type counts.***

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## 2 Syntax

*tabl\_reca\_weib* = *RECA\_WEIBULL* (

*LIST\_PARA*

= /

“*Me*,

/

“*SIGM\_REFE*”,

*RESU* =

*\_F* (

*EVOL\_NOLI*

=

*resu*,

[*evol\_noli*]

*MODEL*

=

*Mo*,

[*model*]

*CHAM\_MATER*

=

*chmat*,

**[cham\_mater]**

**TEMPLE**

=

**temp,**

**[R]**

**LIST\_INST\_RUPT =**

**lreel,**

**[l\_R]**

**/TOUT\_ORDRE**

=

**“YES”,**

**/**

**NUME\_ORDRE**

=

**l\_nuor, [l\_I]**

**/**

**INST =**

**l\_inst, [l\_R]**

**/**

**LIST\_INST**

=

**l\_inst, [listis]**

/  
**ALL**  
=  
"YES"  
,  
/  
**GROUP\_MA**  
=  
**lgrma**  
,  
[l\_gr\_maille]  
/  
**NET**  
=  
**l\_maille**  
,  
[l\_maille]

**COEF\_MULT**  
=/coef, [R]

/  
**1.**

,

**[DEFECT]**

)

**OPTION**

=

/

**“SIGM\_ELGA”**

,

**[DEFECT]**

/

**“SIGM\_ELMOY”,**

**CORR\_PLAST**

=

/

**“NOT”,**

**[DEFECT]**

/

**“YES”,**

**METHOD**

=

/

**“MAXI\_VRAI”,**

**[DEFECT]**

/



**“REGR\_LINE”,**

**INCO\_GLOB\_RELA =/inrel, [R]**

**/**

**1.E-3,**

**[DEFECT]**

**ITER\_GLOB\_MAXI =/maglob, [R]**

**/**

**10, [DEFECT]**

**INFORMATION**

**=**

**/**

**1,**

**[DEFECT]**

/  
2,

[I]

)

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***3 Operands***

***3.1 Operand LIST\_PARA***

***LIST\_PARA***

*/“Me,*

*/“SIGM\_REFE”,*

*List parameters of the model of Weibull whose retiming is required (m, U or both).*

### **3.2 Word**

*key RESU*

#### **3.2.1 Operand**

**EVOL\_NOLI**

**EVOL\_NOLI =**

*resu,*

*Name of a concept result of the evol\_noli type.*

#### **3.2.2 Operand**

**MODEL**

**MODEL**

**=**

*Mo,*

*Name of the model on which retiming is carried out.*

#### **3.2.3 Operand**

**CHAM\_MATER**

**CHAM\_MATER**

**= chmat,**

*Name of the field affected material on the model. This one must imperatively contain the value initial of the parameters of the method of Weibull (key word WEIBULL of DEFI\_MATERIAU [U4.43.01]) with knowing:*

**V 0**

*: volume of reference*

**m**

*: exhibitor of the statistical law of Weibull*

**U**

*: constraint of cleavage*

#### **3.2.4 Operand**

## **TEMPLE**

**TEMPLE = temp,**

**Temperature associated with the resu result. If this one is indicated, one will readjust the constraint of cleavage U for each result.**

### **3.2.5 Operand**

**LIST\_INST\_RUPT**

**LIST\_INST\_RUPT =  
lreel,**

**List moments of rupture of the base of resu result on which they will be calculated forced of Weibull (these moments are interpolated if they do not coincide at the moments of the result resu). This list of moments must be strictly increasing and contain at least two moments. The minimum moment (respectively maximum) of this list must of course be necessarily higher (resp. lower) than the minimum moment (resp. maximum) of the list moments of the resu result.**

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### **3.2.6 Operands**

**ALL/GROUP\_MA/MESH**

**The fields of calculation are specified by:**

**/ALL**  
**=**  
**“YES”,**

*Only one field is defined and it coincides with all the structure.*

**/**  
**GROUP\_MA = lgrma,**

*Each group of meshes of the list lgrma defines a field of calculation.*

**/**  
**NET**  
**=**  
**l\_maille,**

*Each mesh of the list l\_maille defines a field of calculation.*

### **3.2.7 Operands**

**TOUT\_ORDRE/NUME\_ORDRE/INST/LIST\_INST**

*See [U4.71.00].*

### **3.2.8 Operand**

**COEF\_MULT**

**COEF\_MULT = coef,**

*Multiplying coefficient of the power m-ième of the constraint of Weibull intended for the catch in count symmetries in the field (the default value is 1. cf POST\_ELEM [U4.81.22]).*

### **3.3 Operand**

**OPTION**

**/**  
**OPTION = “SIGM\_ELGA”,**

*The elementary field of the maximum principal constraint is calculated from representation of the stress field at the points of Gauss.*

**/**  
**OPTION = “SIGM\_ELMOY”,**

*The elementary field of the maximum principal constraint is calculated from representation of the stress field realised compared to the points of Gauss.*

### **3.4 Operand CORR\_PLAST**

/  
**CORR\_PLAST = “YES”,**

*The stress field of Weibull is evaluated with the plastic correction.*

/  
**CORR\_PLAST = “NOT”,**

*The stress field of Weibull is evaluated without plastic correction.*

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### **3.5 Operand**

#### **METHOD**

/  
*METHOD = "MAXI\_VRAI",*

*The method of retiming employed is that of the maximum of probability.*

/  
*METHOD = "REGR\_LINE",*

*The method of retiming employed is that of the linear regression.*

### **3.6 Word**

*key*

**INCO\_GLOB\_RELA**

*INCO\_GLOB\_RELA =/incret, [R]*

/  
*1.E-3,*

*[DEFECT]*

*The algorithm of retiming continues the iterations if:*

*m*

*1 - m*

-

*K*

+

*K*

*U (K +) (T)*

*l*

*U (K) (T)*

*Max*

*; Max*

*incret*

*m*

>

*K*

*T*

*U (K) (T)*

### ***3.7 Word***

***key***

***ITER\_GLOB\_MAXI***

*ITER\_GLOB\_MAXI =/maglob, [R]*

/

*10, [DEFECT]*



*Iteration count of maximum retiming carried out.*

### **3.8 Operand INFORMATION**

*INFORMATION*

=

*Indicate the level of impression of the results of the operator,*

*1:  
no impression,*

*2:  
impression of information relating to retiming.*

*The impressions are made in the file "MESSAGE".*

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### **4 Example of use**

*For the use of RECA\_WEIBULL, one will be able to refer to the case test SSNA103 [V6.01.103].*

*It is an axisymmetric modeling of a cylindrical test-tube (407 mm length and ray of 68 mm) subjected to a traction. Example of retiming of the parameter U of the method of Weibull by method of regression linear on three bases of results corresponding to temperatures*

*distinct (the module of Weibull  $m$  is fixed and equal to 24).*

### **Results:**

*With the resulting one from retiming, the table result gives for each constraint of Weibull, the probabilities of rupture experimental and theoretical as for each temperature  $T$  associated with a base with results, the module of Weibull  $m$  selected and the constraint of cleavage  $U$  readjusted.*

*count T1*

-----  
*SIGMA\_WEIBULL PROBA\_EXP PROBA\_THE TEMP MR. SIGMA\_U*

2.08428E+03	1.06871E-03	6.25000E-02	- - -
2.37776E+03	7.43857E-02	6.25000E-02	- - -
2.46999E+03	1.75251E-01	1.25000E-01	- - -
2.47245E+03	1.79089E-01	1.87500E-01	- - -
2.47546E+03	1.83876E-01	2.50000E-01	- - -
2.49280E+03	1.15850E-01	6.25000E-02	- - -
2.52318E+03	1.51827E-01	1.25000E-01	- - -
2.56806E+03	2.22304E-01	1.87500E-01	- - -
2.57728E+03	4.14074E-01	3.12500E-01	- - -
2.57965E+03	1.63465E-01	1.25000E-01	- - -
2.58412E+03	4.34295E-01	3.75000E-01	- - -
2.58768E+03	4.45012E-01	4.37500E-01	- - -
2.59680E+03	2.79917E-01	2.50000E-01	- - -
2.59780E+03	4.76213E-01	5.00000E-01	- - -
2.60437E+03	4.96954E-01	5.62500E-01	- - -
2.60474E+03	2.97664E-01	3.12500E-01	- - -
2.61696E+03	5.37625E-01	6.25000E-01	- - -
2.62152E+03	2.31018E-01	1.87500E-01	- - -
2.63019E+03	3.59960E-01	3.75000E-01	- - -
2.63703E+03	3.78073E-01	4.37500E-01	- - -
2.64761E+03	6.39443E-01	6.87500E-01	- - -
2.65847E+03	3.07571E-01	2.50000E-01	- - -
2.68228E+03	3.65713E-01	3.12500E-01	- - -
2.68274E+03	5.11962E-01	5.00000E-01	- - -
2.69140E+03	7.79587E-01	7.50000E-01	- - -
2.70481E+03	8.18018E-01	8.12500E-01	- - -
2.70819E+03	5.93363E-01	5.62500E-01	- - -
2.71978E+03	4.70198E-01	3.75000E-01	- - -
2.72917E+03	8.79111E-01	8.75000E-01	- - -
2.73173E+03	6.69628E-01	6.25000E-01	- - -
2.73291E+03	5.09893E-01	4.37500E-01	- - -
2.73574E+03	8.93367E-01	9.37500E-01	- - -

2.74213E+03 7.02782E-01 6.87500E-01 - - -  
2.75526E+03 7.43533E-01 7.50000E-01 - - -  
2.75581E+03 7.45195E-01 8.12500E-01 - - -  
2.75636E+03 7.46854E-01 8.75000E-01 - - -  
2.77232E+03 6.34158E-01 5.00000E-01 - - -  
2.77688E+03 8.06319E-01 9.37500E-01 - - -  
2.79613E+03 7.09063E-01 5.62500E-01 - - -  
2.80708E+03 7.42320E-01 6.25000E-01 - - -  
2.81475E+03 7.64896E-01 6.87500E-01 - - -  
2.81803E+03 7.74361E-01 7.50000E-01 - - -  
2.84430E+03 8.44366E-01 8.12500E-01 - - -  
2.88043E+03 9.19411E-01 8.75000E-01 - - -  
3.00687E+03 9.99143E-01 9.37500E-01 - - -  
- - - -5.00000E+01 2.40000E+01 2.77168E+03  
- - - -1.00000E+02 2.40000E+01 2.72013E+03  
- - - -1.50000E+02 2.40000E+01 2.64542E+03

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**Code\_Aster** ®

*Version*

7.4

*Titrate:*

*Operator POST\_K\_BETA*

*Date:*

08/02/05

*Author (S):*

**A. DAHL, S. BUGAT, R. FERNANDES** *Key*

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*Organization (S): EDF-R & D /MMC, AMA*

***Instruction manual  
U4.8- booklet: Postprocessing and dedicated analyses  
Document: U4.82.07***

***Operator POST\_K\_BETA***

***1 Goal***

***Analyze harmfulness of defect by the method K-beta.***

***This method aims to evaluate the factors of margins with respect to the starting of the tear coating (in first point of the defect) and with respect to the brittle fracture of the base metal or of welded joint (in second point of the defect).***

***POST\_K\_BETA calculates the stress intensity factors to the two points of the defect, using constraints with the nodes resulting from the mechanical resolution [R7.02.10].***

***This method calculates the stress intensity factors on models in which the crack is not represented. It uses the constraints with the nodes along a segment of support of the defect postulated. The stress intensity factors obtained are those of a defect under coating of elliptic profile, under the assumption of an elastic behavior of materials.***

***The “correction”, specific to the defects under coating stuck to the interface, makes it possible to hold account plasticization with the two points of the crack side coating (point A) and side base metal (point B).***

***Product a concept of the type counts.***

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## ***2 Syntax***

***tk [table] = POST\_K\_BETA (***

***GRID***

***=***

***my,***

***[grid]***

***MATER\_REV = chechmate, [material]***

***EPAIS\_REV***

***=***

***epais\_rev,***

**[R]**

**FISSURE =\_F (**

**/ SHIFT =/-2.10-4,  
[DEFECT]**

**/shift, [R]**

**/ DEPTH =  
depth, [R]**

**/ LENGTH =  
length, [R]**

**/ ORIENTATION =/"CIRC",  
/"LONGI",**

**),**

**KID = (\_F (**

**/ TABL\_MECA\_REV =  
table\_rev, [table]**

**/ TABL\_MECA\_MDB =  
table\_mdb, [table]**

**/ TABL\_THER =  
table\_ther, [table]**

**/ ENTITLE =  
heading, [K]**

), ),

**TITRATE**

=

*titrate*

,

*[l\_K]*

)

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*3 Operands*

*Axisymmetric schematization of a section of tank with presence of a defect under-coating.*

*Center Base metal  
the tank  
Depth  
defect  
Coating  
Shift  
defect  
With  
B  
laughed  
erev  
emdb*

### **3.1 Operand GRID**

*Concept of the grid type.*

### **3.2 Operand MATER\_REV**

*Name of the concept of the material type defining material constituting the coating. Necessary for to recover the yield stresses, for the plastic correction of the stress intensity factors.*

### **3.3 Operand EPAIS\_REV**

*Thickness of the coating. Necessary for the correction of the stress intensity factors by factors of edges and for the plastic correction.*

### **3.4 Word key FISSURE**

*Key word factor for the geometrical characterization of the defect. It can be used only only once.*

### **3.4.1 Operand SHIFT**

*Shift of the crack in the coating starting from the interface coating/base metal. To note that the shift is necessarily negative. By defect, shift = 2.104.*



### **3.4.2 Operand DEPTH**

*Radial dimension of the defect.*

### **3.4.3 Operand LENGTH**

*The second dimension of the defect (axial or orthoradiale according to the orientation of the defect).*

### **3.4.4 Operand ORIENTATION**

*Characterization of the orientation of the defect: “CIRC” for a circumferential defect,  
“LONGI” for a longitudinal defect.*

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### **3.5 Word**

*key*

*KID*

*Key word factor for the characterization of the thermomechanical transient. The repetition of this key word is possible.*

### **3.5.1 Operands**

#### ***TABL\_MECA\_REV and TABL\_MECA\_MDB***

*Tables providing the transient of the constraints undergone by the tank during the history of loading, respectively side coating (of point A of the defect to the interface) and side metal of base (interface with the point B of the defect).*

### **3.5.2 Operand**

#### ***TABL\_THER***

*Count providing the thermal transient in the tank during the history of the loading of point A with the point B.*

### **3.5.3 Operand**

#### ***ENTITLE***

*Heading to specify the group of nodes considered.*

### **3.6 Operand**

#### ***TITRATE***

*Titrate attached to the concept produced by this operand [U4.03.01].*

## **4 Example**

*Examples of use of order POST\_K\_BETA are provided in the case test EPICU01. Before the use of order POST\_K\_BETA, it is necessary to record the constraints and them temperatures along the defect.*

*In the example below, the ways chem1, chem2 and chem3 on which statements of constraint and of temperature will be carried out are first of all defined.*

*Definition of chem1 which goes from the point of the defect side coating until the interface.*

***CHEM1=INTE\_MAIL\_2D (GRID = EMAIL,***

***GROUP\_MA***

***=***

***“R”,***

***INFORMATION***

***=***

***2,***

***PRECISION***

***=***

***1.0E-6,***

**DEFI\_SEGMENT**  
=  
**\_F (**  
**ORIGIN**  
=  
**(DEBFIS,**  
**0.0),**  
**GROUP\_NO\_EXTR**  
=  
**“Pi”,**

)

)

*Definition of chem2 which goes from the interface to the point of the defect side base metal.*

**CHEM2=INTE\_MAIL\_2D (GRID = EMAIL,**  
**GROUP\_MA**  
=  
**“Me,**  
**PRECISION**  
=  
**1.0E-6,**  
**INFORMATION**  
=  
**2,**  
**DEFI\_SEGMENT**  
=  
**\_F (**

**GROUP\_NO\_ORIG**

=

**“Pi”**,

**END**

=

**(EXTRABS,**

**0.0),**

)

)

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**Operator POST\_K\_BETA**

**Date:**

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**Author (S):**

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*Definition of chem3 which goes from the point of the defect side coating to that side base metal.*

**CHEM3=INTE\_MAIL\_2D (GRID = EMAIL,  
PRECISION**

**=**

**1.0E-6,**

**INFORMATION**

**=**

**2,**

**DEFI\_SEGMENT**

**=**

**\_F (**

**ORIGIN**

**=**

**(DEBFIS,**

**0.0),**

**END**

**=**

**(EXTRABS,**

**0.0),**

)

)

*Statement of the constraints on chem1: the constraints are recorded on the part of the defect located in coating.*

***S1\_G=POST\_RELEVE\_T (ACTION=\_F***  
***(WAY***  
***=***  
***CHEM1,***  
***ENTITLE***  
***=***  
***“GLOBAL1”,***  
***RESULT***  
***=***  
***SIG,***  
***TOUT\_CMP***  
***=***  
***“YES”,***  
***NOM\_CHAM***  
***=***  
***“SIGM\_ELNO\_DEPL”,***  
***LIST\_INST***  
***=***  
***LINST\_ME,***  
***OPERATION***  
***=***  
***“EXTRACTION”,***

)

)

***Statement of the constraints on chem2: the constraints are recorded on the part of the defect located in base metal.***

***S2\_G=POST\_RELEVE\_T (ACTION=\_F***  
***(WAY***  
***=***  
***CHEM2,***  
***ENTITLE***  
***=***  
***“GLOBAL2”,***  
***RESULT***  
***=***  
***SIG,***  
***TOUT\_CMP***  
***=***  
***“YES”,***  
***NOM\_CHAM***  
***=***  
***“SIGM\_ELNO\_DEPL”,***  
***LIST\_INST***  
***=***  
***LINST\_ME,***  
***OPERATION***  
***=***  
***“EXTRACTION”,***

)

)

*Statement of the temperatures on chem3: the temperature is recorded along the defect.*

***TEMP\_G=POST\_RELEVE\_T (ACTION=\_F***  
***(WAY***  
***=***

**CHEM3,**  
**ENTITLE**  
**=**  
**“GLOBAL3”,**  
**RESULT**  
**=**  
**TEMP,**  
**TOUT\_CMP**  
**=**  
**“YES”,**  
**NOM\_CHAM**  
**=**  
**“TEMP”,**  
**LIST\_INST**  
**=**  
**LINST\_TH,**  
**OPERATION**  
**=**  
**“EXTRACTION”,**

)

)

*After having taken these various readings, the calculation of the stress intensity factor can be done indeed using order **POST\_K\_BETA**.*

**TB\_KBETA = POST\_K\_BETA (GRID = EMAIL,**  
**MATER\_REV**  
**=**  
**MAME\_RE2,**  
**EPAIS\_REV**



=  
*EPREV,*  
*FISSURE =*

*\_F*  
(  
*DEPTH*  
=  
*6.,*  
*LENGTH*

=  
*60.,*  
*SHIFT*

=  
*-1.E-05,*  
*ORIENTATION=*  
*“CIRC”*  
)  
*KID*

= (*\_F (TABL\_MECA\_REV = S1\_G,*  
*TABL\_MECA\_MDB*  
=  
*S2-G,*  
*TABL\_THER*

=  
*TEMP\_G,*  
*ENTITLE*

=  
*“NOEINF”),),*  
*TITRATE*  
=

**'FIC  
BY  
METHOD  
K-BETA'**

)  
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**Code\_Aster ®  
Version  
7.4**

**Titrate:  
Operator POST\_K\_BETA**

**Date:  
08/02/05  
Author (S):  
A. DAHL, S. BUGAT, R. FERNANDES Key  
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*Titrate:*

*Operator POST\_CHAM\_XFEM*

*Date:*

*02/03/06*

*Author (S):*

*S. GENIAUT, C. REZETTE Key*

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*Organization (S): EDF-R & D /AMA, DeltaCAD*

*Instruction manual*

## ***U4.8- booklet: Postprocessing and dedicated analyses***

***Document: U4.82.22***

### ***Operator POST\_CHAM\_XFEM***

#### ***1 Goal***

***To create a SD Résultat containing the fields post-to treat method X-FEM.***

***It makes it possible to generate the fields displacements in order to post-treat them on the fissured grid.***

***Product a concept of the resultat\_sdaster type.***

***The order POST\_MAIL\_XFEM [U4.82.21] which makes it possible to generate the fissured grid is essential before the use of POST\_CHAM\_XFEM.***

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***Code\_Aster ®***

***Version***

***8.2***

***Titrate:***

***Operator POST\_CHAM\_XFEM***

***Date:***

***02/03/06***

***Author (S):***

***S. GENIAUT, C. REZETTE Key***

***:***

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**Code\_Aster** ®

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Titrate:

Operator *POST\_CHAM\_XFEM*

Date:

02/03/06

Author (S):

**S. GENIAUT, C. REZETTE** Key

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### 3 Syntax

*resu2 [resultat\_sdaster] = POST\_CHAM\_XFEM (*

*GRID = my,*

*[maillage\_sdaster]*

*MODEL = Mo, [modele\_sdaster]*

*RESULT*

*=*

*resu,*

*[resultat\_sdaster]*

*NOM\_CHAM =*

*“DEPL”*

*[TXM]*

*)*

### 4 Operands

*MODEL*

***Name of model X-FEM generated by order MODI\_MODELE\_XFEM.***

## ***GRID***

***Name of grid X-FEM generated by order POST\_MAIL\_XFEM [U4.82.21].***

## ***RESULT***

***Name of the concept result resulting beforehand from a STAT\_NON\_LINE.***

## ***NOM\_CHAM***

***Name of the field post-to be treated.***

***For the moment, only the field displacement (“DEPL”) can be post-treaty.***

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***Date:***

***02/03/06***

***Author (S):***

***S. GENIAUT, C. REZETTE Key***

***:***

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## ***5 Examples***

***of use***

### ***5.1***

***Bar fissured with X-FEM (treated by test SSNV173A)***

#### ***5.1.1 Extract of the command file***

**BEGINNING ();**

...

**# Definition of model X-FEM**

**MODELEIN=AFFE\_MODELE (MAILLAGE=MAILLAG2,**

**AFFE=\_F (GROUP\_MA= ("FLIGHT"),**

**PHENOMENE=' MECANIQUE',**

**MODELISATION='3D\_XFEM',**

**),**

**);**

**# Definition of the crack (planes)**

**LN=FORMULE (NOM\_PARA= ("X", "Y", "Z"), VALE=' Z-12.5 ');**

**LT=FORMULE (NOM\_PARA= ("X", "Y", "Z"), VALE=' X-10. ');**

**FISS=DEFI\_FISS\_XFEM (MODELE=MODELEIN,**

**DEFI\_FISS=\_F (**

**FONC\_LT=LT,**

**FONC\_LN=LN,**

**),**

**GROUP\_MA\_ENRI=' VOL',**

**ORIE\_FOND=\_F (PFON\_INI= (2.5, 0. , 12.5),**

**VECT\_ORIE= (0. , 0. , 1. ),**

**PT\_ORIGIN= (- 0.5, 0. , 1.5),),**

**CONTACT=\_F (...)**

**);**

**# Taken into account of the crack in model X-FEM**

**MODELEK=MODI\_MODELE\_XFEM (MODELE\_IN=MODELEIN,**

**FISSURE=FISS,**

**INFO=2,**

**);**

**# Conception of the grid fissures**

**MA\_XFEM=POST\_MAIL\_XFEM (MODELE=MODELEK)**

**# Definitions of the loadings and conditions limiting and material, then assignments**



...

**# Resolution**

**UTOT=STAT\_NON\_LINE (MODELE=MODELEK,...)**

**# Conception of the SD result containing the field of displacement to the nodes of the grid fissures**

**DEPL=POST\_CHAM\_XFEM (MAILLAGE=MA\_XFEM,  
MODELE=MODELEK,  
NOM\_CHAM=' DEPL',  
RESULTAT=UTOT)**

**END ();**

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**Titrate:**

**Operator POST\_CHAM\_XFEM**

**Date:**

**02/03/06**

**Author (S):**

**S. GENIAUT, C. REZETTE Key**

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**5.1.2 Visualization of the field displacement obtained by POST\_CHAM\_XFEM**

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***S. GENIAUT, C. REZETTE Key***

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***Code\_Aster ®***

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***Titrate:***

## ***Operator POST\_FATIGUE***

***Date:***

***31/01/06***

***Author (S):***

***J. Key ANGLES, A.M. DONORE***

***:***

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***Organization (S): EDF-R & D /AMA***

***Instruction manual***

***U4.8- booklet: Postprocessing and dedicated analyses***

***Document: U4.83.01***

## ***Operator POST\_FATIGUE***

### ***1 Goal***

***To calculate, in a point, the damage of tiredness of a structure subjected to a history of loading.***

***With the difference of CALC\_FATIGUE, POST\_FATIGUE does not operate on a field but on a “signal” extracted beforehand from a calculation or defines in addition.***

*The various methods available [R7.04.01] are:*

*methods based on uniaxial tests: methods of Wöhler, Manson-Whetstone sheath and Taheri. These methods have as a common point to determine a value of damage from evolution during the characterizing time of a scalar component, for the calculation of damage, the state of constraints or structural deformations.*

*With this intention, it is necessary to extract, by a method of counting of cycles, the cycles elementary of loading undergone by the structure, to determine the elementary damage associated each cycle and to determine the total damage by a rule of linear office plurality,*

*method of Lemaître generalized.*

*This method makes it possible to calculate the damage (of Lemaître or Lemaître-Sermage) with to leave the data of the tensor of the constraints and the cumulated plastic deformation,*

*criteria of Crossland and Dang Van-Papadopoulos.*

*These criteria apply to uniaxial or multiaxial loadings periodic. They provide a value of criterion indicating if there is damage or not.*

*Product a concept of the type counts.*

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*Count*

*matters*

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*2 Syntax*

*tabl\_post\_fatig = POST\_FATIGUE*

(

*# if purely uniaxial loading (or regarded as uniaxial)*

**/LOADING = "UNIAXIAL",**

**HISTORY =**

**\_F (**

**/SIGM = histsigm**

**/[function]**

**/**

**[formula]**

**/**

**EPSI**

**=**

**histepsi/**

**[function]**

**/**

**[formula]**

**),**

**COUNTING =/"RAINFLOW"**

**,**

**/**

**"RCCM"**

**,**

**/**

**"NATURAL"**

,  
*DELTA\_OSCI* =/*delta*  
, [*R*]  
/  
*0.*  
,  
[*DEFECT*]

*COEF\_MULT* = *\_F* (  
*KT*  
  
=  
*kt*  
)  
[*R*]

*CORR\_KE* = “*RCCM*”,

*DAMAGE* =/“*WOHLER*”  
,  
/  
“*MANSON\_COFFIN*”  
,  
/  
“*TAHERI\_MANSON*”  
,  
/  
“*TAHERI\_MIXTE*”  
,

*MATER*  
=  
*to subdue*  
,



***CORR\_SIGM\_MOYE =/"GOODMAN"***

,  
/  
***"TO STACK"***

,

***TAHERI\_NAPPE***

=  
***fnappe***

,  
/  
***[tablecloth]***

***/[formula]***

***TAHERI\_FONC***

=  
***ffonc***

,  
/  
***[function]***

*/[formula]*

**OFFICE PLURALITY**

=  
"LINEAR"  
,

*# Finsi*  
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*# if loading periodic (for tiredness with great numbers of cycles and for periodic cycles)*

*/LOADING = "PERIODIC",*

*HISTORY = \_F (*

*SIGM\_XX = fxx,/[function]/[formula]*

*SIGM\_YY = fyy,/[function]/[formula]*

*SIGM\_ZZ = fzz,/[function]/[formula]*

*SIGM\_XY = fxy,/[function]/[formula]*

***SIGM\_XZ = fxz,/[function]/[formula]***

***SIGM\_YZ = fyz,/[function]/[formula]***

)

***CRITERION =/"CROSSLAND"***

,  
/  
***"PAPADOPOULOS"***  
,

***DAMAGE = "WOHLER"***

,

***MATER***

=  
***to subdue***  
,  
***[to subdue]***

***COEF\_CORR***

=

/

**corr**

,

**[R]**

**/d0/0**

,

**[DEFECT]**

**# Finsi**

**# if loading unspecified (damage of Lemaitre or Lemaitre-Sermage)**

**/LOADING = "UNSPECIFIED",**

**HISTORY = \_F (**

**SIGM\_XX = fxx,/[function]/[formula]**

**SIGM\_YY = fyy,/[function]/[formula]**

$$\mathbf{SIGM\_ZZ} = f_{zz},/[function]/[formula]$$

$$\mathbf{SIGM\_XY} = f_{xy},/[function]/[formula]$$

$$\mathbf{SIGM\_XZ} = f_{xz},/[function]/[formula]$$

$$\mathbf{SIGM\_YZ} = f_{yz},/[function]/[formula]$$

$$\mathbf{EPSP} = p$$
$$,/[function]/[formula]$$

$$\mathbf{TEMP} = temp,/[function]/[formula]$$

)

***TOO BAD***

=

***“LEMAITRE”***,

***MATER***

=

***to subdue***

,

***OFFICE PLURALITY***

=

***“LINEAR”***

,

***# Finsi***

***INFORMATION =/1,***

***[DEFECT]***

***/ 2,***

***TITRATE***

=

*titrate*

*[l\_Kn]*

)

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*3 Operands*

*3.1 Operand*

*LOADING*

*This key word makes it possible the user to specify the type of treated loading. The loading can be “UNIAXIAL”, “PERIODIC” or “UNSPECIFIED”. With each loading corresponds its (or its) method (S) of evaluation of the damage by tiredness.*



### **3.2 Word**

**key**

#### **HISTORY**

*This key word gathers all the phase of definition of the history of loading.*

*According to the method of calculation of the damage, the history of loading can be the evolution:*

*.  
of a value of constraint or uniaxial deformation in the course of time,*

**Note:**

*That does not mean that the loading cannot be multiaxial, but only that for the calculation of the damage, the loading is characterized by the evolution of one scalar component, in the course of time (signed von Mises, invariant of a signed nature 2,...). It is the evolution of this scalar component which the user must provide to the order **POST\_FATIGUE**.*

*.  
tensor of constraints in the course of time,*

*.  
tensor of constraints, cumulated plastic deformation and temperature with the course time.*

#### **3.2.1 Operand**

##### **SIGM**

*SIGM = histsigm,*

*Name of the function or the formula describing the history of the loading in constraints in a point. It is a function or a formula of the parameter INST, which gives the evolution in the course of time of a scalar component characterizing the state of stresses of the structure.*

*This operand is obligatory for the calculation of the damage by a method of WOHLER.*

#### **3.2.2 Operand**

##### **EPSI**

*EPSI = histepsi,*

*Name of the function or the formula describing the history of the loading in deformations in one not. It is a function or a formula of the parameter INST, which gives the evolution to the course time of a scalar component characterizing the state of structural deformations.*

***This operand is obligatory for the calculation of the damage by the methods of MANSON\_COFFIN or TAHERI\_MANSON or TAHERI\_MIXTE.***

### ***3.2.3 Operands SIGM\_XX/SIGM\_YY/SIGM\_ZZ/SIGM\_XY/SIGM\_XZ/ SIGM\_YZ***

***Names of the functions or the formulas describing the history of each component of the tensor of constraints in the course of time. Each function or formula depends on parameter INST. All them functions or formulas must be defined for the same moments.***

***In 2D are obligatory operands SIGM\_XX, SIGM\_YY, SIGM\_ZZ and SIGM\_XY.***

***In 3D are obligatory operands SIGM\_XX, SIGM\_YY, SIGM\_ZZ, SIGM\_XY, SIGM\_XZ and SIGM\_YZ.***

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### ***3.2.4 Operand***

***EPSP***

***EPSP = p,***

***Name of the function describing the history of the plastic deformation cumulated in the course of time,  
only for the calculation of the damage of LEMAITRE.***

*This function or formula depends on parameter INST and must be defined for the same moments that functions or formulas describing the history of the components of the tensor of the constraints.*

*Operand EPSP must be used jointly with operands SIGM\_XX,...*

### **3.2.5 Operand TEMP**

*TEMP = temp,*

*Name of the function or the formula describing the history of the temperature in the course of time, only for the calculation of the damage of LEMAITRE. It is used in this case to determine value of the mechanical characteristics (Young modulus E, Poisson's ratio and parameter material S) at the moments of calculation of the damage.*

*This function or formula depends on parameter INST and must be defined for the same moments that functions or formulas describing the history of the components of the tensor of the constraints.*

*The operand TEMP must be used jointly with operands EPSP, SIGM\_XX,...*

### **3.3 Operand DELTA\_OSCI**

*DELTA\_OSCI = delta,*

*Filtering of the history of the loading. In all the cases, if the function remains constant or decreasing on more than two consecutive points one removes the intermediate points for to keep that two extreme points. Then, one removes history of loading the points for which the variation of the value of the constraint is lower than the value delta. By defect delta is equal to zero, which amounts keeping all the oscillations of the loading, even those of low amplitude.*

*Example: Let us consider the following history of loading:*

*N°  
not  
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15  
Moment  
0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14.  
Loading 4. 7. 2. 10. 9.6 9.8  
5. 9. 3. 4. 2. 2.4 2.2 12. 5.*

***N°***

***not***

***16 17 18 19 20 21 22 23 24 25 26 27 28 29***

***Moment 15.***

***16.***

***17.***

***18.***

***19.***

***20.***

***21. 22. 23. 24. 25. 26. 27. 28.***

***Loading 11. 1. 4. 3. 10. 6. 8. 12. 4. 8. 1. 9. 4. 6.***

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*The extraction of the peaks of this history of loading, with a value of delta of 0.9 conduit with to destroy all the oscillations of amplitude lower than 0.9. What leads to the history of loading following:*

*N°*

*not*

*1 2 3 4 7 8 9 10 11 14 15 16 17 18 19*

*Moment*

*0. 1. 2. 3. 6. 7. 8. 9. 10. 13. 14. 15. 16. 17. 18.*

*Loading 4. 7. 2. 10. 5. 9. 3. 4. 2. 12. 5. 11. 1. 4. 3.*

*N°*

*not*

*20 21 23 24 25 26 27 28 29*

*Moment 19.*

20.

22.

23.

24.

25.

26. 27. 28.

*Loading 10. 6. 12. 4. 8. 1. 9. 4. 6.*

*One removed:*

.  
*item 5 bus*

=  
)  
5  
(  
- (4) < 0.9 ,

.  
*item 6 bus*

=  
(6) - (4) < 0.9 ,

.  
*item 12 bus*

=  
12

(  
) -

)  
11

(  
< 0.9 ,

.

*the point 13 bus*

=

)

13

(

-

)

11

(

< 0.9 .

*In the same way one removes the point 22 bus the history of loading is increasing between the items 21, 22 and 23 and thus one keep only the extreme points.*

### **3.4 Word**

**key**

**COEF\_MULT**

**COEF\_MULT = \_F**

*This key word factor gathers the coefficients of performance of the history of loading. For the moment, only one multiplying coefficient of the history of loading is available: the coefficient of stress concentration *KT*.*

*Values of the coefficient of stress concentration are available in the *RCC\_M*.*

#### **3.4.1 Operand**

**KT**

**KT = kt**

*kt is the coefficient of stress concentration which depends on the geometry of the part, of geometry of a possible defect and type of loading. This coefficient is used to apply with the history of loading “filtered” a homothety of kt report/ratio.*

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### ***3.5 Operand COUNTING***

*COUNTING =*

*To be able to calculate the damage undergone by a structure, the cycles should beforehand be extracted elementary of the history of loading. For that of many methods are available. In Code\_Aster, three methods were programmed.*

*/“RAINFLOW”*

*,*

*Method of counting of extended in cascade or method of RAINFLOW (recommendation AFNOR A03-406 of November 1993) for the extraction of the cycles elementary of the history of loading [R7.04.01].*

*/*

*“RCCM”*

*,*

*Method of the RCC-M [R7.04.01].*

*/*

*“NATURAL”*

*,*

*Method known as natural which consists in generating the cycles in the order of their application [R7.04.01].*

### ***3.6 Operand CORR\_KE***

*CORR\_KE = “RCCM”,*



*This operand makes it possible to take account of an elastoplastic coefficient of concentration  $K_e$ , which is defined by the RCC-M as being the relationship between the amplitude of real deformation and the amplitude of deformation determined by an elastic analysis.*

$K$

$= 1$

if

$< 3S$

$E$

$m$

$K$

$= 1 + (1 - N)$

$E$

$(/3Sm -) 1 (N (m) 1) \text{ if } 3S$

$< < 3m S$

$m$

$m$

$K = 1 N$

if

$3m S$

$E$

$m$

$<$

*where  $S_m$  is the acceptable maximum constraint and  $N$  and  $m$  two constants depending on material.*

*The values  $S$*

$N$

$m$

$m$ ,

and

*are provided in operator `DEFI_MATERIAU [U4.43.01]` under the word key factor `TIRES` and operands `SM_KE_RCCM`, `N_KE_RCCM` and `M_KE_RCCM`.*

### **3.7 Operand**

#### **TOO BAD**

*To calculate the damage undergone by a structure in a point, various methods are available [R7.04.01].*

#### **3.7.1 Methods based on uniaxial tests: method of Wöhler, method of Manson-whetstone sheath, methods of Taheri**

*These methods have as a common point to determine a value of damage starting from the evolution with run from the time of a **scalar component** characterizing the state of constraint or deformation of structure.*

*That does not mean that the state of stresses cannot be multiaxial, but only that for calculation of the damage one chose a uniaxial component characterizing the state of stress or of deformation (forced of von Mises signed, invariant of a nature 2 signed of the tensor of deformations,...).*

*The methods of Manson-Whetstone sheath and Taheri use the deformations generated by loading.*

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*The method of Wöhler uses the constraints generated by the loading.*

*DAMAGE = “WOHLER”,*

*For a history of constraints associated with a uniaxial loading, the number of cycles with*

*rupture is given using the curve of Wöhler of the Nrupt material =*

**WOHLER**

.

2

*The curve of Wöhler of material must be introduced into operator DEF1\_MATERIAU [U4.43.01] under one of the three possible mathematical forms [R7.04.01]:*

*.  
point by point discretized function (key word factor TIRES, operand WOHLER),*

*.  
analytical form of Basquin (key word factor TIRES, operands A\_BASQUIN and BETA\_BASQUIN),*

*.  
form “current zone” (key word factor TIRES, operands E\_REFE, A0, A1, A2, A3 and SL and key word factor ELAS operand E).*

***Notice on the curves of tiredness:***

*For the small amplitudes of constraints, the problem of the prolongation of the curve of tiredness can be posed: for example, for the curves of tiredness of the RCC-M beyond 106 cycles, the corresponding constraint, 180 MPa is regarded as limit of endurance, i.e. very forced lower than 180 MPa must produce a factor of null use or an infinite number of cycles acceptable.*

*The method adopted here corresponds to this concept of limit of endurance: if the amplitude of constraint is lower than the first X-coordinate of the curve of tiredness, then one takes one factor of null use i.e. an infinite number of cycles acceptable.*

*DAMAGE = “MANSON\_COFFIN”,*

*For a uniaxial history of loading of type deformations, the number of cycles to the rupture is given using the curve of Manson-Whetstone sheath of material*

*Nrupt =*

*MANSON\_ WHETSTONE SHEATH*

*.  
2*

*The curve of Manson-Whetstone sheath of material must be introduced into operator DEF1\_MATERIAU [U4.43.01] (key word factor TIRES, operand MANSON\_COFFIN).*

*DAMAGE = “TAHERI\_MANSON”,*

*This method of calculation of the damage applies only to loadings in deformations.*

*Are N cycles elementary (extracted by a method of counting) of half-amplitude*

$I_1$ ,  
 $I_2$   
 $K$   
 $N$   
 $2$

*The value of the elementary damage of the first cycle is determined by interpolation on curve of Manson-Whetstone sheath of material.*

*The calculation of the elementary damage of the following cycles is carried out by the algorithm described  $C_i$  below:*

$+$   
 $\cdot$   
*If*  
 $I_1$   
 $I$

$2$   
 $2$

*the calculation of the elementary damage of the cycle  $(I + 1)$  is determined by interpolation on curve of Manson-Whetstone sheath of material,*

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+  
.  
*If*  
*I I*  
*I*  
<  
2  
2

*one determines:*

*I*  
*I*  
*J*  
*+I =*  
*+I*

*Fnappe*  
*, Max*

2  
2  
*j < i 2*  
\*  
*i+1*  
*i+1*  
=

*Ffonc*

2

2

where:

*Fnappe* is a tablecloth introduced under operand *TAHERI\_NAPPE*,

*Ffonc* is a function introduced under operand *TAHERI\_FONC*.

*\*i+ 1*

The value of the damage of the cycle (*I +*)

*1* is obtained by interpolation of

on the curve of

2

Manson-whetstone sheath of material.

*NR*

is the number of cycles to the rupture of the cycle (*I +*)

*1*

*I*

*rupt 1*

+

*I + 1*

*NR*

= *MANSON\_COFFIN*

*I*

*rupt 1*

+

2

and

*I*

*Dom 1*

+ is the damage of the cycle (*I +*)

*1 = 1 Nrupt.*

*I + 1*

The curve of Manson-Whetstone sheath of material must be introduced into operator *DEFI\_MATERIAU*

[U4.43.01] (key word factor *TIRES*, operand *MANSON\_COFFIN*).

*DAMAGE* = “*TAHERI\_MIXTE*”,

*This method of calculation of the damage applies only to loadings in deformations.*

*Are N cycles elementary (extracted by a method of counting) of half-amplitude*

*I*

, ,

*N*

*L*

.

*2*

*2*

*The value of the elementary damage of the first cycle is determined by interpolation on curve of Manson-Whetstone sheath of material.*

*The calculation of the elementary damage of the following cycles is carried out by the algorithm described below:*

*I + 1*

.

*If*

*I*

*2*

*2*

*the calculation of the elementary damage of the cycle (I +) I is determined by interpolation on curve of Manson-Whetstone sheath.*

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*I + 1*

*.*  
*If*  
*I*  
*<*

*2*  
*2*

*one determines:*

*I*  
*+*  
*I*  
*I + 1*  
*I*  
*= Fnappe*  
*, Max*

*2*  
*2*  
*J < I 2*

*where Fnappe is a tablecloth introduced under the operand of TAHERI\_NAPPE.*

*I + 1*  
*The value of the damage of the cycle (I +)*



*I* is obtained by interpolation of  
on  
2  
curve of Wöhler of material.

*NR*  
is the number of cycles to the rupture for the cycle (*I* +)  
*I*  
*I*  
rupt *I*  
+

*I* + *I*  
*NR*  
= *WÖHLER*

*I*  
rupt *I*  
+

2

and  
*I*  
*Dom I*  
+ is the damage of the cycle (*I*  
) *I*  
+ .

*Dom*  
*I*  
= /  
*I I*  
+

*NR*  
.  
*I*  
rupt *I*  
+

*This method requires the data of the curve of Wöhler and the curve of Manson-Whetstone sheath material which must be introduced into operator DEFI\_MATERIAU [U4.43.01] (key word factor TIRES).*

### 3.7.2 Methods of Lemaître and Lemaître-Sermage

*These two methods make it possible to calculate the damage  $D$  ( $T$ ) starting from the data of the tensor of constraints ( $T$ ) and of the plastic deformation cumulated  $p$  ( $T$ ).*

*They thus apply to unspecified loadings and are used only in postprocessing of one plastic or viscoplastic law having  $p$  like variable.*

*The evolution of  $D$  is defined by:*

$S$

$1$

$D \& =$

$1$

$2$

$3$

$(1 + ) +$

$eq$

$(1 - 2 )$

$2$

$p$

$if$

$\&$

$p >$

$($

$p$

$H$

$D$

$1 - D) 2s$

$3 ES$

$2 ES$

$D =$

$0$

*if not*

*where E: Young modulus,  $\nu$ : Poisson's ratio, S and S: parameters material: constraint eq equivalent of von Mises: hydrostatic pressure, p: cumulated plastic deformation and p: H D threshold of damage.*

*DAMAGE = "LEMAITRE",*

*Allows to calculate the damage of Lemaître or Lemaître-Sermage D (T) starting from the data tensor of the constraints (T) and cumulated plastic deformation p (T). To note that it damage of Lemaître is obtained by assigning value 1.0 with the exhibitor S (S = 1).*

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**3.8 Operand**

**CORR\_SIGM\_MOYE**

*CORR\_SIGM\_MOYE*

=

/

**"GOODMAN"**

,

/

“TO STACK”

,  
*This operand is used only in the case of the calculation of the damage by the method of WOHLER.*

*If the part is not subjected to pure or symmetrical alternate constraints, i.e. if average constraint of the cycle is not null, one can balance the curve of Wöhler to calculate the number of effective cycles to the rupture using the diagram of Haigh [R7.04.01].*

*Starting from a cycle (S, S  
alt  
m) identified in the signal, one calculates the value of the alternate constraint corrected Salt.*

*If the line of Goodman is used*

*S  
S  
=  
alt  
alt  
·  
1 - m*

*U  
S  
If one uses the parabola To stack*

*S  
S  
=  
alt  
alt  
·*

*2  
1 - m  
U  
S*

*The value of the limit to the rupture of the Su material must be introduced into the operator DEF1\_MATERIAU [U4.43.01] (key word factor TIRES, Su operand).*

### **3.9 Operand**

#### **TAHERI\_NAPPE**

*TAHERI\_NAPPE = fnappe,*

*This operand makes it possible to specify the name of a tablecloth.*

*fnappe*  
*, max necessary to the calculation of the damage by methods TAHERI\_MANSON and*  
*2*

*TAHERI\_MIXTE.*

*The tablecloth must have as parameters X and EPSI.*

*The tablecloth introduced under operand TAHERI\_NAPPE is the cyclic curve of work hardening with prestressed material.*

*The cyclic curve of work hardening without pre-work hardening, given under key word TAHERI\_FONC, must be obligatorily one of the curves defining the tablecloth. This curve must be given for X = 0.*

### **3.10 Operand**

#### **TAHERI\_FONC**

*TAHERI\_FONC = ffonc,*

*This operand makes it possible to specify the name of a function*

*ffonc*  
*necessary to the calculation of*  
*2*  
*damage by method TAHERI\_MANSON.*

*The parameter of this function must be SIGM.*

*This function is the cyclic curve of work hardening of material.*

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### **3.11 Operand**

#### **MATER**

*MATER = to subdue,*

*Allows to specify the name of the MATER material created by DEFI\_MATERIAU [U4.43.01].*

*The MATER material must contain the values of all the data materials necessary to calculation of the damage.*

### **3.12 Operand**

#### **OFFICE PLURALITY**

*OFFICE PLURALITY = "LINEAR",*

*The methods of WOHLER, MANSON\_COFFIN and TAHERI calculate a value of damage for each elementary cycle extracted the uniaxial loading introduced by the user.*

*The operand OFFICE PLURALITY makes it possible to require the calculation of the total damage undergone by the structure in one not.*

*The only rule available is the rule To mine, which consists in summoning all the damage elementary  $D =$*

*$D_i$ .*

*$I$*

### **3.13 Operands**

#### **CRITERION**

*CRITERION =  
/“CROSSLAND”,  
/  
“PAPADOPOULOS”  
,*

*The criteria of Crossland and Dang Van-Papadopoulos apply to loadings uniaxial or multiaxial **periodicals**.*

*The user introduces the values of each component of the tensor of the constraints into various moments (to,  $T$   
 $K NR$ ), and one suppose that  $[T, T$   
 $O$   
 $NR]$  is one period of the loading.*

*The loadings must be in constraints.*

*The goal of these criteria is not to determine a value of damage, but a value of criterion  $R_{crit}$  such as:*

*$R_{crit} = 0$  step of damage,*

*$R_{crit} > 0$  possible damage.*

*One can however determine a value of damage by extension [§3.13.3].*

### **3.13.1 Criterion of Crossland**

**$R$   
= +  $P$  has  
-  $B$   
 $crit$   
has  
 $max$**

**$l$   
~  
~  
where**

**=  
 $Max Max S$   
has  
 $(It) - S (t0)$**

*amplitude*

*is*

*of cission*

*2 0t0 T*

*0*

*T*

*1*

*T*

*~*

*with S deviative of the tensor of the constraints*

*1*

*P*

*=*

*max*

*Max traces*

*is*

*pressure hydrostati*

*that maximum*

*0tT 3*

*D*

*has =*

*- 0*

*d0 and B =*

*0*

*3*

*0*

*3*



*with:*

*is  
of*

*limit  
cisailleme*

*in*

*endurance  
pure*

*NT  
alternated,*

*0*

*D*

*is  
of*

*limit  
traction*

*in*

*endurance  
- compressio  
alternated.*

*pure*

*N  
0*

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### ***3.13.2 Criterion of Dang Van-Papadopoulos***

***R***  
***K \* has P***  
***B***  
***crit***  
***=***  
***+***  
***-***  
***max***

***where K \* = R with R ray of the smallest sphere circumscribed with the way of loading in***  
***~***  
***the space of the diverters of constraints S***

***1***  
***R =***  
***Max***  
***(~S (T) - C) \* (~***  
***: S (T) - C)***  
***\****

***0 T T***  
***2***  
***~***  
***where C \* =***

***~***  
***MinMax (S (T) C***  
***-): (S (T) C***  
***- )***  
***center***

*is*

*of hypersphère*

*1*

*P*

=

*max*

*Max traces*

*is*

*pressure hydrostati*

*that maximum*

*0tT 3*

*D D*

*0*

*0*

*has =*

-

*B =*

*0*

*0*

*3 3*

*with:*

*is*

*0*

*of*

*limit*  
*cisailleme*

*in*

*endurance*  
*pure*

*NT*  
*alternated,*

*D*

*is*  
*0*

*of*

*limit*  
*traction*

*in*

*endurance*  
*- compressio*  
*alternated.*

*pure*

*N*

### ***3.13.3 Operand COEF\_CORR***

***COEF\_CORR = corr,***

***The criteria of Crossland and Dang Van-Papadopoulos allow for loadings periodicals to calculate a Rcrit value which indicates if there is damage or not for the number of cycles associated with the limits with endurances and D.***

***0***

***0***

***These criteria do not give a value of the damage, which can however be interesting.***

***With this intention, one proposes to use the value of the criterion and the curve of Wöhler of material,***

*in  
defining an equivalent constraint*

*\* (  
= **R**  
+ **b**  
crit  
) ×*

*.  
corr*

*The value of the damage is obtained while applying \* to the curve of Wöhler of material.*

*So that there is coherence between the criterion and the curve of Wöhler, it is necessary that:*

*\*  
no damage  
0*

*>  
too bad  
0*

*for a curve of Wöhler defined in shearing and that:*

*\* **D**  
no damage  
0*

*> **D**  
too bad  
0*

*for a curve of Wöhler defined in traction and compression.*

*The user can thus specify a value CORR, by taking account of the type of curve of Wöhler it has.*

***D**  
The value taken by defect is 0 in coherence with curves of Wöhler in*

**0**  
**traction and compression.**

**Note:**

**If  $R$**   
 **$< 0$ , if the prolongation on the left of the curve of Wöhler is**  
**crit**

**linear (in `DEFI_FONCTION (... PROL_GAUCHE = "LINEAR"...`), the user**  
**a damage different from zero will obtain. To obtain a null damage when  $R$**

**$< 0$ ,**

**crit**

**it is necessary that the prolongation on the left equal to "IS EXCLUDED" or "CONSTANT".**

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**3.14 Operand**

**INFORMATION**

**INFORMATION =/1,**

**Impression:**

**.**

**elementary cycles determined by the method of counting chosen by the user,**

**.**

**elementary damage associated each cycle for methods `WOHLER`,**  
**`MANSON_COFFIN` and `TAHERI`,**

•  
*damage of LEMAITRE in each point of calculation,*  
•  
*total damage (if the user asked for his calculation).*

*INFORMATION =/2,*

*Impression:*

•  
*history of loading introduced by the user under operands SIGM and EPSI,*  
•  
*peaks extracted the history of loading (introduced under operands SIGM and EPSI),*  
•  
*elementary cycles determined by the method of counting chosen by the user,*  
•  
*elementary damage associated each cycle for methods WOHLER, MANSON\_COFFIN and TAHERI,*  
•  
*damage of LEMAITRE in each point of calculation,*  
•  
*total damage (if the user asked for his calculation).*

*The impressions are made in the file message.*

### *3.15 Operand TITRATE*

*TITRATE = title*

*Titrate associated with the table.*

### *3.16 Count produced*

*Operator POST\_FATIGUE creates a table which is different according to calculations from postprocessing carried out:*

•  
*Loading uniaxial (Wöhler methods, Manson-Whetstone sheath and Taheri).*

*The table includes/understands five parameters:*

**NB\_CYCL**

*: a number of elementary cycles extracted by the method of counting,*

**VALE\_MIN**

*: values of the constraints or minimal deformations of each cycle elementary,*

**VALE\_MAX**

*: values of the constraints or maximum deformations of each cycle elementary,*

**TOO BAD**

*: values of the damage for each elementary cycle,*

**DOMM\_CUMU**: *value of the total damage after office plurality on all the cycles elementary.*

.

*Periodic loading (criteria of Crossland and Dang Van-Papadopoulos).*

*The table includes/understands five parameters:*

**CRITERION**

*: value of the criterion*

**PRES\_HYDRO\_MAX**: *value of the maximum hydrostatic pressure,*

**AMPLI\_CISSION**: *value of the amplitude of cission has (if calculated),*

**RAYON\_SPHERE**

*: value of the ray of the sphere circumscribed with the loading  $k^*$  (if calculated),*

**TOO BAD**

*: value of the damage of Wöhler (if requested by the user).*

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**.**

**Unspecified loading (damage of Lemaître and Lemaître-Sermage).**

**The table includes/understands two parameters:**

**TOO BAD**

**: value of the damage in each point of discretization loading,**

**D\_CUMULE**

**: value of the cumulated damage (if requested by the user).**

**Order IMPR\_TABLE [U4.91.03] makes it possible to print the produced table.**

## **4 Examples**

### **4.1 Calculation of the damage of Wöhler (with correction of the constraint average)**

**# Definition of the loading**

**taun = DEFI\_FONCTION (**

**NOM\_PARA = "INST",**

**VALE = (0. , 50. ,**

**1. , 600. ,**

**2. , 50. ,**

**3. , - 500. ,**

**4. , 50. ,))**

**# Definition of the curve of Wöhler**

**wohl = DEFI\_FONCTION (**

**NOM\_PARA = "SIGM",**

**INTERPOL = "LOG",**

**PROL\_DROIT = "LINEAR",**

**PROL\_GAUCHE = "LINEAR",**

**VALE = (138. , 1000000. ,  
::  
..  
2900., 10.,))**

**# Definition of Material**

**chechmate = DEFI\_MATERIAU (  
TIRE = \_F (WOHLER = wohl)  
RCCM = \_F (KNOWN = 850. ))**

**# Calculation of damage**

**COUNT = POST\_FATIGUE (  
LOADING = "UNIAXIAL",  
HISTORY = \_F (SIGM = taun),  
COUNTING = "RCCM",  
MATER = chechmate,  
DAMAGE = "WOHLER",  
OFFICE PLURALITY = "LINEAR",  
INFORMATION = 2)**

***This example results from test SZLZ100 (see [V9.01.100]).***

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## 4.2

### **Calculation of the damage of Taheri**

*# Definition of the loading*

*taun = DEFI\_FONCTION (*

*NOM\_PARA = "INST",*

*PROL\_DROITE = "LINEAR",*

*PROL\_GAUCHE = "LINEAR",*

*VALE = (0. , 0. ,*

*1. , 3.5,*

*2. , 3. ,*

*3. , 3.5,*

*4. , 3. ,*

*5. , 3.5,*

*6. , 1. ,*

*7. , 2.5,*

*8. , 0. ,*

*9. , 0.5, ))*

*# Definition of the Ffonic function: cyclic curve of work hardening of*

*# material*

*f\_eps = DEFI\_FONCTION (*

*NOM\_PARA = "SIGM",*

*PROL\_DROITE = "LINEAR",*

*PROL\_GAUCHE = "LINEAR",*

*VALE = (0. , 0. ,*

*1000., 10.,)*

*TITRATE = "Function of Taheri"*

)

*# Definition of the Fnappe tablecloth: cyclic curve of work hardening with pre  
# forced of material*

*f\_epsmax = DEFI\_NAPPE (*

*NOM\_PARA = "X",*

*PROL\_DROITE = "LINEAR",*

*PROL\_GAUCHE = "LINEAR",*

*PARA = (0.5, 1. ,),*

*NOM\_PARA\_FONC = 'EPSI',*

*DEFI\_FONCTION = (*

*\_F (PROL\_DROITE = "LINEAR",*

*PROL\_GAUCHE = "LINEAR",*

*VALE = (0. , 25. ,*

*10. , 525.,)),*

*\_F (PROL\_DROITE = "LINEAR",*

*PROL\_GAUCHE = "LINEAR",*

*VALE = (0. , 50. ,*

*10. , 550.,*

*))),*

*TITRATE = "TABLECLOTH OF TAHERI")*

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*# Definition of the curve of Wöhler*

```
f_wohl = DEFI_FONCTION (  
NOM_PARA = "SIGM",  
PROL_DROITE = "LINEAR",  
PROL_GAUCHE = "LINEAR",  
VALE = (0. , 200000. ,  
200. , 0.),  
TITRATE = "FUNCTION OF WOHLER"  
)
```

*# Definition of the curve of Manson-Whetstone sheath*

```
f_mans = DEFI_FONCTION (  
NOM_PARA = "EPSI",  
PROL_DROITE = "LINEAR",  
PROL_GAUCHE = "LINEAR",  
VALE = (0. , 200000. ,  
2. , 0.),  
TITRATE = "FUNCTION OF MANSON-COFFIN")
```

*# Definition of material*

```
mat0 = DEFI_MATERIAU (  
TIRE = _F (WOHLER = f_wohl,  
MANSON_COFFIN = f_mans))
```

*# Calculation of the damage*

```
tabl1 = POST_FATIGUE (  
LOADING = "UNIAXIAL",  
HISTORY = _F (EPSI = taun),  
COUNTING = "RAINFLOW",  
DAMAGE = "TAHERI_MANSON",  
TAHERI_FONC = f_eps,  
TAHERI_NAPPE = f_epsmax,  
MATER = mat0,  
OFFICE PLURALITY = "LINEAR",  
INFORMATION = 2)
```

```
tabl2 = POST_FATIGUE (  
LOADING = "UNIAXIAL",  
HISTORY = _F (EPSI = taun),  
COUNTING = "RAINFLOW",  
DAMAGE = "TAHERI_MIXTE",  
TAHERI_NAPPE = f_epsmax,  
MATER = mat0,
```

*OFFICE PLURALITY = "LINEAR",  
INFORMATION = 2)*

*This example results from test SZLZ108 (see [V9.01.108]).*

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### ***4.3***

#### ***Calculation of the criteria of Crossland and Dang Van-Papadopoulos***

*# Definition of the loading*

*taun1 = DEFI\_FONCTION (*

*NOM\_PARA = "INST",*

*VALE = (1. , 411. ,*

*2. , 0.,*

*3. , -411.,))*

*taun2 = DEFI\_FONCTION (*

*NOM\_PARA = "INST",*

*VALE = (1. , 205. ,*

*2. , 0.,*

*3. , -205.,))*

*taun3 = DEFI\_FONCTION (*

*NOM\_PARA = "INST",*

*VALE = (1. , 0. ,*

*2. , 0.,*

3. , 0.,))

*# Definition of material*

```
mat0 = DEFI_MATERIAU (
TIRE = _F (WOHLER = whol,
D0 = 540.97,
TAU0 = 352. ,))
```

*# Calculation of the criterion of Crossland*

```
table1 = POST_FATIGUE (
LOADING = "PERIODIC",
HISTORY = _F (SIGM_XX = taun1, SIGM_XY = taun2,
SIGM_YY = taun3, SIGM_XZ = taun3,
SIGM_ZZ = taun3, SIGM_YZ = taun3),
```

```
CRITERION = "CROSSLAND",
MATER = mat0,
INFORMATION = 2)
```

*# Calculation of the criterion of Dang Van-Papadopoulos*

```
table2 = POST_FATIGUE (
LOADING = "PERIODIC",
HISTORY = _F (SIGM_XX = taun1,
SIGM_YY = taun3,
SIGM_ZZ = taun3,
SIGM_XY = taun2,
SIGM_XZ = taun3,
SIGM_YZ = taun3),
```

```
CRITERION = "PAPADOPOULOS",
MATER = mat0,
INFORMATION = 2)
```

*This example results from test SZLZ107 (see [V9.01.107]).*

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### **4.4**

#### ***Calculation of the damage of Lemaître***

*# Definition of the loading*

*taun1 = DEFI\_FONCTION (*

*NOM\_PARA = "INST",*

*VALE = (43.11, 300. ,*

*100. , 300.,*

*1000. , 300.,*

*10000. , 300.,*

*20000. , 300.,*

*21000. , 300.,*

*22000. , 300.,*

*22200. , 300.,*

*22400. , 300., ))*

*taun2 = DEFI\_FONCTION (*

*NOM\_PARA = "INST",*

*VALE = (43.11, 0. ,*

*100. , 0.,*

*1000. , 0.,*

*10000. , 0.,*

*20000. , 0.,*

*21000. , 0.,*

*22000. , 0.,*

*22200. , 0.,*

*22400. , 0., ))*

*t\_epsp = DEFI\_FONCTION (*

*NOM\_PARA = "INST",*

*VALE = (43.11, 0.019996,*

*100. , 0.046384,*



1000. , 0.46384 ,  
10000. , 4.6384 ,  
20000. , 9.2768 ,  
21000. , 9.74064 ,  
22000. , 10.20448 ,  
22200. , 10.297248 ,  
22400. , 10.390016 , )

*t\_temp* = *DEFI\_FONCTION* (  
*NOM-PARA* = "INST",  
*VALE* = (43.11, 20. ,  
100. , 20.,  
1000. , 20.,  
10000. , 20.,  
20000. , 20.,  
21000. , 20.,  
22000. , 20.,  
22200. , 20.,  
22400. , 20., )

*t\_e* = *DEFI\_FONCTION* (  
*NOM\_PARA* = "TEMP",  
*VALE* = (20. , 2.E+5, ),  
*PROL\_DROITE* = "CONSTANT",  
*PROL\_GAUCHE* = "CONSTANT", )

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*Operator POST\_FATIGUE*

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```
t_nu = DEFI_FONCTION (
NOM_PARA = "TEMP",
VALE = (20. , 0. ,),
PROL_DROITE = "CONSTANT",
PROL_GAUCHE = "CONSTANT")
```

```
t_s = DEFI-FONCTION (
NOM_PARA = "TEMP",
VALE = (20. , 7. ,),
PROL_DROITE = "CONSTANT",
PROL_GAUCHE = "CONSTANT",)
```

```
epsp_s = DEFI-FONCTION (
NOM_PARA = "TEMP",
VALE = (20. , 0.02,),
PROL_DROITE = "CONSTANT",
PROL_GAUCHE = "CONSTANT",)
```

```
mat1 = DEFI_MATERIAU (
ELAS_FO = _F (E = t_e,
NAKED = t_nu),
DOMMA_LEMAITRE = _F (S = t_s,
EPSP_SEUIL = epsp_s,
EXP_S
= 1.0 )
)
TAB_1 = POST_FATIGUE (
LOADING = "UNSPECIFIED",
HISTORY = _F (SIGM_XX = taun1, SIGM_XY = taun2,
SIGM_YY = taun2, SIGM_XZ = taun2,
SIGM_ZZ = taun2, SIGM_YZ = taun2,
EPSP = t_epsp,
TEMP = t_temp),

MATER = mat1,
DAMAGE = "LEMAITRE",
INFORMATION = 2)
```

This example results from test SZLZ109 (see [V9.01.109]).

## 4.5 Calculation of the damage of Lemaitre-Sermage

*TAUN1=DEFI\_FONCTION (NOM\_PARA=' INST',  
VALE= (43.11, 300. ,*

*100., 300.,  
1000., 300.,  
10000., 300.,  
20000., 300.,  
21000., 300.,  
22000., 300.,  
22200., 300.,  
22400., 300., ) )*

*TAUN2=DEFI\_FONCTION (NOM\_PARA=' INST',  
VALE= (43.11, 0. ,*

*100., 0.,  
1000., 0.,  
10000., 0.,  
20000., 0.,  
21000., 0.,  
22000., 0.,  
22200., 0.,  
22400., 0., ) )*

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*T\_EPSP=DEFI\_FONCTION (NOM\_PARA=' INST',*

*VALE* = (43.11, 0.019996,  
 100., 0.046384,  
 1000., 0.46384,  
 10000., 4.6384,  
 20000., 9.2768,  
 21000., 9.74064,  
 22000., 10.20448,  
 22200., 10.297248,  
 22400., 10.390016, ) )

*T\_TEMP* = *DEFI\_FONCTION* (*NOM\_PARA* = 'INST',  
*VALE* = (43.11, 20. ,  
 100., 20.,  
 1000., 20.,  
 10000., 20.,  
 20000., 20.,  
 21000., 20.,  
 22000., 20.,  
 22200., 20.,  
 22400., 20., ) )

*T\_E* = *DEFI\_FONCTION* (*NOM\_PARA* = 'TEMP',  
*PROL\_DROITE* = 'CONSTANT',  
*PROL\_GAUCHE* = 'CONSTANT',  
*VALE* = (20. , 2.E+5,))

*T\_NU* = *DEFI\_FONCTION* (*NOM\_PARA* = 'TEMP',  
*PROL\_DROITE* = 'CONSTANT',  
*PROL\_GAUCHE* = 'CONSTANT',  
*VALE* = (20. , 0. ,))

*T\_S* = *DEFI\_FONCTION* (*NOM\_PARA* = 'TEMP',  
*PROL\_DROITE* = 'CONSTANT',  
*PROL\_GAUCHE* = 'CONSTANT',  
*VALE* = (20. , 7.0,))

*EPSP\_S* = *DEFI\_FONCTION* (*NOM\_PARA* = 'TEMP',  
*PROL\_DROITE* = 'CONSTANT',  
*PROL\_GAUCHE* = 'CONSTANT',  
*VALE* = (20. , 0.02,))

*MAT2* = *DEFI\_MATERIAU* (*ELAS\_FO* = *\_F* (*E* = *T\_E*,  
*NAKED* = *T\_NU*,),

```
DOMMA_LEMAITRE=_F (S = T_S,  
EPSP_SEUIL = EPSP_S,  
EXP_S = 1.003,);
```

```
TAB_2=POST_FATIGUE (CHARGEMENT=' QUELCONQUE',  
HISTOIRE=_F (SIGM_XX = TAUN1,  
SIGM_YY = TAUN2,  
SIGM_ZZ = TAUN2,  
SIGM_XY = TAUN2,  
SIGM_XZ = TAUN2,  
SIGM_YZ = TAUN2,  
EPSP = T_EPSP,  
TEMP = T_TEMP,),  
MATER=MAT2,  
DOMMAGE=' LEMAITRE',  
CUMUL=' LINEAIRE',);
```

*This example results from test SZLZ109 (see [V9.01.109]).*

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*One can find other examples in the tests:*

*SZLZ101 ([V9.01.101]): Calculation of the damage/Rainflow method.*

*SZLZ102 ([V9.01.102]): Tire with various methods counting.*

*SZLZ103 ([V9.01.103]): Tire counting by Rainflow method normalizes AFNOR.*

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*Organization (S): EDF-R & D /AMA*

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***Operator CALC\_FATIGUE***

***1 Goal***

*To calculate a field of damage of tiredness undergone by a structure and to determine the plan criticize in which shearing is maximum.*

*Calculation of a field of damage: starting from a history of equivalent constraints (forced von Mises signed) or of deformations equivalent (invariant of the second signed order) calculated to nodes or at the points of Gauss and stored in a concept result of the evol\_elas type, evol\_noli or dyna\_trans, one calculates a field of size which contains the damage undergone by the structure in each node or in each point of Gauss.*

*With this intention, in each node or each point of Gauss, CALC\_FATIGUE:*

*reads in the structure of data result the equivalent constraint of von Mises signed (VMIS\_SG) or the second signed invariant (INVA\_2SG),*

*extract by a method of counting of cycles (method RAINFLOW) elementary cycles of loading (history of the equivalent constraint or equivalent deformation) undergone by the structure,*

*determine the elementary damage associated with each elementary cycle,*

*determine the total damage undergone by the structure by a linear rule of office plurality while summoning elementary damage.*

*Critical plan and maximum shearing: starting from a history of constraints calculated at the points of Gauss (SIEF\_ELGA, or SIEF\_ELGA\_DEPL) or with nodes (SIEF\_NOEU\_ELGA or SIGM\_NOEU\_DEPL)*

*and stored in a concept result of the evol\_elas type or evol\_noli, if the loading is periodic, we calculate a field of size which contains inter alia: the half amplitude of maximum shearing, the associated normal vector, the number of cycles to the rupture and the damage corresponding to the points of Gauss or the nodes. If the loading is not periodical the field of sizes contains the maximum damage and the normal vector associated the points of Gauss or with the nodes.*

*Product a concept of the cham\_elem\_DOMMAG type or cham\_elem\_FACY\_R or cham\_no\_FACY\_R.*

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### ***2 Syntax***

***CHAM [cham\_elem\*] = CALC\_FATIGUE (***

***TYPE\_CALCUL =/"CUMUL\_DOMMAGE",***

***/***

***"FATIGUE\_MULTI",***

***# If TYPE\_CALCUL = "CUMUL\_DOMMAGE" - > calculation of the damage***

***# Choice of the option of calculation***

***OPTION***

***=/"DOMA\_ELNO\_SIGM"***

***,***

***/***

***"DOMA\_ELGA\_SIGM"***

***,***

***/***

***"DOMA\_ELNO\_EPSI"***

***,***

***/***

***"DOMA\_ELGA\_EPSI"***

***,***

***/***

***"DOMA\_ELNO\_EPME"***

,  
/  
**“DOMA\_ELGA\_EPME”**  
,

***# Reading of the history of constraint or deformation***

***HISTORY = \_F (***

***RESULT***

***=***

***LMBO,***

***/***

***[evol\_elas]***

***/***

***[evol\_noli]***

***/***

***[dyna\_trans]***

***EQUI\_GD =***

***/***

***“VMIS\_SG”, [DEFECT]***

***/***

***“INVA\_2\_SG”,***

***)***

***# Calculation of the damage***

*DAMAGE* =/“*WOHLER*”,  
/  
“*MANSON\_COFFIN*”,  
/  
“*TAHERI\_MANSON*”,  
/  
“*TAHERI\_MIXTE*”  
,

*MATER*  
=  
*to subdue*,  
[*to subdue*]

*TAHERI\_NAPPE*  
=  
*tablecloth*,  
/  
[*tablecloth*]

/  
[*formula*]

*TAHERI\_FONC*  
=  
*fonc*,

/  
*[function]*

/  
*[formula]*

),

***# Finsi***

***# If TYPE\_CALCUL = "FATIGUE\_MULTI" - > Calculation of the maximum shearing or of***

***maximum damage***

***TYPE\_CHARGE =/"PERIODIC",***

/  
“NON\_PERIODIQUE”,

**OPTION**

=  
/  
“DOMA\_ELGA”,

/  
“DOMA\_NOEUD”,

**RESULT**

=  
**LMBO,**  
/  
*[evol\_elas]*  
/  
*[evol\_noli]*

**CHAM\_MATER =**  
*cham\_mater,*  
*[cham\_mater]*

**# If TYPE\_CHARGE = “PERIODIC”**

**CRITERION =/“MATAKE”,**

*/“DANG\_VAN\_MODI\_AC”,*

*METHOD =/“CERCLE\_EXACT”,*

*# Finsi*

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**# If *TYPE\_CHARGE* = “NON\_PERIODIQUE”**

*CRITERION* =/“*DOMM\_MAXI*”,

/  
“*DANG\_VAN\_MODI\_AV*”,

/  
“*FATEMI\_SOCIE*”,

*PROJECTION* =/“*UN\_AXE*”,

/  
"DEUX\_AXES",

DELTA\_OSCI =/delta,  
[R]

/  
0.,

[DEFECT]

# **Finsi**

/  
**GRID**  
=  
grid,  
[grid]

/  
**GROUP\_MA**  
=  
grma,  
[l\_gr\_maille]

/  
**NET**  
=



*my,*  
*[l\_maille]*

/

*GROUP\_NO*

=

*grno,*  
*[l\_gr\_noeud]*

/

*NODE*

=

*No,*  
*[l\_noeud]*

*COEF\_PREECROU*

=

/

*coef\_pre,*  
*[R]*

/

*1.0,*  
*[DEFECT]*

***# If (GROUP\_MA! = None gold NETS! = None gold \***

***GROUP\_NO! = None gold NODE! = None)***

***# Finsi***

***# Finsi***

**# Level  
of impression**

**INFORMATION =/1,  
[DEFECT]**

/ 2,

)  
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### **3 Operands**

#### **3.1 Word**

**key**

**TYPE\_CALCUL**

*This key word makes it possible to calculate is a field of damage of tiredness undergone by a structure, if*

*TYPE\_CALCUL = "CUMUL\_DOMMAGE", is the critical plan in which shearing is maximum, if*

*TYPE\_CALCUL = "FATIGUE\_MULTI".*

*The following table indicates the key words which are usable according to the type of selected calculation.*

**TYPE\_CALCUL**

**Key word**

**Paragraph**

**"CUMUL\_DOMMAGE"**

**OPTION**

3.2

**"CUMUL\_DOMMAGE"**

**HISTORY**

3.3

**"CUMUL\_DOMMAGE"**

**TOO BAD**

3.4

**"CUMUL\_DOMMAGE"**

**MATER**

3.5

**"CUMUL\_DOMMAGE"**

**TAHERI\_NAPPE**

3.6

**"CUMUL\_DOMMAGE"**

**TAHERI\_FONC**

3.7

**"FATIGUE\_MULTI"**

**TYPE\_CHARGE**

3.8

**“FATIGUE\_MULTI”**

**OPTION**

3.9

**“FATIGUE\_MULTI”**

**RESULT**

3.10

**“FATIGUE\_MULTI”**

**CHAM\_MATER**

3.11

**“FATIGUE\_MULTI”**

**CRITERION**

3.12

**“FATIGUE\_MULTI”**

**METHOD**

3.13

**“FATIGUE\_MULTI”**

**PROJECTION**

3.14

**“FATIGUE\_MULTI”**

**DELTA\_OSCI**

3.15

**“FATIGUE\_MULTI”**

**GROUP\_MA/MESH/GROUP\_NO/NODE**

3.16

**“FATIGUE\_MULTI” COEF\_PREECROU**

3.17

**“FATIGUE\_MULTI”**

**GRID**

3.18

### **3.2 Word**

**key**

**OPTION**

*This key word factor makes it possible to specify the type of damage to be calculated:*

.

*“DOMA\_ELNO\_SIGM” for the calculation of the damage to the nodes starting from a field of constraints.*

*The structure of data result specified under the key word factor RESULT must contain it field of reference symbol EQUI\_ELNO\_SIGM (calculable by CALC\_ELEM), which defines between other the value of the equivalent constraint of von Mises signed (component VMIS\_SG) calculated with the nodes.*

•  
“**DOMA\_ELGA\_SIGM**” for the calculation of the damage at the points of Gauss starting from a field of constraints.

The structure of data result specified under the key word factor **RESULT** must contain it field of reference symbol **EQUI\_ELGA\_SIGM** (calculable by **CALC\_ELEM**), which defines between other the value of the equivalent constraint of von Mises signed (component **VMIS\_SG**) calculated at the points of Gauss.

•  
“**DOMA\_ELNO\_EPSI**” for the calculation of the damage to the nodes starting from a field of deformations.

The structure of data result specified under the key word factor **RESULT** must contain it field of reference symbol **EQUI\_ELNO\_EPSI**, which defines the value of the invariant amongst other things of a signed nature 2 (component **INVA\_2SG**) calculated with the nodes.

•  
“**DOMA\_ELGA\_EPSI**” for the calculation of the damage at the points of Gauss starting from a field of deformations.

The structure of data result specified under the key word factor **RESULT** must contain it field of reference symbol **EQUI\_ELGA\_EPSI**, which defines the value of the invariant amongst other things of a signed nature 2 (component **INVA\_2SG**) calculated at the points of Gauss.

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*“DOMA\_ELNO\_EPME” for the calculation of the damage to the nodes starting from a field of mechanical deformations, out-thermics: = B.u - HT.*

*The structure of data result specified under the key word factor RESULT must contain it field of reference symbol EQUI\_ELNO\_EPME (calculable by CALC\_ELEM), which defines between other the value of the invariant of a signed nature 2 (component INVA\_2SG) calculated with the nodes.*

*“DOMA\_ELGA\_EPME” for the calculation of the damage at the points of Gauss starting from a field of mechanical deformations, out-thermics: = B.u - HT.*

*The structure of data result specified under the key word factor RESULT must contain it field of reference symbol EQUI\_ELGA\_EPME, which defines the value of the invariant amongst other things of a signed nature 2 (component INVA\_2SG) calculated at the points of Gauss.*

### **3.3**

#### **Key word factor HISTORY**

*This key word factor gathers all the phase of definition of the history of loading.*

*The history of loading is the evolution of a value of the constraint or deformation during time.*

#### **3.3.1 Operand**

##### **RESULT**

*RESULT = LMBO*

*Name of the concept result containing the stress fields or the fields of deformation defining the history of loading. More precisely, the concept result must contain one of fields of reference symbol EQUI\_ELNO\_SIGM, EQUI\_ELGA\_SIGM, EQUI\_ELNO\_EPSI, EQUI\_ELGA\_EPSI, EQUI\_ELNO\_EPME or EQUI\_ELGA\_EPME according to the desired option of calculation.*

#### **3.3.2 Operand**

##### **EQUI\_GD**

*EQUI\_GD =/“VMIS\_SG”,*

*/*

*“INVA\_2\_SG”*

*To be able to calculate the damage undergone by a structure, a method of Wöhler, Manson-Whetstone sheath or a method of Taheri, it is necessary to have a history of loading in constraints or in deformations “uniaxial”. With this intention it is necessary to transform the tensor of constraints or the tensor of deformations in a uniaxial field (scalar) “equivalent”.*

*“VMIS\_SG”*

*to calculate the damage starting from a history of loading of the type constraint of von Mises signed,*

*“INVA\_2\_SG” to calculate the damage starting from a history of loading of the type invariant of a nature 2 signed of the deformation.*

### **3.4 Operand TOO BAD**

*To be able to calculate the damage undergone by a structure, the cycles should beforehand be extracted elementary of the history of loading.*

*For that of many methods are available. Method available in Code\_Aster for calculation of the damage by the Wöhler method or Manson-Whetstone sheath, is the method of counting of extended in cascade or method of Rainflow [R7.04.01].*

*For the calculation of the damage by methods TAHERI\_MANSON and TAHERI\_MIXTE, one uses method of counting known as natural which consists in generating cycles in the order of their application.*

*Once the extracted elementary cycles, this operand makes it possible to specify the method of calculation of damage for each elementary cycle.*

*DAMAGE =/“WOHLER”*

*For a history of loading of the type forced, the number of cycles to the rupture is determined by interpolation of the curve of Wöhler of material for a level of constraint alternated given (to each elementary cycle a level of amplitude of constraint corresponds*

*=*

*-*

*max*

*min and an alternate constraint Salt = 1/2).*

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*One can use method WOHLER only for options “DOMA\_ELNO\_SIGM” or “DOMA\_ELGA\_SIGM”. Moreover, it is necessary that the concept specified result contains it respectively field of reference symbol EQUI\_ELNO\_SIGM or EQUI\_ELGA\_SIGM (calculable by CALC\_ELEM).*

*The curve of Wöhler of material must be introduced into operator DEFI\_MATERIAU [U4.43.01], under one of the three possible forms [R7.04.02]:*

*point by point discretized function (key word TIRES, operand WOHLER),*

*analytical form of Basquin (key word TIRES, operands A\_BASQUIN and BETA\_BASQUIN),*

*form “current zone” (key word TIRES, operands E\_REFE, A0, A1, A2, A3 and SL and word key ELAS operand E).*

### ***Notice on the curves of tiredness:***

*For the small amplitudes, the problem of the prolongation of the curve of tiredness can to pose: for example, for the curves of tiredness of the RCC-M beyond 106 cycles, corresponding constraint 180 MPa is regarded as limit of endurance, i.e. that very forced lower than 180 MPa must produce a factor of null use, or one an infinite number of cycles acceptable.*

*The method adopted here corresponds to this concept of limit of endurance: if the amplitude of constraint is lower than the first X-coordinate of the curve of tiredness, then one takes one factor of null use i.e. a number of infinite acceptable cycle.*

**DAMAGE =/“MANSON\_COFFIN”**

*For a history of loading of the deformations type, the number of cycles to the rupture is determined by interpolation of the curve of Manson-Whetstone sheath of material for a level of alternate deformation given (to each elementary cycle corresponds a level of amplitude of deformation =*



-  
*max*  
*min and an alternate deformation  $E_{alt} = 1/2$ ).*

*One can use method MANSON\_COFFIN only for options “DOMA\_ELNO\_EPSI” or “DOMA\_ELGA\_EPSI”, “DOMA\_ELNO\_EPME” or “DOMA\_ELGA\_EPME”. Moreover, it is necessary that it concept specified result contains respectively the field of reference symbol EQUI\_ELNO\_EPSI, EQUI\_ELGA\_EPSI, EQUI\_ELNO\_EPME or EQUI\_ELGA\_EPME (calculable by CALC\_ELEM).*

*The curve of Manson-Whetstone sheath must be introduced into operator DEFI\_MATERIAU [U4.43.01] (word key TIRES, operand MANSON\_COFFIN).*

*DAMAGE =/“TAHERI\_MANSON”*

*This method of calculation of the damage applies only to loadings of the deformation type, i.e. for options “DOMA\_ELNO\_EPSI”, “DOMA\_ELGA\_EPSI”, “DOMA\_ELNO\_EPME” or “DOMA\_ELGA\_EPME”. Moreover, it is necessary that the concept specified result contains it respectively field of reference symbol EQUI\_ELNO\_EPSI, EQUI\_ELGA\_EPSI, EQUI\_ELNO\_EPME or EQUI\_ELGA\_EPME (calculable by CALC\_ELEM).*

*Are N cycles elementary of half amplitude*  
*1 ,...*  
*N.*  
*2*  
*2*

*The calculation of the elementary damage of the first cycle is determined by interpolation on the curve of Manson-Whetstone sheath of material.*

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*The calculation of the elementary damage of the following cycles is determined by the algorithm described below:*

*+*

*.*

*If*

*I 1*

*I*

*2*

*2*

*the calculation of the elementary damage of the cycle (I +) I is determined by interpolation on curve of Manson-Whetstone sheath.*

*+*

*.*

*If*

*I 1*

*I*

*<*

*2*

*2*

*one determines:*

+

*I I*  
*i+1*  
*J*  
*= F*

, *Max*

*2*  
*TABLECLOTH*

*2*  
*J I*  
*<*  
*2*  
*\* I*

+

*I*  
*i+1*  
*= F*  
*2*  
*FONC 2*

*where FNAPPE is a tablecloth introduced under operand TAHERI\_NAPPE.*

*FFONC is a function introduced under operand TAHERI\_FONC.*

\*

*The value of the damage of the cycle (I +)*  
*I is obtained by interpolation of*  
*i+1 on the curve of*

*2*  
*Manson-whetstone sheath of the material (Nrupti+1 = a number of cycles to the rupture for the cycle*

\*

*(I)*  
*I*

+ =

+  
 1  
 1  
 1  
 MANSON\_ WHETSTONE SHEATH  
 and Dom  
 $I + 1 =$   
 ).

2  
 $i+1 = \text{damage of the cycle (}$   
 $)$   
 $Nrupti+1$

The curve of Manson-Whetstone sheath must be introduced into operator DEF1\_MATERIAU [U4.43.01]  
 (word  
 key TIRES, operand MANSON\_COFFIN).

**Note:**

- 1) The tablecloth or the formula introduced under operand TAHERI\_NAPPE is in fact cyclic curve of work hardening with prestressed material.
- 2) The function or the formula introduced under operand TAHERI\_FONC is in fact cyclic curve of work hardening of material.
- 3) The tablecloth or the formula introduced under operand TAHERI\_NAPPE, must have "X" and "EPSI" like parameters.
- 4) The function or the formula introduced under operand TAHERI\_FONC, must have for parameter "SIGM".

DAMAGE =/"TAHERI\_MIXTE"

This method of calculation of the damage applies only to loadings of the deformation type, i.e. for options "DOMA\_ELNO\_EPSI", "DOMA\_ELGA\_EPSI", "DOMA\_ELNO\_EPME" or "DOMA\_ELGA\_EPME". Moreover, it is necessary that the concept specified result contains it respectively  
 field of reference symbol EQUI\_ELNO\_EPSI, EQUI\_ELGA\_EPSI, EQUI\_ELNO\_EPME or EQUI\_ELGA\_EPME (calculable by CALC\_ELEM).

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*Are N cycles elementary of half amplitude*

*I ,...*

*N.*

*2*

*2*

*The calculation of the elementary damage of the first cycle is determined by interpolation on the curve of Manson-Whetstone sheath of material.*

*The calculation of the elementary damage of the following cycles is determined by the algorithm described*

*below:*

*+*

*.*

*If*

*I 1*

*I*

*2*

*2*

*the calculation of the elementary damage of the cycle (I +)*

*1 is determined by interpolation on curve of Manson-Whetstone sheath.*

+

.

*If*

*I 1*

*I*

<

2

2

*one determines:*

+

*I 1*

*i+1*

*J*

*= F*

*, Max*

2

*TABLECLOTH*

2

*JI*

<

2

*where FNAPPE is a tablecloth introduced under operand TAHERI\_NAPPE.*

*The value of the damage of the cycle (I +)*

*1 is obtained by interpolation of*

*i+1 on the curve of*

2

*Wöhler of the material (Nrupti+1 = a number of cycles to the rupture for the cycle*

(

+1

I

)

I

+ I =

I

**WOHLER**

*and Dom*

$I + I =$

).

2

$i+1 = \text{damage of the cycle (}$

)

*Nrupti+1*

*This method requires the data of the curves of Wöhler and Manson-Whetstone sheath of the material, which*

*must be introduced into operator DEF1\_MATERIAU [U4.43.01] (key word factor TIRES).*

**Note:**

*1) The tablecloth or the formula introduced under operand TAHERI\_NAPPE is in fact cyclic curve of work hardening with prestressed material.*

*2) The tablecloth or the formula introduced under operand TAHERI\_NAPPE, must have “X” and “EPSI” like parameters.*

**3.5 Operand**

**MATER**

*MATER = to subdue*

*Allows to specify the name of the MATER material created by DEF1\_MATERIAU [U4.43.01].*

*The MATER material must contain the definition of the curve of Wöhler of material for the calculation of*

*damage by the methods “WOHLER” and “TAHERI\_MIXTE” and the definition of the curve of Manson-whetstone sheath of material for the calculation of the damage by methods*

*“MANSON\_COFFIN”,*

*“TAHERI\_MANSON” and “TAHERI\_MIXTE”.*

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### **3.6 Operand**

**TAHERI\_NAPPE**

*This operand makes it possible to specify the name of a tablecloth F*

*,  
TABLECLOTH 2*

*MAX necessary to the calculation of  
damage by methods “TAHERI\_MANSON” and “TAHERI\_MIXTE”.*

*The tablecloth must have “X” and “EPSI” like parameters.*

**Note:**

*This tablecloth is in fact the cyclic curve of work hardening with prestressed material.*

### **3.7 Operand**

**TAHERI\_FONC**

*This operand makes it possible to specify the name of a function FFONC 2 necessary to the calculation  
of  
damage by method “TAHERI\_MANSON”.*

*The parameter of this function must be “SIGM”.*

**Note:**

*This function is in fact the cyclic curve of work hardening of material.*

### **3.8 Operand**



## **TYPE\_CHARGE**

*This operand makes it possible to specify the type of loading applied to the structure:*

.  
*PERIODIC, the loading is periodic;*

.  
*NON\_PERIODIQUE, the loading are not periodical.*

## **3.9 Operand OPTION**

*This operand makes it possible to specify the place where postprocessing will be made:*

.  
*DOMA\_ELGA, postprocessing are made at the points of Gauss of the grid;*

.  
*DOMA\_NOEUD, postprocessing are made with the nodes of the grid or part of the grid, cf. operands: GROUP\_MA, MESH, GROUP\_NO and NO.*

## **3.10 Operand RESULT**

*RESULT = LMBO*

*Name of the concept result containing the stress fields defining the history of loading.  
More precisely, the concept result must contain the field of reference symbol SIEF\_ELGA and/or SIEL\_ELGA\_DEPL and/or SIEF\_NOEU\_ELGA and/or SIGM\_NOEU\_DEPL.*

## **3.11 Operand CHAM\_MATER**

*CHAM\_MATER = cham\_mater*

*Allows to specify the name of the field of the material cham\_mater created by AFFE\_MATERIAU [U4.43.03].*

*The MATER material defined with the order DEFI\_MATERIAU and which is used for the assignment of material with the grid with order AFFE\_MATERIAU must contain the definition of the curve of Wöhler as well as information necessary to the implementation of the criterion, to see the key words factors TIRES and CISA\_PLAN\_CRIT of order DEFI\_MATERIAU [U4.43.01].*

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### **3.12 Operand**

#### **CRITERION**

*CRITERION* =/“MATAKE”,  
/“DANG\_VAN\_MODI\_AC”,  
/“DOMM\_MAXI”,  
/“DANG\_VAN\_MODI\_AV”,  
/“FATEMI\_SOCIE”,

*Allows to specify the name of the criterion which half amplitude of shearing will have to satisfy to it maximum.*

:

*Notation*

**N** \*

: *normal*

*which*

*in*

*plan*

*with*

*amplitude*

*cisailleme*

*of*

*maximum*

*is*

*NT*

;

*(N)*

*: amplitude*

*cisailleme*

*of*

*normal*

*of*

*plan*

*one*

*in*

*constraint*

*in*

*NT*

*N;*

*(N)*

*: amplitude*

*cisailleme*

*of*

*déformatio*

*in*

*NT*

*normal*

*of*

*plan*

*one*

*in*

*N*

*N;*

*Nmax (N):*

*maximum*

*constraint*

*on*

*normal*

*normal*

*of*

*plan*

*N;*

*:*

*of*

*limit*

*cisailleme*

*in*

*endurance*

*pure*

*NT*

*;*

*alternated*

*0*

*D*

:

*of*

*limit*

*traction*

*in*

*endurance*

*- compressio*

;

*alternated*

*pure*

*N*

*O*

*P*

:

*hydrostati*

*pressure*

*that;*

*C*

*: being useful coefficient*

*T*

*count*

*in*

*to take*

*with*

*précrouis*

*possible*

*one*

;

*wise*

*p*

:  
of  
limit  
elasticity.  
y

**Criterion of MATAKE**

$(N) *_{+} has NR () * B \acute{e}q$

**3.12-1**

2

max N

where has and B are two constant data by the user under key words MATAKE\_A and MATAKE\_B of the key word factor CISA\_PLAN\_CRIT of DEFI\_MATERIAU, they depend on characteristics materials and are worth:

D D

0

0

has = -

B =.

0

2

2

0

If the user has the results of two tensile tests compression, alternated and the other not, the constant ones has and B are given by:

(

2 -

1)

has = (

1 -

2 )

,

- 2 m

*m*

*l*

*B = (*

*×*

*2 -*

*l)*

*,  
+ 2*

*2*

*m*

*with*

*l the amplitude of loading for the alternate case (= 0*

*m*

*) and*

*2 the amplitude of*

*loading for the case where the average constraint is nonnull (*

*0*

*m*

*).*

*Moreover, we define an equivalent constraint within the meaning of MATAKE, noted (N:*

*eq*

*)\**

*eq (N)*

*F*

*\* = C p*

*(N) \*+ has Nmax (N) \*,*

*2*

*T*

*where F/T represents the report/ratio of the limits of endurance in inflection and alternating torsion, and must be*

*informed under key word COEF\_FLEX\_TORS of the key word factor CISA\_PLAN\_CRIT of DEFI\_MATERIAU.*

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**Criterion** *DANG\_VAN\_MODI\_AC*

*(N) \*+ aP B éq*

**3.12-2**

2

*where has and B are two constant data by the user under key words D\_VAN\_A and D\_VAN\_B key word factor CISA\_PLAN\_CRIT of DEFI\_MATERIAU, they depend on the characteristics materials. If the user has two tensile tests compression, alternate the other not the constant ones has and B are worth:*

3

(

-

2

1 )

*m*

1

= × *has*

**B** =

×

2 (

1 -

2) - 2 *m*



(  
2 -  
1)  
,  
+ 2  
2  
m  
with  
1 the amplitude of loading for the alternate case ( $= 0$   
m  
) and  
2 for the case where  
average constraint is nonnull (  
0  
m  
).

Moreover, we define an equivalent constraint within the meaning of DANG VAN, noted  
(N  
eq  
)  
\* :

eq (N)  
C  
\* = C p  
(N)  
\* + P has,

2  
T

where C/T represents the report/ratio of the limits of endurance in alternated shearing and traction, and must  
to be well informed under key word COEF\_CISA\_TRAC of the key word factor CISA\_PLAN\_CRIT of  
DEFI\_MATERIAU.

For more information, to consult the document [R7.04.04].

**Criterion DOMM\_MAXI**

*Criterion DOMM\_MAXI is an evolution of the criterion of MATAKE. Contrary to the two criteria precedents, this criterion selects the critical plan according to the damage calculated in each plan. It is the plan in which the damage is maximum which is retained. This criterion is adapted to nonperiodic loadings, which induces the use of a method of counting of cycles so to calculate the elementary damage. To count the cycles, we use the method RAINFLOW.*

*The once known elementary damage is cumulated linearly to determine it too bad.*

*To calculate the elementary damage we project the history of the constraints of shearing on one or two axes in order to reduce this one to a unidimensional function time = F*

*. After having extracted the elementary under-cycles from with method RAINFLOW*

*P  
(T)*

*P  
we define an elementary equivalent constraint for any elementary under-cycle I:*

*Max*

*Min*

*I  
(I N I N -*

*I*

*N*

*I*

*N*

*I*

*p (), p2 ())*

*(I p (), p2 ())*

*eq (N)*

*= C*

*+*

*P*

*aMax (I*

*I*

*Nmax1 (N), Nmax2 (N) 0*

*, ),*

**éq 3.12-3**

with  $N$  the normal of the plan running,  $I$

$I$   
 $p1(N)$  and  $p2(N)$  values of shear stresses  
 projected under-cycle  $I$  and

$I$   
 $NR$   
 $I$   
 $max1(N)$  and  $NR\ max\ 2(N)$  normal constraints maximum of  
 under-cycle  $I$ . From  $I$

$eq(N)$  and of a curve of tiredness we determine the number of cycles  
 with the elementary rupture

$I$   
 $NR(N)$  and damage corresponding  $I$   
 $D(N)$

$I$   
 $= I\ NR(N)$ . In

[éq 3.12-3] is a corrective term which makes it possible to use a curve of tiredness in  
 traction and compression. The constant ones has and must be indicated under the key words  
 $DOMM\_A$  and  $COEF\_CISA\_TRAC$  of the key word factor  $CISA\_PLAN\_CRIT$  of  $DEFI\_MATERIAU$ .

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We use a linear office plurality of damage. That is to say  $K$  the number of elementary under-cycles, for a normal  $N$  fixed, the cumulated damage is equal to:

$$D(N) = I \cdot K$$

$$= I \cdot K$$

To determine the normal vector \*

$N$  corresponding to the maximum cumulated damage we make to vary  $N$ , the normal vector \*

$N$  corresponding to the maximum cumulated damage is then given by:

$$D(N) = \max_N (D(N))$$

### **Criterion DANG\_VAN\_MODI\_AV**

The step and the techniques implemented to calculate this criterion are identical to those used for criterion DOMM\_MAXI. The only difference lies in the definition of the constraint equivalent elementary where the hydrostatic pressure  $p$  replaces the maximum normal constraint  $N_{max}$ :

Max

Min

$$I \cdot N$$

$I$

$N$

$I$

$N$

$I$

$$p_1, p_2$$

$$(p_1, p_2)$$

$$eq(N)$$

$$= C$$

+

$P$   
 $a_{Max}(I)$   
 $I$

$I$   
 $P(N), 2$   
 $P(N) 0$   
, ).

2

*The constant ones has and are to be informed by the user under key words  $D\_VAN\_A$  and  $COEF\_CISA\_TRAC$  of the key word factor  $CISA\_PLAN\_CRIT$  of  $DEFI\_MATERIAU$ .*

*For more information to consult the document [R7.04.04].*

### ***Criterion of FATEMI\_SOCIE***

*The criterion of FATEMI and SOCIE is defined by the relation:*

$N$   
 $NR$   
 $N$

$max$   
 $eq(N)$   
 $( )$   
 $( )$   
 $=$   
 $I + K$

2

y

*where  $K$  is a constant which depends on the characteristics materials. Contrary to the others criteria, it uses shearing in deformation instead of shearing in constraint. Moreover, them various quantities which contribute to the criterion are multiplied and not added. The criterion of FATEMI and SOCIE are usable after an elastic design or elastoplastic. This criterion selects*

*the plan criticizes according to the damage calculated in each plan. It is the plan in which damage is maximum which is retained.*

*This criterion is adapted to the nonperiodic loadings, which leads us to use the method of counting of cycles RAINFLOW to calculate the elementary damage. Damage elementary are then cumulated linearly to determine the damage.*

*In order to calculate the elementary damage we project the history of shearing in deformation on one or two axes in order to reduce this one to a unidimensional function time*

*F*

*p =*

*(T). After having extracted the elementary under-cycles with method RAINFLOW us let us define an elementary equivalent deformation for any elementary under-cycle I:*

*Max*

*- Min*

*I*

*(I*

*I*

*I*

*I*

*I*

*p (N),*

*p2 (N))*

*(I p (N), p2 (N))*

*eq (N) = CP*

*(1+aMax (I*

*I*

*Nmax1 (N), Nmax2 (N), 0)*

*2*

***éq 3.12-5***

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*K*

with  $A =$

,  $N$  **the** normal in the plan running,  $I$

$p1 (N)$

$I$

and  $p2 (N)$  values of shearings in

$y$

deformation projected of under-cycle  $I$ ,

$I$

$N_{max1} (N)$

$I$

and  $N_{max2} (N)$  being two values of the constraint

maximum normal of under-cycle  $I$ . From  $I$

$eq (N)$  and of a curve of Manson-Whetstone sheath us

let us determine the number of cycles to the elementary rupture

$I$

$NR (N)$  and corresponding damage

$I$

$D (N)$

$I$

$= I NR (N)$ .

In the equation [éq 3.12-5] is a corrective term which to use a curve of Manson-Whetstone sheath obtained

in traction compression.  $C_p$  is a coefficient which makes it possible to take into account possible préécrouissage.



*The constant ones has and must be indicated under key words FATSOC\_A and COEF\_CISA\_TRAC key word factor CISA\_PLAN\_CRIT of order DEFI\_MATERIAU.*

*As we use a linear office plurality of damage, if  $m$  is the number of under-cycles elementary, then for a normal  $N$  fixed, the cumulated damage is equal to:*

$$D(N) = \sum_{i=1}^m D(N)$$

*To find vector normal  $N^*$  corresponding to the maximum cumulated damage we vary  $N$ . Normal vector  $N^*$  associated the maximum cumulated damage is then given by:*

$$N^* = \max(D(N))$$

### **3.13 Operand METHOD**

*METHOD = "CERCLE\_EXACT"*

*Allows to specify the name of the method which will be used to calculate to it half amplitude of maximum shearing.*

*The method of the "CERCLE\_EXACT" is used to determine the circle circumscribed at the points which are in plans of shearing. This method rests on the process which consists in obtaining it ring which passes by three points, cf document [R7.04.04].*

### **3.14 Operand PROJECTION**

*If the loading is not periodical, it is necessary to project the history of shearing on one or two axes, cf document [R7.04.04].*

*UN\_AXE, the history of shearing are projected on an axis;*

*DEUX\_AXES, the history of shearing are projected on two axes.*

### **3.15 Operand DELTA\_OSCI**

*DELTA\_OSCI = /delta,  
/  
0.0,*

*Filtering of the history of the loading. In all the cases, if the function remains constant or decreasing on more than two consecutive points one removes the intermediate points for to keep that two extreme points. Then, one removes history of loading the points for which the variation of the value of the constraint is lower than the value delta. By defect delta is equal to zero, which amounts keeping all the oscillations of the loading, even those of weak amplitude. For more information to see the documentation of order POST\_FATIGUE, [U4.83.01], even operand.*

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### **3.16 Operands**

**GROUP\_MA/MESH/GROUP\_NO/NODE**

*GROUP\_MA = l<sub>gma</sub>,*

*The options are calculated on the groups of meshes contained in the list l<sub>gma</sub>.*

*NET = l<sub>ma</sub>,*

*The options are calculated on the meshes contained in the list l<sub>gma</sub>.*

*GROUP\_NO = l<sub>gno</sub>,*

*The options are calculated on the groups of nodes contained in the list lno.*

*NODE = lno,*

*The options are calculated on the nodes contained in the list lno.*

### **3.17 Operand**

#### **COEF\_PREECROU**

*COEF\_PREECROU =/coef\_pre,*

*/*

*1.0,*

*This coefficient is used to take into account the effect of possible a préécrouissage.*

### **3.18 Operand**

#### **GRID**

*GRID = grid,*

*Allows to specify the name of the grid given by the user.*

### **3.19 Operand**

#### **INFORMATION**

*INFORMATION =/1*

*Impression:*

*.*

*no impression*

*/2*

*Impression:*

*.*

*parameters of the calculation of the damage (a number of the sequence numbers, numbers points of calculation, type of the calculation of the damage (forced, deformations), localization damage (nodes or points of Gauss), type of the equivalent component (VMIS\_SG or INVA\_2SG), method of extraction of cycles (RAINFLOW) and method of calculation of damage (WOHLER or MANSON\_COFFIN or TAHERI\_MANSON or TAHERI\_MIXTE).*

*point by point of the history of loading, of the cycles extracted and the value from too bad.*

*field of damage.*

*The impressions are made in the file MESSAGE.*

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#### **4 Example**

***One will be able to refer to test SZLZ105 concerning the damage and the office plurality of damage, with***

***tests SSLV135a and SSLV135b as regards relating to the periodic loadings like with the tests SSLV135c and SSLV135d for the case where the loading is not periodical.***

## **4.1**

### ***Calculation of the equivalent history of loading***

**DEPL**  
=  
**CALC\_ELEM**  
(  
**reuse**  
=  
**DEPL,**  
**MODEL**  
=  
**CPLAN,**  
**CHAM\_MATER =**  
**CHECHMATE,**  
**OPTION**  
=  
(  
"SIEF\_ELGA\_DEPL",  
"EPSI\_ELGA\_DEPL",  
"EQUI\_ELGA\_SIGM",  
"EQUI\_ELGA\_EPSI",  
"EQUI\_ELNO\_SIGM",  
"EQUI\_ELNO\_EPSI",  
  
)  
**RESULT**  
=  
**DEPL**

)

## 4.2

### *Definition of the curve of Wöhler of material and associated damage*

```
WOHL = DEFI_FONCTION (  
NOM_PARA  
=  
“SIGM”,  
VALE  
=  
(  
0.  
,  
1000.,  
10.  
,  
0.,  
),  
PROL_DROITE  
=  
“LINEAR”,  
PROL_GAUCHE  
=  
“LINEAR”,  
TITRATE  
=  
'FUNCTION  
OF  
WOHLER'  
)
```

*# Definition of material*

```
= DEFI_MATERIAU SUBDUE (TIREDNESS = _F (WOHLER = WOHL))
```

*# Calculation of the damage to the nodes starting from the history of constraint of von*

*Settings signed (the loading being homogeneous with constraints, damage calculate by interpolation on a curve of Wöhler of material).*

**DMG\_WOHL = CALC\_FATIGUE (**

**TYPE\_CALCUL = "CUMUL\_DOMMAGE",  
OPTION**

**=  
"DOMA\_ELNO\_SIGM",**

**HISTORY**

**=\_F  
(RESULT = DEPL,  
EQUI\_GD**

**=  
"VMIS\_SG",**

**)**

**DAMAGE =  
"WOHLER",  
MATER**

**=  
SUBDUE,  
INFORMATION**

**=  
2**

)

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**4.3 Definition of the curve of Manson\_Coffin of material and damage associated**

**MANS = DEFI\_FONCTION (**

**NOM\_PARA**

**=**

**“EPSI”,**

**VALE**

**=**

**(**

**0.**

**,**

**1000.,**

**10.**

**, 0.,**

**),**

**PROL\_DROITE**



=  
**“LINEAR”,**  
**PROL\_GAUCHE**

=  
**“LINEAR”,**

**TITRATE**

=  
**'FUNCTION**  
**OF**  
**MANSON**  
**COFFIN'**

)

*# Definition of material*

**MAT1 = DEFI\_MATERIAU (TIREDNESS = \_F (MANSON\_COFFIN = MANS))**

*# Calculation of the damage to the nodes starting from the history of the value of the invariant of a nature 2 signed (the loading being homogeneous with deformations, the damage is calculated by interpolation on a curve of Manson\_Coffin of material).*

**DMG\_MCOF = CALC\_FATIGUE (**

**TYPE\_CALCUL = “CUMUL\_DOMMAGE”,**  
**OPTION**

=  
**“DOMA\_ELNO\_EPSI”,**  
**HISTORY**

**=\_F (**  
**RESULT**

=  
**DEPL,**

***EQUI\_GD***

=

***“INVA\_2\_SG”,***

),

***DAMAGE =***

***“MANSON\_COFFIN”,***

***MATER***

=

***MATI,***

***INFORMATION***

=

***2***

)

#### ***4.4 Definition of the curves of cyclic work hardening and work hardening cyclic with prestressing***

***F\_NAPPE = DEFI\_NAPPE (***

***NOM\_PARA = “X”,***

***PROL\_DROITE***

=

***“LINEAR”,***

***PROL\_GAUCHE***

=  
“*LINEAR*”,

*PARA = (0.5, 1. ,),*  
*NOM\_PARA\_FONC*

=  
“*EPSI*”,  
*DEFI\_FONCTION*

=\_F (  
*PROL\_DROITE*

=  
“*LINEAR*”,  
*PROL\_GAUCHE*

=  
“*LINEAR*”,  
*VALE*

=  
(  
*0.,*  
*25.,*  
*10.,525.,),*

)

*\_F (*  
*PROL\_DROITE*  
*=*  
*“LINEAR”,*  
*PROL\_GAUCHE*  
*=*  
*“LINEAR”,*  
*VALE*

*=*  
*(*  
*0.*  
*, 50.,*  
*10.,550.,)))*,  
*TITRATE*  
*=*  
*'TABLECLOTH*  
*of*  
*TAHERI'*

)

*F\_FONC = DEFI\_FONCTION (*  
*NOM\_PARA*  
*= “SIGM”,*  
*PROL\_DROITE*  
*=*  
*“LINEAR”,*  
*PROL\_GAUCHE*  
*=*  
*“LINEAR”,*  
*PARA*

*=*

*(*

*0.,*

0.,  
100.,  
10.),  
**TITRE=' FUNCTION**  
**of**  
**TAHERI')**  
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**Operator CALC\_FATIGUE**

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**31/01/06**

**Author (S):**

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**4.5 Calculation of the damage by methods “TAHERI\_MANSON” and  
“TAHERI\_MIXTE”**

**MAT2 = DEFI\_MATERIAU (**

**TIRE = \_F (**

**WOHLER = WOHL,**

**MANSON\_COFFIN**

**=**

**MANS**

**)**

**)**

**DMG\_TMA = CALC\_FATIGUE (**

***TYPE\_CALCUL = "CUMUL\_DOMMAGE",***

***OPTION***

***=***

***"DOMA\_ELNO\_EPSI",***

***HISTORY***

***=\_F (***

***RESULT***

***=***

***DEPL,***

***EQUI\_GD***

***=***

***"INVA\_2\_SG"***

***)***

***DAMAGE =***

***"TAHERI\_MANSON",***

***MATER***

***=***

***MAT2,***

***TAHERI\_NAPPE***

***=***

***F\_NAPPE,***

***TAHERI\_FONC***

***=***

***F\_FONC,***

***INFORMATION***

***=***

***2***

)

***DMG\_TMI = CALC\_FATIGUE (***

***TYPE\_CALCUL = "CUMUL\_DOMMAGE",***

***OPTION***

***=***

***"DOMA\_ELNO\_EPSI",***

***HISTORY***

***=\_F (***

***RESULT***

***=***

***DEPL,***

***EQUI\_GD***

***=***

***"INVA\_2\_SG"***

***),***

***DAMAGE =***

***"TAHERI\_MIXTE",***

***MATER***

***=***

***MAT2,***

***TAHERI\_NAPPE***

=  
**F\_NAPPE,**  
**INFORMATION**

=  
2

)

#### **4.6** **Calculation of the half amplitude of maximum shearing by the method:** **“CERCLE\_EXACT”**

*This example is drawn from the case SSLV135a test. Here the loading is periodic and the damage is calculated at the points of Gauss.*

**STEEL = DEFI\_MATERIAU (ELAS = \_F (E = 200000. ,**  
**NAKED = .3,**  
**ALPHA = 0. ),**  
**TIRE = \_F (WOHLER = WHOL,),**  
**CISA\_PLAN\_CRIT = \_F (CRITERION = “MATAKE”,**  
**COEF\_FLEX\_TORS = 1.5,**  
**MATAKE\_A = 1.0,**  
**MATAKE\_B = 2.0,)**  
)

**CHECHMATE = AFFE\_MATERIAU (GRID = CUBIC,**  
**AFFE = \_F (ALL = “YES”,**  
**MATER = STEEL,**  
**TEMP\_REF = 20. )**  
)

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***31/01/06***  
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***SOL\_NL = STAT\_NON\_LINE (TITLE =***  
***“TEST ALTERNATE TRACTION AND COMPRESSION - CRITICAL PLAN”,***  
***MODEL = TROISD,***  
***CHAM\_MATER = CHECHMATE,***  
***EXCIT = \_F (LOAD = TR\_CS,***  
***FONC\_MULT = COEF,***  
***TYPE\_CHARGE = “FIXE\_CSTE”),***  
***COMP\_ELAS = \_F (RELATION = “ELAS”,***  
***DEFORMATION = “SMALL”,***  
***ALL = “YES”),***  
***INCREMENT = \_F (LIST\_INST = LINST,)***  
***NEWTON = \_F (MATRIX = “ELASTIC”,***  
***REAC\_INCR = 0))***

***FATI\_NL=CALC\_FATIGUE (TYPE\_CALCUL = “FATIGUE\_MULTP”,***  
***OPTION = “DOMA\_ELGA”,***  
***TYPE\_CHARGE = “PERIODIC”,***  
***RESULT = SOL\_NL,***  
***CHAM\_MATER = CHECHMATE,***  
***CRITERION = “MATAKE”,***  
***COEF\_PREECROU = 1.0,***  
***METHOD = “CERCLE\_EXACT”***  
***)***

***4.7***  
***Calculation of the damage when the loading is not periodical***

***This example is drawn from the case SSLV135d test. Here the loading is not periodic, the damage is calculated at the points nodes on part of the whole of the grid: “FACE1”, “FACE3” and “FACE5”.***

```
STEEL = DEFI_MATERIAU (ELAS = _F (E = 200000. ,  
NAKED = .3,  
ALPHA = 0. ),  
TIRE = _F (WOHLER = WHOL,)  
CISA_PLAN_CRIT = _F (CRITERE= "DANG_VAN_MODI_AV",  
D_VAN_A = 1.0,  
D_VAN_B = 2.0,  
COEF_CISA_TRAC = 1.5)  
)
```

```
CHECHMATE = AFFE_MATERIAU (GRID = CUBIC,  
AFFE = _F (ALL = "YES",  
MATER = STEEL,  
TEMP_REF = 20. ))
```

```
SOL_L = MECA_STATIQUE (TITLE =  
"TEST ALTERNATE TRACTION AND COMPRESSION - DANG_VAN_MODI_AV",  
MODEL = TROISD,  
CHAM_MATER = CHECHMATE,  
EXCIT = _F (LOAD = TR_CS,  
FONC_MULT = COEF),  
LIST_INST = LINST,  
)
```

```
SOL_L = CALC_ELEM (reuse = SOL_L,  
RESULT = SOL_L,  
OPTION = "SIGM_ELNO_DEPL",  
)
```

```
SOL_L = CALC_NO (reuse = SOL_L,  
RESULT = SOL_L,  
OPTION = "SIGM_NOEU_DEPL"  
)
```

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**Operator CALC\_FATIGUE**

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```
FATI_LNO2=CALC_FATIGUE (TYPE_CALCUL = "FATIGUE_MULTI",  
OPTION = "DOMA_NOEUD",  
TYPE_CHARGE = "NON_PERIODIQUE",  
RESULT = SOL_L,  
CHAM_MATER = CHECHMATE,  
GROUP_MA = ("FACE1", "FACE3", "FACE5"),  
GRID = CUBIC,  
CRITERION = "DANG_VAN_MODI_AV",  
COEF_PREECROU = 1.0,  
PROJECTION = "DEUX_AXES",  
)
```

**4.8**

**Calculation of the damage with criterion FATEMI\_SOCIE**

***This example is drawn from the case SSLV135e test. Here the loading is not periodic, the damage is calculated with the nodes on part of the whole of the grid: "FACE1", "FACE2" and "FACE3".***

```
STEEL = DEF1_MATERIAU (ELAS =_F (E = 200000. ,  
NAKED = 0.3,  
ALPHA = 0.0),  
TIRE =_F (MANSON_COFFIN = MANCOF,)  
CISA_PLAN_CRIT =_F (CRITERION = "FATEMI_SOCIE",  
FATSOC_A = 1.0,  
COEF_CISA_TRAC = 1.5)  
)
```

```
CHECHMATE = AFFE_MATERIAU (GRID = CUBIC,  
AFFE =_F (ALL = "YES",  
MATER = STEEL,  
TEMP_REF = 20. ))
```

**# CALCULATION WITH STAT\_NON\_LINE**

# -----

***SOL\_NL = STAT\_NON\_LINE (TITLE =***  
***“TEST ALTERNATE TRACTION AND COMPRESSION - FATEMI\_SOCIE”,***  
***MODEL = TROISD,***  
***CHAM\_MATER = CHECHMATE,***  
***EXCIT = \_F (LOAD = TR\_CS,***  
***FONC\_MULT = COEF,***  
***TYPE\_CHARGE = “FIXE\_CSTE”),***  
***COMP\_ELAS = \_F (RELATION = “ELAS”,***  
***DEFORMATION = “SMALL”,***  
***ALL = “YES”),***  
***INCREMENT = \_F (LIST\_INST = LINST,)***  
***NEWTON = \_F (MATRIX = “ELASTIC”,***  
***REAC\_INCR = 0))***

***SOL\_NL = CALC\_ELEM (reuse = SOL\_NL,***  
***RESULT = SOL\_NL,***  
***OPTION = (“EPSI\_ELGA\_DEPL”,***  
***“SIEF\_ELNO\_ELGA”,***  
***“EPSI\_ELNO\_DEPL”)***  
***)***

***SOL\_NL = CALC\_NO (reuse = SOL\_NL,***  
***RESULT = SOL\_NL,***  
***ALL = “YES”,***  
***GROUP\_MA\_RESU = (“FACE1”, “FACE2”, “FACE3”),***  
***OPTION = (“SIEF\_NOEU\_ELGA”, “EPSI\_NOEU\_DEPL”)***  
***)***

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***Operator CALC\_FATIGUE***

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**F\_NLNO2A=**CALC\_FATIGUE (TYPE\_CALCUL = "FATIGUE\_MULTI",  
**OPTION = "DOMA\_NOEUD",**  
**TYPE\_CHARGE = "NON\_PERIODIQUE",**  
**RESULT = SOL\_NL,**  
**CHAM\_MATER = CHECHMATE,**  
**COEF\_PREECROU = 1.0,**  
**GROUP\_MA = ("FACE1", "FACE2", "FACE3"),**  
**GRID = CUBIC,**  
**CRITERION = "FATEMI\_SOCIE",**  
**PROJECTION = "DEUX\_AXES",**  
)

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**Operator POST\_RCCM**

**Date**

:

**22/02/06**

**Author (S):**

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**Organization (S): EDF-R & D /AMA, CS IF**

## ***Instruction manual***

### ***U4.8- booklet: Postprocessing and dedicated analyses***

#### ***Document: U4.83.11***

## ***Operator POST\_RCCM***

### ***1 Goal***

***To check criteria of the RCC-M (Edition 1991). They are in particular the criteria of level 0 and certain criteria of level A of the §B3200, and the criteria of tiredness of the §B3600.***

***The criteria of level 0 aim at securing the material against the damage of excessive deformation, of plastic instability and elastic and elastoplastic instability. These criteria require the calculation of equivalent constraints of Pm membrane, local membrane Pl and membrane plus inflection Pm+Pb.***

***The criteria of level A aim at securing the material against the damage of deformation progressive and of tiredness. Except tiredness, they require the calculation of the amplitude of variation of constraint linearized, noted Sn, and possibly of the Sn\* quantity. For tiredness, they require in more it calculation of the amplitude of variation of constraint in a point, noted Sp.***

***Order POST\_RCCM carries out calculations of Pm, Pm+Pb, Sn, Sn\*, Sp, of the number of cycles acceptable and of the factor of use in fatigue. In entry, it is necessary to specify is the computation result***

***thermomechanical on a line of piping (TYPE\_RESU\_MECA=' TUYAUTERIE'), that is to say tables constraints on a segment of analysis built afterwards of thermomechanical calculations 2D or 3D (TYPE\_RESU\_MECA=' EVOLUTION'), that is to say tables of constraints on a segment of analysis correspondent with unit loadings and the associated torques of loading (TYPE\_RESU\_MECA=' UNITAIRE').***

***Product a structure of data of the type counts.***

***Before a first use, it is advised to refer to the council and reference documents, in particular the document [U2.09.03].***

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***2 Syntax***

***TABL\_POST\_RCCM = POST\_RCCM (***

***TYPE\_RESU***

***=***

***/***

***“VALE\_MAX”,***

***[DEFECT]***

***/***

***“DETAILS”,***

***INFORMATION***

/1

,

[DEFECT]

/2,

**TITRATE**

=

*titrate,*

[KN]

**TYPE\_RESU\_MECA**

=

/

**“EVOLUTION”,**

[DEFECT]

**/“UNIT”,**

**/“PIPING”,**

**/TYPE\_RESU\_MECA = “EVOLUTION”**

**OPTION =/**

**“SN”,**

**/“PM\_PB”,**



*/“FATIGUE\_ZH210”,*

*MATER = chechmate, [to subdue]*

*TRANSITOIRE=\_F (*

*TABL\_RESU\_MECA*

*=*

*tabmeca,*

*/*

*[table]*

*TABL\_SIGM\_THER = tabth*

*,*

*/*

*[table]*

*NB\_OCCUR*

*=*

*/*

*nocc,*

*[I]*

*/*

*1,*

*[DEFECT]*

*/TOUT\_ORDRE = “YES”,*

*/*

*NUME\_ORDRE =*

*lordre*

*,*

*[I\_I]*

/  
**LIST\_ORDRE =**  
**lordre**  
,  
**[listIs]**  
/  
**INST**  
**=**  
**linst**  
,  
**[l\_R]**  
  
/  
**LIST\_INST**  
**=**  
**linst**  
,  
**[listr8]**  
  
**/ PRECISION**  
**=**  
/  
**prec,**  
**[R]**  
  
/  
**1.D-06**  
,  
**[DEFECT]**  
  
**/ CRITERION =**  
/  
**“RELATIVE”, [DEFECT]**  
  
/  
**“ABSOLUTE”**  
,

)

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*/TYPE\_RESU\_MECA = "UNIT"*

*OPTION =/*

*"SN",*

*/ "PM\_PB",*

*/ "TIREDNESS",*

*MATER = chechmate, [to subdue]*

*TYPE\_KE =*

*/*

*"KE\_MECA",*

*[Defect]*

*/*

*"KE\_MIXTE"*

*CHAR\_MECA*

= *\_F*

(

*NUME\_CHAR*

=

*numchar,*

*[I]*

*NOM\_CHAR*

=

*nomchar,*

*[KN]*

*TYPE\_CHAR*

=

/

*“SEISM”,*

*[KN]*

/

*typechar,*

*[KN]*

*MX*

=

*MX*

,

[R]

*MY*

=

*my*

,

[R]

*MZ*

=

*mz*

,

[R]

*FX*

=

*fx*

,

[R]

*FY*

=

*fy*

,

[R]

*FZ*

=

*fz*

,

*[R]*

)

*RESU\_MECA\_UNIT=\_F (*

*TABL\_MX =*

*tabsigmx*

,

*[tabl]*

*TABL\_MX =*

*tabsigmy*

,

*[tabl]*

*TABL\_MX =*

*tabsigmz*

,

*[tabl]*

*TABL\_FX = tabsigfx*

,

*[tabl]*

*TABL\_FY = tabsigfy*

,

*[tabl]*

*TABL\_FZ = tabsigfz*

,  
*[tabl]*

*TABL\_PRES*

=  
*tabsigpr*

,  
*[tabl]*

)  
*RESU\_THER=\_F (*

*NUME\_RESU\_THER*

=  
*numtran,*  
*[I]*

*TABL\_RESU\_THER*

=  
*count,*

*[tabl]*)  
*SITUATION=\_F (*

*NUME\_SITU*

=  
*numsitu,*  
*[I]*

*NOM\_SITU*

=



*nomsitu,*  
*[KN]*

*NB\_OCCUR*  
=  
*nbocc,*  
*[I]*

*NB\_CYCL\_SEISME = nbsss,*  
*[I]*

*NUME\_GROUPE*  
=  
*numgroup*  
  
*[I]*

*NUME\_PASSAGE*  
=  
*(num1,*  
*num2)*  
*[L\_I]*

*COMBINABLE =/"YES", [DEFECT]*

*/"NOT", [kN]*

*PRES\_A*

=

*pressed*

,

[R]

*PRES\_B*

=

*pressb*

,

[R]

*TEMP\_REF\_A = tempa,*

[R]

*TEMP\_REF\_B = tempb,*

[R]

*CHAR\_ETAT\_A = (list\_num\_char\_meca), [L\_I]*

*CHAR\_ETAT\_B = (list\_num\_char\_meca), [L\_I]*

*NUME\_RESU\_THER = list\_num\_tran*

,

[L\_I]

)  
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*/TYPE\_RESU\_MECA = "PIPING"*

*OPTION*

*=/"TIREDNESS",*

*MODEL*

*=*

*model*

*,*

*[model]*

*ZONE\_ANALYSE=\_F (*

*/*

*ALL*

*=*

*"YES",*

*[DEFECT]*

*/*

*GROUP\_MA* =  
*gma1*,  
[*groupma*]  
/  
*NET*  
=  
*ma1*  
,  
[*mesh*]

*CARA\_ELEM*  
=  
*will cara*,  
[*cara\_elem*]

*TYPE\_KE* =  
/  
“*KE\_MECA*”,  
[*Defect*]  
/  
“*KE\_MIXTE*”

*CHAM\_MATER*=  
*chmat*,  
[*cham\_mater*]

*RESU\_MECA*=\_F (

*NUME\_CHAR*  
=  
*numchar*,  
[*I*]

*NOM\_CHAR*  
=  
*nomchar*,

[KN]

TYPE\_CHAR

=

/

“SEISM”,

[KN]

/

“OTHER”

,

[DEFECT]

/

RESULT

=

resu

,

/

[evol\_elas]

/

[evol\_noli]

/TOUT\_ORDRE

= “YES”,

/

NUME\_ORDRE =

lordre

,

[l\_I]

/

LIST\_ORDRE =

lordre

,

[listIs]

/  
*INST*  
=  
*linst*  
,*[l\_R]*

/  
*NOEUD\_CMP*  
=  
*lnoecmp,*  
*[l\_K16]*

/  
*LIST\_INST*  
=  
*linst*  
,*[listr8]*

/ *PRECISION*  
=  
/  
*prec,*  
*[R]*

/  
*1.D-06*  
,*[DEFECT]*

/ *CRITERION* =/"*RELATIVE*", *[DEFECT]*

/  
"*ABSOLUTE*"  
,

*NOM\_CHAM* =/"EFGE\_ELNO\_DEPL",  
/  
"SIEF\_ELNO\_ELGA",

/  
*CHAM\_GD* =  
*cham\_effo*, [*cham\_elem*]

)  
*INDI\_SIGM*=\_F (

*C1*  
=  
/  
*1.*,  
[*DEFECT*]

/  
*c1*,  
[*R*]

*C2*  
=  
/  
*1.*,  
[*DEFECT*]

/  
*c2,*  
*[R]*

*C3*  
=  
/  
*0.5,*  
*[DEFECT]*

/  
*c3,*  
*[R]*

*K1*  
=  
/  
*1.,*  
*[DEFECT]*

/  
*k1,*  
*[R]*

*K2*  
=  
/  
*1.,*  
*[DEFECT]*



/  
*k2*,  
[R]

*K3*  
=  
/  
*1.*,  
[DEFECT]

/  
*k3*,  
[R]

/  
*ALL*  
=  
"YES",  
[DEFECT]

/  
*GROUP\_MA* =  
*gma1*,  
[groupma]  
/  
*NET*  
=  
*ma1*  
,  
[mesh]

/  
*GROUP\_NO* =  
*gno1*,  
[groupno]  
/

*NODE =*  
*no1*  
,  
*[node]*

*TYPE\_ELEM\_STANDARD*  
*=*  
*/*  
*“DRO”,*  
*[KN]*  
*/*  
*“NECK”,*  
*[KN]*  
*/*  
*“TRN”,*  
*[KN]*  
*/*  
*“TEE”,*  
*[KN]*  
*)*

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*8.2*

*Titrate:*  
*Operator POST\_RCCM*

*Date*  
*:*  
*22/02/06*

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*:*  
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*RESU\_THER* = *\_F* (

*NUME\_RESU\_THER*

=  
*numtran*,  
[*I*]

*TABL\_RESU\_THER*

=  
*count*,

[*tabl\_post\_releve*]

*TABL\_MOYE\_THER*

=  
*count*,

[*tabl\_post\_releve*]

/  
*ALL*  
=  
"YES",  
[*DEFECT*]

/  
*GROUP\_MA* =  
*gma1*,  
[*groupma*]

/  
*NET*  
=  
*ma1*

,

*[mesh]*

/  
*GROUP\_NO =*  
*gno1,*  
*[groupno]*  
*/NODE*

*= no1*  
,  
*[node]*  
)  
*SITUATION=\_F (*

*NUME\_SITU*  
*=*  
*numsitu,*  
*[I]*

*NOM\_SITU*  
*=*  
*nomsitu,*  
*[KN]*

*NB\_OCCUR*  
*=*  
*nbocc,*  
*[I]*

*NB\_CYCL\_SEISME = nbsss,*  
*[I]*

*NUME\_GROUPE*

=

*numgroup,*

*[I]*

*NUME\_PASSAGE*

= (*num1,*

*num2,*)

*[L\_I]*

*COMBINABLE =/"YES", [DEFECT]*

*/"NOT", [kN]*

*PRES\_A*

=

*pressed*

,

*[R]*

*PRES\_B*

=

*pressb*

,

*[R]*

*TEMP\_REF\_A = tempa,*  
*[R]*

*TEMP\_REF\_B = tempb,*  
*[R]*

*CHAR\_ETAT\_A = (list\_num\_char\_meca), [L\_I]*

*CHAR\_ETAT\_B = (list\_num\_char\_meca), [L\_I]*

*NUME\_RESU\_THER = list\_num\_tran*  
*,*  
*[L\_I]*

)  
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**3**

***Operands commun runs with all the options***

**3.1 Operand**

**TYPE\_RESU**

*TYPE\_RESU = / "VALE\_MAX",*

*/*

*"DETAILS",*

*Type of values contained in the table produced in result:*

.

*VALE\_MAX: only the maximum values are given;*

.

*DETAILS: the computed values at every moment are provided.*

**3.2 Operand**

**TITRATE**

*TITRATE = title*

*Character string describing the title of the table of values created, which appears with the impression of this table by IMPR\_TABLE [U4.91.03].*

**3.3 Operand**

**INFORMATION**

*INFORMATION = /1*

*/2*

*Allows a posting more or less detailed in the file message.*

**3.4**

***Types of results: key word TYPE\_RESU\_MECA***

*Three types of results are manageable by POST\_RCCM:*

- *Of the results of the type evolution of transient/“EVOLUTION”*
- *Of the results of type the unit with combination of situations/“UNIT”*
- *Of the results of the piping type for the application of the RCCM on the lines of piping /“PIPING”,*

*Five types of criteria are accessible each one by an option (key word OPTION):*

·  
*on a segment, starting from tables of constraints extracted from one or more concepts results obtained by a total order (MECA\_STATIQUE, STAT\_NON\_LINE) on one modeling 2D or 3D (results of the “UNIT” type or “EVOLUTION”):*

-  
*criteria of level 0 by option PM\_PB,*

-  
*criteria of level A (except tiredness) by the option SN,*

- *criteria of tiredness (of level A) by option FATIGUE\_ZH210 for the results of type “EVOLUTION” or by the option TIRES for the results of the “UNIT” type.*

*These options can be called only or simultaneously.*

·  
*From several mechanical computation results (MECA\_STATIQUE, STAT\_NON\_LINE, COMB\_SISM\_MODAL) on a line of piping, and complementary data, one can to calculate criteria of tiredness by the option TIRES.*

### **3.5 Count produced**

*Order POST\_RCCM generates a concept of the type counts. Order IMPR\_TABLE [U4.91.03] allows to print the contents of the table. For more information, one will be able to refer to the document [U2.09.03].*

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**4****Operands specific to the results of the TRANSITORY type**

*For a precise description of the calculations carried out by these options, one can consult the document [R7.04.03], the note of use [U2.09.03] and notes it [bib2].*

*One points out however here briefly the definition of the calculated quantities. These options are not available that for the elements of continuous medium 2D and 3D.*

*In the three cases, the characteristics of materials necessary to the calculation of the criteria are to be defined*

*by order DEFI\_MATERIAU [U4.43.01]. The computed values and the values limit are stored in the table tabl\_post\_rccm, which one prints using order IMPR\_TABLE [U4.91.03].*

*The analysis is done on a segment, starting from tables of constraints extracted from one or more concepts*

*results obtained by a total order (MECA\_STATIQUE, STAT\_NON\_LINE) on one modeling 2D or 3D. The tables of constraints can be created by the order POST\_RELEVE\_T. The possible options of calculation are:*

- of the criteria of level 0 by option PM\_PB;*
- of the criteria of level A (except tiredness) by the option SN;*
- of the criteria of tiredness (also of level A) by option FATIGUE\_ZH210 (the old one option FATIGUE\_SPMAX can be simulated easily by FATIGUE\_ZH210, to see case-test RCCM06a).*

*These options can be called only or simultaneously.*

**4.1.1 Operand****MATER**

*MATER = chechmate*

*It is the material containing the characteristics useful to POST\_RCCM and definite under the key word RCCM of DEFI\_MATERIAU [U4.43.01].*

**Notice on the curves of tiredness:**

*For the small amplitudes of constraints, the problem of the prolongation of the curve of tiredness can be posed: for example, for the curves of tiredness of the RCCM beyond 106 cycles, the corresponding constraint, 180 MPa is regarded as limit of endurance, i.e. that very forced lower than 180 MPa must produce a factor of null use, or an infinite number of cycles acceptable.*

*The method adopted here corresponds to this concept of limit of endurance: if the amplitude of constraint is lower than the first X-coordinate of the curve of tiredness, then one takes one factor of null use.*

**4.1.2 Option****PM\_PB**

*Option allowing to calculate the criteria of level 0 which aim at securing the material against damage of excessive deformation, plastic instability and elastic and elastoplastic instability. These criteria require the calculation of the equivalent constraints of Pm membrane, of membrane local Pl, of inflection Pb and membrane plus Pm inflection + Pb.*

*The operands necessary are MATER, the table of constraints TABL\_RESU\_MECA (built by example by POST\_RELEVE\_T after mechanical calculation on the place of postprocessing) and possibly the table of constraints TABL\_SIGM\_THER built starting from a calculation with thermal loading only.*

*The points of calculation are the two ends of the segment of analysis. If several segments of extraction were used to define the same table of constraints, calculation is done successively for each one of them.*

*The values limit are Sm and 1.5 Sm, Sm being working stress function of material and of temperature, given by the key word SM of key word RCCM in DEFI\_MATERIAU [U4.43.01].*

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**Note:**

- *The calculation of PM and PMPB is only done starting from the primary constraints, therefore out constraints of thermal origin. If TABL\_SIGM\_THER is indicated, it is supposed that it result indicated in TABL\_RESU\_MECA corresponds to a thermomechanical calculation and one he thus withdraws the thermal stresses. If only TABL\_RESU\_MECA is indicated, it calculation is done directly starting from the constraints indicated in the table.*
- *The calculation of PM and PMPB following the criteria of the RCCM G3000 is possible for elements of beam POU\_D\_E and POU\_D\_T, using operator CALC\_ELEM [U4.81.01] (options “PMPB\_ELGA\_SIEF” and “PMPB\_ELNO\_SIEF”).*

**4.1.3 Option**

**SN**

*Option allowing to calculate the criteria of level A (except tiredness) which aim at securing the material against the damage of progressive deformation. They require the calculation of the amplitude of variation of constraint linearized in a point, noted  $S_n$ .*

*If the user asks it (presence of operand RESU\_SIGM\_THER) one also the calculation carries out of  $S_n^*$ . The points of calculation are the two ends of the segment.*

*The operands necessary are MATER and the table of constraints TABL\_RESU\_MECA (built by example by POST\_RELEVE\_T after mechanical calculation on the place of postprocessing) to inform in the TRANSITORY key word. The calculation of  $S_n^*$  is carried out if a table of the thermal stresses TABL\_SIGM\_THER is provided.*

*The points of calculation are the two ends of the segment of analysis. If several segments of extraction were used to define the same table of constraints, calculation is done successively for each one of them.*

*The limiting  $S_n$  value is  $3 S_m$ ,  $S_m$  being working stress function of material and of temperature, given by the key word SM of the key word factor RCCM in DEFI\_MATERIAU [U4.43.01].*

**Note:**

*Key word TABL\_RESU\_MECA can be repeated several times under only one key word TRANSIENT. For the calculation of SN and  $S_n^*$ , there will be however no combination between*

*situations thus defined: each table of constraints will be treated successively.*

#### **4.1.3.1 Calculation of $S_n^*$**

*If operand **TABL\_SIGM\_THER** of the key word **TRANSITORY** factor is present, one carries out also it*

***$S_n$  calculation \*.***

*It is necessary, so that calculation is coherent and in conformity with the **RCC-M**, that constraints provided in*

***TABL\_SIGM\_THER** were obtained with a thermal loading only, knowing that the result given by **TABL\_RESU\_MECA** can be due to a combination of this thermal loading with other loadings. It is necessary thus that the moments of table **TABL\_SIGM\_THER** correspond to those of table **TABL\_RESU\_MECA**.*

#### **4.1.4 Option FATIGUE\_ZH210**

*Option allowing to calculate the factor of use resulting from the combination of one or more transients, according to the method of additional **RCC-M ZH210**.*

*The amplitude of variation of constraint in each end of the segment of analysis is calculated to leave tables of constraints **TABL\_RESU\_MECA**, for each combination of moments belonging to (X) transient (S) definite (S) by the user. Then one applies a method of combination and office plurality for to obtain the factor of total use, cf [U2.09.03].*

*The moments corresponding to the extreme states must be specified by the user by the operands **NUME\_ORDRE**, **INST** or **LIST\_INST**.*

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**Note:**

*Key word **TABL\_RESU\_MECA** can be repeated several times under only one key word **TRANSIENT**. For the fatigue analysis, the results contained in each table of constraints will be combined between them.*

**4.2 Word**

*key*

**TRANSIENT**

*This key word factor makes it possible to define it (or them) transitory (S) to study.*

**4.2.1 Operand**

**ENTITLE**

*Allows to give a name to the transient. This name will be posted in the produced table.*

**4.2.2 Operand**

**TABL\_RESU\_MECA**

*TABL\_RESU\_MECA = tabmeca*

*Count of the constraints on the segment of analysis, built for example by **POST\_RELEVE\_T** with to start from mechanical results of *evol\_elas* type and *evol\_noli*.*

**4.2.3 Operand**

**TABL\_SIGM\_THER**

*TABL\_SIGM\_THER = tabth*

*Count of the constraints on the segment of analysis, built for example by **POST\_RELEVE\_T** on one result obtained with a thermal loading only. This key word allows in particular the calculation of  $S_n^*$  [§4.1.3.1].*

**4.2.4 Operand**

**NB\_OCCUR**

*NB\_OCCUR = /nocc, [DEFECT]*

/

1,

*A number of occurrences for the calculation of the factor of use.*

#### **4.2.5 Operands *TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/INST/LIST\_INST/PRECISION/CRITERION***

*TOUT\_ORDRE, NUME\_ORDRE, LIST\_ORDRE, INST, LIST\_INST*

*These key words allow the selection of the sequence numbers corresponding to the gathered fields in the tables of constraints *tabmeca* (and *tabth* possibly) under the reference symbols previously specified. The sequence numbers are given either directly (key words *TOUT\_ORDRE, NUME\_ORDRE, LIST\_ORDRE*), are indirectly by lists of values of theirs variables of access (key words *INST, LIST\_INST*).*

*PRECISION,  
CRITERION*

*Key words (optional) defining the precision (1.D-6 by defect) and the search criterion (*RELATIVE* by defect) of a sequence number starting from a value of moment.*

#### **4.3 Phase of execution**

*If *RESU\_SIGM\_THER* is present, it is checked that the moments of calculation of the table *tabth* are identical to those of the table *tabmeca*. On the other hand, one cannot check only the transients thermics which contributed to the mechanical results *tabth* and *tabmeca* are identical. It is with the user to ensure coherence (including on the data materials).*

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#### **4.4 Example of use**

*An example of use of operator POST\_RCCM with results of the EVOLUTION type can be found in the case test RCCM01.*

*A calculation of the criteria of the RCCM proceeds in the following way:*

- *definition of the parameters of material and the curve of tiredness,*
- *definitions of the mechanical and thermal loadings,*
- *linear thermomechanical calculation or not linear,*
- *(if calculation of SN\*) mechanical calculation with thermal loading only,*
- *definition of the segment of analysis and extraction of the results with POST\_RELEVE\_T or MACR\_LIGN\_COUPE,*

*then (possibly in continuation):*

```
SN1=POST_RCCM (MATER=MAT,  
TYPE_RESU=' VALE_MAX',  
TYPE_RESU_MECA=' EVOLUTION',  
OPTION=' SN',  
TITRE=' SN, RESULT: RESU2b WITH RESUTH',  
TRANSITOIRE=_F (TABL_RESU_MECA = T_RESU2b,  
TABL_SIGM_THER = T_RESUTHb,  
)
```

```
IMPR_TABLE (TABLE = sn1)
```

*For more information, one will be able to refer to the document [U2.09.03].*

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### ***Operands specific to the results of the PIPING type***

*From several mechanical computation results (MECA\_STATIQUE, STAT\_NON\_LINE, COMB\_SISM\_MODAL) on a line of piping, and data complementary. One calculates criteria of tiredness by the option TIRES.*

#### ***5.1 Opening remarks concerning the stages preliminary to it postprocessing***

*The data necessary to postprocessing are summarized here (and detailed with the § according to):*

.

*Geometry of the line of piping.*

.

*The material field: it is the chart of materials assigned to the groups of meshes of grid by AFFE\_MATERIAU for which it is necessary to add the curve of tiredness, E\_REFE, M\_KE and N\_KE (key words RCCM).*

.

*AFFE\_CARA\_ELEM makes it possible to affect the elementary characteristics.*

.

*Indices of constraints (in each node of the grid).*

.

*The scenario of operation containing the list of the situations:*

-

*For each situation:*



-  
*Numbers of occurrences of each situation (thus of each stabilized state).*

-  
*Pressure and average temperature of each stabilized state.*

-  
*List mechanical loadings of each stabilized state.*

-  
*The group of membership of the situation.*

-  
*The associated thermal transient.*

.  
*Results of calculations for each mechanical loading (including the seism), located by its number, with for information the name of the loading case: field by elements with the nodes generalized efforts, for each loading (EFGE\_ELNO\_DEPL, or SIEF\_ELNO\_ELGA).*

.  
*For each node, a reference to a definite thermal result below.*

.  
*Results of thermal calculations: calculations EF 2D or 3D which give these infos depend at the same time of the geometry and the transient. There is thus a thermal calculation by type of junction, and by type of transient. In practice one carries out two POST\_RELEVE\_T per transient and by different type of thickness or geometry: a POST\_RELEVE\_T with the option EXTRACTION, and a second with the AVERAGE option*

*Preliminary calculations to carry out are thus:*

.  
*Calculations of the type beam (elastic design) for each loading (one is only useful oneself moments, expressed in a local reference mark with each element, locates presumably identical for all the results) composing each of the two stabilized states of each situation.*

.  
*A seismic calculation (inertial answer and displacements of anchoring) (only one type of seism taken into account).*

.  
*The calculation of each thermal transient, in as many grids 2D or 3D there is different thicknesses or components.*

*The operands and key words of the option TIREDNESS were selected in order to allow a use later in bond with tool OAR. They are thus inspired by the specifications of the data base OAR [bib3].*

## **5.2 Operand**

### **CHAM\_MATER**

**CHAM\_MATER** = *chmat*

*It is the material field containing, for all the meshes of the model, the characteristics material useful to TIREDNESS and definite under key words ELAS\_FO, TIREDNESS and RCCM of DEFI\_MATERIAU [U4.43.01] (E, NAKED, ALPHA, WOHLER, E\_REFE, M\_KE, N\_KE, SM).*

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### ***Notice on the curves of tiredness:***

*For the small amplitudes of constraints, the problem of the prolongation of the curve of tiredness can be posed: for example, for the curves of tiredness of the RCCM beyond 106 cycles, the corresponding constraint, 180 MPa is regarded as limit of endurance, i.e. that very forced lower than 180 MPa must produce a factor of null use, or an infinite number of cycles acceptable.*

*The method adopted here corresponds to this concept of limit of endurance: if the amplitude of constraint is lower than the first X-coordinate of the curve of tiredness, then one takes one factor of null use.*

### **5.3 Operand**

**CARA\_ELEM**

*CARA\_ELEM*

= *will cara*

*It is the field of characteristics of the elements of beams (external ray and thickness, angle and*

*radius of curvature of the elbows) defined by AFFE\_CARA\_ELEM.*

#### **5.4 Operand MODEL**

*MODEL*  
= *model*

*It is the model (finite element of beam) on which were carried out calculations of the loadings mechanics.*

#### **5.5 Operand TYPE\_KE**

*TYPE\_KE =*  
/  
*“KE\_MECA”*,  
*[Defect]*  
/  
*“KE\_MIXTE”*

*The elastoplastic factor of correction Ke can be calculated in two ways:*

·  
*KE\_MECA: it is the original method, only available in the versions former to version 7.2 [cf R7.04.03]*

·  
*KE\_MIXTE: Since the modifying 1997 of the RCC-M, one can choose another formula, based on a decomposition of Salt:*

*I*  
*(I,)*  
*E*  
*J*  
*C*  
= .  
·  
,  
·  
,  
+  
,

.  
,  
*alt*  
*(Kmeca (Sn (p Q) Smeca*  
*p*  
*(I J) K ther (Sn (p Q) Sther*

*p*  
*(I J) with:*  
*2nd*

*E*  
*E*  
*K meca (S*

,  
*is equal to Ke defined in [R7.04.03], and*  
*N (p Q)*  
*E*

*l*

*ther*  
*K*  
*S p Q*

*E*  
*(N (,))*

*l*  
*= max*

.  
*.86*  
*l*

*l*

-

.  $S$

66

.

$I$

+  $N$

$S_m$

$S_{meca}$

$p$

$(I, J)$  represents the quantity  $S_p$ , amplitude of variation on mechanical behalf of constraints, between the moments  $I$  and  $J$ , or maximum value of this quantity during the transient, calculated on the basis of request of mechanical origin: pressure, actual weight, seism (inertial and displacements of anchoring), thermal expansion.

$S_{ther}$ , represents the  $S_p$  quantity calculated starting from the generated mechanical constraints

$p$

$(I, J)$

only by the thermal transients.

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## **5.6 Word**

*key*

**ZONE\_ANALYSE**

*This key word makes it possible to limit the fatigue analysis to meshes or groups of mesh of the line of piping.*

### **5.6.1 Operands**

**ALL/GROUP\_MA/MESH**

/

**ALL**

=

**“YES”**

,

**/GROUP\_MA**

=

**gma1**

,

**[groupma]**

/

**NET**

=

**ma1**

,  
[mesh]

*By defect the calculation of the factor of use is made for all the nodes of the model.*

*These key words make it possible to restrict the analysis with meshes or groups meshes, which makes it possible to save computing time.*

## **5.7 Word**

**key**

**RESU\_MECA**

*This key word factor makes it possible to define the results of mechanical calculations. It is répétable as much of time that there are mechanical loadings different as a whole from the situations.*

### **5.7.1 Operand**

**NUME\_CHAR**

*Number of the mechanical loading. This number is used to define the loadings associated with each situation (see key word SITUATION).*

### **5.7.2 Operand**

**NOM\_CHAR**

*Name (optional) of the mechanical loading.*

### **5.7.3 Operand**

**TYPE\_CHAR**

**TYPE\_CHAR**

=

/

“SEISM”,

[KN]

/

“OTHER”

,  
[DEFECT]

*Mechanical type of loading. This type is used only in the case of it SEISM, which profits from a particular treatment (combination quadratic from efforts). In the other cases, the combinations are linear.*

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**5.7.4 Operand**

**RESULT/CHAM\_GD**

/

**RESULT**

=

*resu,*

/

[*evol\_elas*]

/

[*evol\_noli*]

**/TOUT\_ORDRE = “YES”**



,

/

*NUME\_ORDRE* =

*lordre*

,

[*l\_I*]

/

*LIST\_ORDRE* =

*lordre*

,

[*listIs*]

/

*INST*

=

*linst*

,

[*l\_R*]

/

*NOEUD\_CMP*

=

*lnoecmp,*

[*l\_K16*]

/

*LIST\_INST*

=

*linst*

,

[*listr8*]

/

*PRECISION*

=

/

*prec,*

[*R*]

/

*1.D-06*

,

[*DEFECT*]

/ *CRITERION* =

/  
“*RELATIVE*”, [*DEFECT*]

/  
“*ABSOLUTE*”

,

*NOM\_CHAM*

=  
/  
“*EFGE\_ELNO\_DEPL*”,

/  
“*SIEF\_ELNO\_ELGA*”,

/  
*CHAM\_GD* =  
*cham\_effo*

,  
[*cham\_elem*]

)  
*Results of calculations for each loading: fields by elements with the nodes of efforts generalized:*

*one can give:*

· *is a field by element*

: *cham\_effo* which is of type *EFGE\_ELNO\_DEPL*, or  
*SIEF\_ELNO\_ELGA*,

· *is a structure of data result (exit of MECA\_STATIQUE or STAT\_NON\_LINE)*  
*with parameters of extraction*

: moment,  $NOM\_CHAM='EFGE\_ELNO\_DEPL'$ , or  
 “ $SIEF\_ELNO\_ELGA$ ”...) either resulting from  $COMB\_SISM\_MODAL$  or  $MODE\_STATIQUE$  with  
 additional parameter of extraction  $NOEUD\_CMP$ .

For the latter, the fields of efforts relating to the seism are the moments for each component  
 of each seism (resulting from a quadratic combination  $NOEUD\_CMP= (“COMBI”, “QUAD”)$ ), for  
 the inertial response and of the nodes and the directions: for example  $NOEUD\_CMP= (“N1”, “DX”)$   
 for  
 displacements of anchorings.

## 5.8 Operand $INDI\_SIGM$

$INDI\_SIGM=_F ($

$C1$   
 =  
 /  
 1.  
 ,  
 [DEFECT]

=  
 /  
 $c1$   
 ,  
 [R]

$C2$   
 =  
 /  
 1.

,  
[DEFECT]

=  
/  
c2  
,  
[R]

C3  
=  
/  
0.5  
,  
[DEFECT]

=  
/  
c3  
,  
[R]

K1  
=  
/  
1.  
,  
[DEFECT]

=  
/  
k1  
,

[R]

*K2*

=

/

1.

,

[DEFECT]

=

/

*k2*

,

[R]

*K3*

=

/

1.

,

[DEFECT]

=

/

*k3*

,

[R]

/

*ALL*

=

“YES”,

/

*GROUP\_MA* =

```
gma1
,
[groupma]
/
NET
=
ma1
,
[mesh]

/
GROUP_NO =
gno1
,
[groupno]
/NODE

= no1
,
[node]

TYPE_ELEM_STANDARD
=
/
“DRO”,
[KN]

/
“NECK”,
[KN]
```

/  
“TRN”,  
[KN]

/  
“TEE”,  
[KN]

)  
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Values of the indices of constraints to be used in the analysis of tiredness (values codified in RCC-M B3683, variable according to the type of junction). the user provides for each group of meshes, or each node of each mesh, values of C1, C2, C3, K1, K2, K3, knowing that values by defect are those which correspond to the right parts of pipings, which facilitates the introduction data. One will be able to have for example:

```
INDI_SIGM= _F (
GROUP_MA=' GMA1'),
(assignement of the default values for all the nodes of all the meshes of GMA1)
```

```
_F (
MAILLE=' MA2', NOEUD=' NO2', C1=1.2, C2=1.4...),
(assignement of particular indices for node NO2 of mesh MA2)
```

*TYPE\_ELEM\_STANDARD* is an optional key word, purely informative, making it possible to post more clearly in the table results according to the type of elements and junctions. One will be able to give, as in OAR, [bib3] a description of the type:

- *DRO*: to some extent right,
- *NECK*: for an elbow,
- *TRN*: for a transition from thickness,
- *TEE*: for a t-piece.

## 5.9 Word

key

### **RESU\_THER**

This key word factor makes it possible to define the results of thermal calculations. It is répétable as many time

that there are different thermal calculations and geometrical discontinuities or materials.

As an indication, there can be: (Nb discontinuities) \* (Nb thermal transients).

### 5.9.1 Operand

#### **NUME\_RESU\_THER**

**NUME\_RESU\_THER**

=

numtran [I]



*Number of the thermal transients. This number is used to identify it thermal transient associated each situation (see key word SITUATION).*

### **5.9.2 Operand**

#### **TABL\_RESU\_THER**

##### **TABL\_RESU\_THER**

=

*count*

*[tabl\_post\_releve]*

*Count resulting from POST\_RELEVE\_T, containing for each thermal calculation transient, the statement of the temperatures on a section (chosen by the user) of grid 2D or 3D of a junction or a right part at various moments of transient. The origin of the section must be the internal skin.*

##### **TABL\_MOYE\_THER**

=

*count*

*[tabl\_post\_releve]*

*Count resulting from POST\_RELEVE\_T, (OPERATION=' MOYENNE') containing for each transitory thermal calculation, averages of order 0 and 1 of the temperatures on the selected section (in coherence with TABL\_RESU\_THER) at various moments of transient.*

*These quantities are used to calculate the values of T*

*, T*

*, T and T*

*1*

*2*

*has*

*B*

*[R7.04.03].*

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### 5.9.3 Operands

**ALL/GROUP\_MA/MESH/GROUP\_NO/NODE**

*/ALL = "YES",*

*/*

*GROUP\_MA*

*=*

*gma1*

*,*

*[groupma]*

*/*

*NET*

*=*

*ma1*

*,*

*[mesh]*

*/GROUP\_NO*

*=*

*gno1*

*,*

*[groupno]*

*/NODE*  
 = *no1*  
 ,  
 [*node*]

*The table and the transient are associated is with a group of meshes, (in general this group contains all the right parts which see the same transient thermics), is with a mesh, and a node of this mesh (what corresponds in general with a junction). One will be able to have for example:*

```
RESU_THER = _F (NUME_RESU_THER =
1,
TABL_RESU_THER = tabl1,
TABL_MOYE_THER = tabl11,
GROUP_MA=' gma1'),
_F (NUME_RESU_THER = 1,
TABL_RESU_THER = tabl2,
TABL_MOYE_THER = tabl22,
```

```
NET
=
"ma1"
,
NODE
=
"no2"
)
```

### ***5.10 Word*** ***key*** ***SITUATION***

*This key word factor makes it possible to define the definitions of the situations. It is répétable as many time as it y has situations.*

#### ***5.10.1 Operands NUME\_SITU/NOM\_SITU/NB\_OCCUR***

***NUME\_SITU***

=  
*numsitu,*  
**[I]**

*NOM\_SITU*  
=  
*nomsitu,*  
**[KN]**

*NB\_OCCUR*  
=  
*nbocc*  
,  
**[I]**

*NB\_CYCL\_SEISME*  
=  
*nbsss*  
,  
**[I]**

*Number of the situation, and name (indicative). NB\_OCCUR corresponds to the key word OCCURRENCE of file OAR and indicates the number of occurrences of the situation. NB\_CYCL\_SEISME provides the number of under-cycles for each occurrence of seism.*

### **5.10.2 Operands PRES\_A/PRES\_B/TEMP\_REF\_A/TEMP\_REF\_B**

*PRES\_A*  
=  
*pressed*  
,

**[R]**

***PRES\_B***

**=**

***pressb***

**,**

**[R]**

***TEMP\_REF\_A = tempa,***

**[R]**

***TEMP\_REF\_B = tempb,***

**[R]**

***Temperatures (stabilized) and pressures associated with each of the two states stabilized situation.***

***These operands are useless if the situation corresponds to a seism.***

### ***5.10.3 Operands CHAR\_ETAT\_A/CHAR\_ETAT\_B***

***CHAR\_ETAT\_A***

**=**

***(list\_num\_char\_meca)***

**,**

**[L\_I]**

***CHAR\_ETAT\_B***

=  
(list\_num\_char\_meca)  
,

***List mechanical numbers of loadings associated in each stabilized state.  
These numbers correspond to key word NUME\_CHAR of the key word factor CHAR\_MECA.  
Operand CHAR\_ETAT\_B is useless if the situation corresponds to a seism, only  
the loadings provided under CHAR\_ETAT\_A are used (quadratic combination)  
(they must correspond to the results of inertial calculation using  
COMB\_SISM\_MODAL, and of each displacement of anchoring under seism, obtained either  
using MODE\_STATIQUE, that is to say on a case-by-case basis).***

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### ***5.10.4 Operand NUME\_RESU\_THER***

***NUME\_RESU\_THER = list\_num\_tran***

***[L\_I]***

***List numbers of tables resulting from thermal calculations associated the situation. With  
each situation is associated a thermal transient (or several in the case of  
various sections of lines). If for a given situation, there is***

*physically two transients, like heating-cooling for example, it is of use in B3600 to combine these two transients in only one.*

*For each situation, one provides N tables which represent the calculation of same thermal transient in various places of the line (for each thickness or each discontinuity). These numbers must belong to the list of the provided numbers under key word NUME\_RESU\_THER of the key word factor RESU\_THER.*

### **5.10.5 Operand NUME\_GROUPE/NUME\_PASSAGE**

**NUME\_GROUPE**

=

**numgroup**

, [I]

**NUME\_PASSAGE**

=

**(num1,**

**num2)**

,

**[L\_I]**

*Number of group to which the situation belongs.*

*The fatigue analysis combines between them only the situations of the same group, except if there is a situation of passage between the two groups.*

*For the situations of passage, num1 and num2 indicate the two numbers of groups connected by this situation. A situation of passage is defined, like one another situation, by two lists of loadings and a thermal transient. It can to belong to a group of situations containing of other situations.*

### **5.10.6 COMBINABLE operand**

**COMBINABLE =**

**/“YES”**

,

**[DEFECT]**

**/“NOT”**

**[KN]**

*This key word indicates if a situation is combinable with the others inside sound group (case general).*

*If COMBINABLE=' NON', that means that the situation is a under-cycle.*

### **5.10.7 Operand NB\_CYCL\_SEISME**

**NB\_CYCL\_SEISME = nbsss,**

*A number of cycles associated with each occurrence with the seism, considered as under-cycles in the calculation of the factor of use.*

### **5.11 Example of use**

*Test RCCM02 provides a complete example of use. For more information, one will be able to refer with the document [U2.09.03].*

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**Operands specific to the results of the UNIT type**

### **6.1 Preliminaries**

***It is supposed here that the calculation of the component was carried out in Aster (exploitation of a statement of forced on a segment chosen by the user), or comes from one request at the data base OAR [bib1], in which profiles of constraints can be stored. One here is used common specification of the form of the results resulting from these two ways.***

***Calculations 2D or 3D of the component are to be made only for unit loadings (efforts and unit total moments applied to the limits of the model, by connections 3D beam for example). It are combined then linearly according to the values of the efforts and moments resulting from calculation beam of piping, for all the loadings intervening in the situations of calculation. Attention, the reference mark used for calculation 2D or 3D must be coherent with that in which are expressed total efforts resulting from calculation beam.***

***Preliminary calculations to carry out in Aster or to extract from the data base OAR (so available):***

.

***Calculation of the line of piping, type beam (elastic design) for each loading, y included/understood the seism (one is generally useful of the moments, expressed in a local reference mark with each element, identical for all the results), in order to deduce the efforts from them to be applied with the limits of the model 2D or 3D.***

.

***Calculation of each thermal transient, on the same grid 2D or 3D.***

***The data necessary to postprocessing are summarized here (and detailed with the § according to):***

.

***The material (presumably single initially) that the segment of study crosses: isotropic elastic material for which it is necessary to add the curve of tiredness, E\_REFE, M\_KE and N\_KE.***

.

*The scenario of operation (available in OAR) containing the list of the situations:*

-

*For each situation:*

-

*Numbers of occurrences of each situation (thus of each stabilized state).*

-

*Pressure and average temperature of each stabilized state.*

-

*List mechanical loadings of each stabilized state.*

-

*The group of membership of the situation.*

-

*The associated thermal transient.*

.

*The definition of each mechanical loading (including the seism), located by sound number, with for information the name of, and the torque loading case of generalized efforts correspondent with this loading, to apply to the limits of the model.*

.

*Results of calculations for each unit mechanical loading (extraction of the values constraints on a segment chosen by the user of the model 2D or 3D).*

.

*Results of thermal calculations: extraction of the constraints on a segment of the model EF 2D or 3D One thus has a thermal calculation by transient.*

### **6.1.1 Option**

#### **PM\_PB**

*Option allowing to calculate the criteria of level 0 which aim at securing the material against damage of excessive deformation, plastic instability and elastic and elastoplastic instability. These criteria require the calculation of the equivalent constraints of Pm membrane, of membrane local Pl, of inflection Pb and membrane plus Pm inflection + Pb.*

*See [§4.1.2].*

### **6.1.2 Option**

#### **SN**

*Option allowing to calculate the criteria of level A (except tiredness) which aim at securing the material against the damage of progressive deformation. They require the calculation of the amplitude of variation of constraint linearized in a point, noted Sn.*

*See [§4.1.3].*

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### **6.1.3 Option**

#### **TIRE**

*The fatigue analyses (option “TIRES”) within the meaning of the RCCM B3200 are carried out on a segment of analysis, starting from statements of constraints on this segment for unit loadings. These calculations are in conformity with what is done in design, and the data necessary are accessible (in the files of analysis of behavior, or in OAR).*

### **6.2 Operand**

#### **MATER**

*MATER = chechmate*

*Name of material containing, for the analyzed segment, the characteristics useful to FATIGUE\_B3200 and definite under key words ELAS and RCCM of DEFI\_MATERIAU [U4.43.01] (E, NAKED, ALPHA, WOHLER, E\_REFE, M\_KE, N\_KE, SM)*

#### **Notice on the curves of tiredness:**

*For the small amplitudes of constraints, the problem of the prolongation of the curve of tiredness can be posed: for example, for the curves of tiredness of the RCCM beyond 106 cycles, the corresponding constraint, 180 MPa is regarded as limit of endurance, i.e. that very forced lower than 180 MPa must produce a factor of null use, or*

*an infinite number of cycles acceptable.*

*The method adopted here corresponds to this concept of limit of endurance: if the amplitude of constraint is lower than the first X-coordinate of the curve of tiredness, then one takes one factor of null use.*

### **6.3 Operand**

#### **TYPE\_KE**

*TYPE\_KE =*  
/  
*“KE\_MECA”,*  
*[Defect]*  
/  
*“KE\_MIXTE”*

*The elastoplastic factor of correction Ke can be calculated in two ways:*

.

*KE\_MECA: it is the original method, only available in the versions former to version 7.2 [cf R7.04.03];*

.

*KE\_MIXTE: Since the modifying 1997 of the RCC-M, one can choose another formula, based on a decomposition of Salt [cf U2.09.03].*

### **6.4 Word**

*key*

#### **CHAR\_MECA**

*This key word factor makes it possible to define, for each mechanical loading appearing in situations, torques applied to the limits of the model, resulting from calculations of the beam type. It is répétable as many time as there are mechanical loadings different as a whole from situations.*

#### **6.4.1 Operand**

##### **NUME\_CHAR**

*Number of the mechanical loading. This number is used to define the loadings associated with each situation (see key word SITUATION).*

#### **6.4.2 Operand**

##### **NOM\_CHAR**

*Name (optional) of the mechanical loading.*

### **6.4.3 Operand**

#### **TYPE\_CHAR**

*TYPE\_CHAR*

=

/

*“SEISM”,*

*[KN]*

/

*typechar,*

*[KN]*

*Mechanical type of loading. This type is used only in the case of the SEISM, which profits of a particular treatment. In the other cases, it is purely informative.*

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## 6.4.4 Operands

### ***MX/MY/MZ/FX/FY/FZ/NEAR***

*MX*

=

*MX*

,

*[R]*

*MY*

=

*my*

,

*[R]*

*MZ*

=

*mz*

,

*[R]*

*FX*

=

*fx*

,

[R]

*FY*

=

*fy*

,

[R]

*FZ*

=

*fz*

,

[R]

*Generalized efforts resulting from calculations of the line of piping, beam type, for each loading, to apply to the profiles of constraints provided under RESU\_MECA\_UNIT, by linear combination.*

*Attention, this supposes that these values are provided in a coherent reference mark with that used for modeling 2D or 3D of the component.*

*Among these efforts one finds also the results of calculations for each seism: moments for each component of each seism, the inertial answer and for displacements of anchorings.*

## **6.5 Word**

**key**

**RESU\_MECA\_UNIT**

**RESU\_MECA\_UNIT=\_F (**

**TABL\_MX =**

**tabsigmx**

**[tabl\_post\_releve]**

*TABL\_MY =  
tabsigmy  
[tabl\_post\_releve]*

*TABL\_MZ =  
tabsigmz  
[tabl\_post\_releve]*

*TABL\_FX = tabsigfx  
[tabl\_post\_releve]*

*TABL\_FY = tabsigfy  
[tabl\_post\_releve]*

*TABL\_FZ = tabsigfz  
[tabl\_post\_releve]*

*TABL\_PRES  
=  
tabsigpr  
[tabl\_post\_releve]*

)  
*This key word factor makes it possible to provide the profiles of constraints on the segment chosen, resulting from unit mechanical calculations. For the realization of these calculations, it is recommended to apply to the limits of the model 3D of the connections of the 3Dpoutre type with specific discrete elements. One of these elements is embedded, and on the other, one applies unit generalized efforts. Let us note that it is of use in*



calculations *RCCM* of the piping type to consider only the moments, it is why the key words factors *TABL\_FX*, *TABL\_FY* *TABL\_FZ* are optional. *TABL\_PRES* corresponding to a calculation under pressure interns unit, without forgetting the basic effect.

## **6.6 Word**

*key*

### ***RESU\_THER***

*This key word factor makes it possible to define the results of thermal calculations. It is répétable as many time that there are different thermal calculations.*

#### **6.6.1 Operand**

##### ***NUME\_RESU\_THER***

*NUME\_RESU\_THER*

=

*numtran [I]*

*Number of the thermal transients. This number is used to identify it thermal transient associated each situation (see key word *SITUATION*).*

#### **6.6.2 Operand**

##### ***TABL\_RESU\_THER***

*TABL\_RESU\_THER*

=

*count*

*[tabl\_post\_releve]*

*Count resulting from *POST\_RELEVE\_T*, containing for each thermal calculation transient, the statement of the constraints due to the thermal loading on the section of grid 2D or 3D chosen by the user at various moments of the transient. The origin section must be the internal skin.*

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## **6.7 Word**

**key**

**SITUATION**

*This key word factor makes it possible to define the definitions of the situations. It is répétable as many time as it y has situations.*

### **6.7.1 Operands**

**NUME\_SITU/NOM\_SITU/NB\_OCCUR**

*NUME\_SITU*

=

*numsitu,*

**[I]**

*NOM\_SITU*

=

*nomsitu,*

**[KN]**

*NB\_OCCUR*

=

*nbocc*

,

[I]

*Number of the situation, and name (indicative). nbocc corresponds to the number occurrences of the situation.*

### **6.7.2 Operands**

***PRES\_A/PRES\_B/TEMP\_REF\_A/TEMP\_REF\_B***

*PRES\_A*

=

*pressed*

,

[R]

*PRES\_B*

=

*pressb*

,

[R]

*TEMP\_REF\_A = tempa,*

[R]

*TEMP\_REF\_B = tempb,*

[R]

*Temperatures (stabilized) and pressures associated with each of the two stabilized states situation.*

### **6.7.3 Operands**

**CHAR\_ETAT\_A/CHAR\_ETAT\_B**

*CHAR\_ETAT\_A = (list\_num\_char\_meca)*

,  
[L\_I]

*CHAR\_ETAT\_B = (list\_num\_char\_meca)*

,  
[L\_I]

*List mechanical numbers of loadings associated in each stabilized state.*

*These numbers correspond to key word NUME\_CHAR of the key word factor CHAR\_MECA.*

### **6.7.4 Operand**

**NUME\_RESU\_THER**

*NUME\_RESU\_THER = list\_num\_tran*

[L\_I]

*List thermal numbers of transients associated the situation. There can be 0 or 1 transient section by section of line (what corresponds to groups of meshes) for each situation. These numbers correspond to key word NUME\_RESU\_THER of key word factor RESU\_THER.*

*If for a given situation, there are physically two transients for a section, like heating-cooling for example, it is of use in B3600 to combine these two transients in only one.*

### **6.7.5 Operand**

**NUME\_GROUPE/NUME\_PASSAGE**

*NUME\_GROUPE*

=

*numgroup*  
*, [L\_I]*

*NUME\_PASSAGE*

= (*num1*,  
*num2*),  
*[L\_I]*

*Number (S) of group (S) of situation for each situation (situations of two different groups cannot be combined between them, except if there is one situation of passage). In general, a situation belongs to only one group. But it can exist cases where the same situation belongs to several groups.*

*For the situations of passage, num1 and num2 indicate the two numbers of groups connected by this situation. A situation of passage is defined, like one another situation, by two lists of loadings and a thermal transient. It can belong to a group.*

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## **6.7.6 Operand**

## **COMBINABLE**

**COMBINABLE** =  
/“YES”  
,  
[DEFECT]

/“NOT”  
,  
[KN]

*This key word indicates if a situation is combinable with the others inside sound group (case general). If COMBINABLE='NON', that means that situation is a under-cycle.*

### **6.7.7 Operand NB\_CYCL\_SEISME**

**NB\_CYCL\_SEISME** = nbsss,

*A number of cycles associated with each occurrence with the seism, considered as under-cycles in the calculation of the factor of use.*

#### **Notice on the seism:**

*Only one loading of the SEISM type can be defined by group of situations. On the other hand it is possible to define several groups of situations comprising each one in the more one loading of the SEISM type.*

## **6.8 Example**

**Tests RCCM04 and RCCM07 provide complete examples of use. For more information, one will be able to refer to the document [U2.09.03].**

## **7 Bibliography**

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*Date:*

31/01/05

*Author (S):*

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***Operator POST\_ZAC***



## ***1 Goal***

***To determine a state adapted or adapted by the method Zarka-Rack.***

***This operator gives within the framework of cyclic elastoplasticity with a model of work hardening linear kinematics the adapted or adapted state of the structure under periodic loading (presumably elastic) refines or not refines, with or without calculation of an initial state (for example the first cycle) elastoplastic. Moreover, it gives estimates of the variables of the amplitude type of constraint or plastic deformation, or their average values with the absolute limit saturated thanks to the method simplified Zarka-Rack (ZAC). The method is not validated for the phenomenon of accommodation in the case of a loading nonclosely connected.***

***The concept produced by this operator is of mult\_elas type comprising one (adaptation) or three (accommodation) sequence numbers equivalent to the values with the absolute limit (average, amplitude) and containing the fields of solution displacements of the homogeneous elastic problems with initial deformations [R7.06.01] as well as the amplitudes of constraints, plastic deformation and an elementary indicator of adaptation or accommodation.***

***Product a concept of the mult\_elas type.***

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***Version***

***7.4***

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***Operator POST\_ZAC***

***Date:***

***31/01/05***

***Author (S):***

***S. TAHERI, J. ANGLES, Key Mr. BONNAMY***

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## ***2 Syntax***

***[mult\_elas] = POST\_ZAC***

(

***MODEL***

=

***Mo***

,

***[model]***

***CHAM\_MATER***

=

***chmater,***

***[cham\_mater]***

***EXCIT =\_F (LOAD***

=

***chi***

,

***[char\_meca]***

***FONC\_MULT***

=  
*fi*  
,  
*[function]*

*TYPE\_CHARGE= "FIXE\_CSTE",*  
*[DEFECT]*

),

*EVOL\_ELAS*  
=  
*evol\_elas*  
,  
*[evol\_elas]*

/  
*NUME\_ORDRE =*  
*l\_nuor*  
,  
*[l\_I]*

/  
**LIST\_INST**  
=  
**l\_inst**  
,  
**[litr8]**

/  
**INST**  
=  
**inst**  
,  
**[l\_R]**

**TEMP\_ZAC**  
=  
/  
**temp**  
,  
**[R]**  
/  
**0.**  
,  
**[DEFECT]**

**EVOL\_NOLI**  
=  
**evol\_noli**

,  
**[evol\_noli]**

**INST\_MAX**

=  
**inst**

,  
**[R]**

**/ PRECISION**

=  
/  
**prec**

,  
**[R]**

/  
**1.0E-3**

,  
**[DEFECT]**

**/ CRITERION =**

/  
**“RELATIVE”**

,  
**[DEFECT]**

/  
**“ABSOLUTE”**

,

)

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***3 Operands***

***3.1 Operands***

***MODEL/CHAM\_MATER***

***MODEL = Mo***

***Name of the model whose elements are the subject of calculation.***

***CHAM\_MATER = chmater***

***Field of affected material to the model Mo. One must find the characteristics material there used during the elastic designs and elastoplastic preconditions to method ZAC.***

***3.2 Word***

***key***

***EXCIT***

***Cf [U4.51.03].***

***Two types of loading are taken into account here:***

***.***

**Boundary conditions kinematics of the problem (of imposed displacement type).**

**If the intermediate variable 0 (initial state for method ZAC) is calculated with to start from an elastoplastic calculation, operator POST\_ZAC needs for calculation for plastic deformation (p T E HT**

=

-

-

) and of the field of temperature which was useful for it calculation.

### **3.3 Operand EVOL\_ELAS**

*EVOL\_ELAS = evol\_elas*

*Name of a concept result of the evol\_elas type.*

*One indicates here the result of the evol\_elas type post-to treat and the moments of elastic design corresponding to the cycle of loading which one seeks the absolute limit by the simplified method ZAC. Two moments are enough in the case of a loading refines (mini load and maximum loading). structure of data must comprise the fields displacements with the nodes and constraints with points of Gauss.*

#### **3.3.1 Operands**

**NUME\_ORDRE/INST/LIST\_INST**

*Cf [U4.71.00].*

### **3.4 Operand TEMP\_ZAC**

*If the characteristics material depend on the temperature, this operand allows to indicate the temperature to which one wants that the characteristics material are used in method ZAC. The values are interpolated in the functions material contained in the field given by operand CHAM\_MATER. The temperature is optional if the constants material are independent of the temperature (constant temperature).*

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### ***3.5 Operand*** ***EVOL\_NOLI***

*EVOL\_NOLI = evol\_noli*

*Name of a concept result of the evol\_noli type.*

*One indicates here the results of the preliminary elastoplastic calculation of which one of the moments will use for*

*P*  
*to determine the initial state within the meaning of method ZAC:*

*C*  
*~*  
*~e*  
*0 =*

*-*  
*+*  
*With*  
*With*  
*With, where ~*

*is it*  
*With*  
*diverter of the constraints (obtained by elastoplastic calculation) and ~*  
*E the diverter of the constraints*

*With*  
*for this same calculation carried out in elasticity. The moment of elastic design are equivalent must be present*

*in the structure of data indicated by key word EVOL\_ELAS. The structure of data must to comprise the fields displacements with the nodes and constraints at the points of Gauss. **If this operand is not indicated, then the initial state within the meaning of method ZAC is null:***



$0 = 0.$

### **3.5.1 Operand INST\_MAX**

*INST\_MAX = inst*  
[R]

*One indicates here the moment tmax (maximum loading before discharge) of elastoplastic calculation (word key EVOL\_NOLI) which will use to determine the initial state. **This moment must also be present in the list of moments provided with key word EVOL\_ELAS.***

### **3.6 Operands PRECISION/CRITERION**

*Cf [U4.71.00]. These operands are to be used with operand INST\_MAX and make it possible to refine the extraction of a field by a real variable of access. By defect PRECISION = 1.D-3 and CRITERION = "RELATIVE".*

## **4 Results provided in the produced concept**

*The produced concept is of mult\_elas type and comprises is a sequence number (situation of adaptation), that is to say three sequence numbers (situation of accommodation).*

*Those are referred by the variable of access NOM\_CAS. This variable of access is worth is: "AVERAGE VALUE", either "AMPLITUDE I", or "AMPLITUDE S".*

*The following fields are stored:*

/  
"DEPL"

*Displacements obtained by the resolution of the homogeneous elastic problems provided with initial deformation (or*

, , ).

lim

moy

I

S

/

*“SIEF\_ELGA”*

*Stress field at the points of Gauss calculated starting from preceding displacements. It represent the state of residual stresses estimated by method ZAC.*

/  
*“ALPH0\_ELGA\_EPSP”*

*Initial State ()*

*0 calculated at the points of Gauss starting from the data of elastoplastic calculation,*

*P*

*P*

*cf [§3.5], (*

*~*

*~*

*C*

*E)*

*0 =*

*-*

*+*

*With*

*With*

*With if this one is indicated if not the initial state is null*

*( = )*

*0*

*0 .*

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“ALPHP\_ELGA\_ALPHP”

*Fields (or*  
*,) calculated at the points of Gauss starting from the projection of*  
*lim*  
*moy*  
*I*  
*S*  
*the initial state ()*  
*el*  
*0 on the intersection of convex of center ~*  
*I and of ray y, y threshold of*  
*plasticity and I index of loading.*

/

“SIGM\_ELNO\_ZAC”

*Average constraints and two amplitudes of constraints to the nodes with the absolute limit:*  
*lim (residual stress) for the sequence number 1 in a case of adaptation,*  
*moy, for the sequence numbers 1,2 and 3 in a case of accommodation.*  
*I*  
*S*

/

“EPSP\_ELNO\_ZAC”

*Average plastic deformations and amplitudes of deformations to the nodes with the absolute limit:*  
*p for the sequence number 1 in a case of adaptation,*  
*lim*  
*p, p, p for the sequence numbers 1,2 and 3 in a case of accommodation.*  
*moy*  
*I*  
*S*

/

“VARI\_ELGA\_ZAC”

*Elementary indicator on the nature of the phenomenon to the absolute limit. Value 1 indicates one*  
*situation of accommodation and the value a 0 situation of adaptation on the element considered.*

*This field is stored on the sequence number 1 only.*

**Caution:**

.  
*The file result comprises a message specifying the situation with the absolute limit (ADAPTATION or ACCOMMODATION).*

.  
*A situation of accommodation in the case of a loading nonclosely connected causes one and emission program stop of a message in the file RESULT: method is then not applicable.*

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## **5 Examples**

### **5.1**

**Calculation without initial state**

**solsta = MECA\_STATIQUE (**

**MODEL = Mo,**

**LIST\_INST = listel,**

**CHAM\_MATER = chmat,**

**EXCIT = \_F (LOAD = chme),**

**OPTION = (“SIEF\_ELGA\_DEPL”, “EPSI\_ELGA\_DEPL”)**

)

***chzac1 = POST\_ZAC (MODEL = Mo, CHAM\_MATER = chmat,***

***EXCIT = \_F (LOAD = chme),***

***EVOL\_ELAS = solsta, LIST\_INST = listel)***

)

## 5.2

### ***Calculation with initial state***

***solpl = STAT\_NON\_LINE (***  
***MODEL = Mo,***  
***CHAM\_MATER = chmat,***  
***EXCIT = \_F (LOAD = chpres, FONC\_MULT = varpress),***  
***EXCIT = \_F (LOAD = chcl),***  
***COMP\_INCR = \_F (RELATION = "VMIS\_CINE\_LINE"),***  
***INCREMENT = \_F (LIST\_INST = listpl, NUME\_INST\_FIN = 20),***  
***NEWTON = \_F (MATRIX = "TANGENT"),***  
***CONVERGENCE = \_F (RESI\_GLOB\_RELA= 0.001,***  
***ITER\_GLOB\_MAXI= 100)***  
***)***

***solsta = MECA\_STATIQUE = (***  
***MODEL = Mo,***  
***LIST\_INST = listel,***  
***CHAM\_MATER = chmat,***  
***EXCIT = \_F (LOAD = chme),***  
***OPTION = ("SIEF\_ELGA\_DEPL", "EPSI\_ELGA\_DEPL")***  
***)***

*chzac2 = POST\_ZAC (MODEL = Mo, CHAM\_MATER = chmat,  
EXCIT*

*=  
\_F (  
CHARGE  
=  
chme  
)*

*EVOL\_ELAS = solsta, LIST\_INST = listel*

*EVOL\_NOLI = solpl, INST\_MAX = 3.*

*)*

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Organization (S): EDF-R & D /AMA

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**Operator COMB\_FOURIER**

**1 Goal**

**To recombine the modes of FOURIER of a structure of data result in directions particular. The modes are produced for a model "AXIS\_FOURIER" by the macro order MACRO\_ELAS\_MULT [U4.51.02].**

**This is possible for displacements, the reactions, the fields of strains and stresses**

*in elasticity.*

*The structure of data produced is of comb\_fourier type.*

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*2 Syntax*

*comb [comb\_fourier] = COMB\_FOURIER*

*(*

*RESULT*

*=*

*resu*

*,*

*[fourier\_elas]*



***NOM\_CHAM = / “DEPL”***

***/ “REAC\_NODA”***

***/ “SIEF\_ELGA\_DEPL”***

***/ “EPSI\_ELNO\_DEPL”***

***/ “SIGM\_ELNO\_DEPL”***

**ENG**

=

**langl,**

**[l\_R]**

)

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### ***3 Operands***

***Recall:***

***The recombination of FOURIER on displacements is written:***

***cosl***

***sinl***

***0***

***NR***

***0***

***U () =***

***cosl***

***custom +***

***has***

***L***

***sin L***

***U***

***L***

***L = 0***

***0***

***- sinl***

***0***

***cosl***

***1***

***2***

***4444***

***3***

**4444**  
**1444 2**  
**4**  
**3**  
**4444**

**Have**  
**Aa**

***A symmetrical harmonic is thus recombined with the matrix Have, a harmonic antisymmetric with the Aa matrix.***

***The recombination of FOURIER on the strains and the stresses is written:***

**NR**  
**L I4**  
**04,2**  
**sin**  
**L I4**  
**04,2**

**() =**

**cos**

**S +**  
**has**  
**L**

**0**  
**sin L I**  
**0**  
**cosl I**  
**L**

**L =**  
**-**

**2,4**

2

2,4

2

0

### **3.1 Operand**

**RESULT**

**RESULT = resu,**

*Name of the concept of the fourier\_elas type from which one will recombine the modes.*

### **3.2 Operand**

**NOM\_CHAM**

**NOM\_CHAM = nomsymb,**

*Reference symbol of the recombined fields.*

### **3.3 Operand**

**ENG**

**ENG = langl,**

*Angle (S) in degrees of (or of) the section (S) where the recombination of FOURIER takes place.*

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*The example below carries out a calculation on 2 harmonics of Fourier by **MACRO\_ELAS\_MULT**, enriches the concept of the **RESULT** type by **CALC\_NO** before recombining the computed fields by **COMB\_FOURIER**.*

**BEGINNING ()****m = LIRE\_MALLAGE ()****Mo = AFFE\_MODELE (GRID = m,****AFFE = \_F (ALL = "YES",****PHENOMENON = "MECHANICAL",****MODELISATION= "axis\_fourier"))****my = DEFI\_MATERIAU (ELAS = \_F (E = 72. ,****NAKED = 0.3,****RHO = 0. ,))****cm = AFFE\_MATERIAU (GRID = m,****AFFE = \_F (ALL = "YES",****MATER = my,))****bloqu = AFFE\_CHAR\_MECA\_F (MODEL = Mo,****DDL\_IMPO = \_F (NODE = "N1", DX = 0. , DY = 0. , DZ = 0. ),****(NODE = "N2", DY = 0. ),****(NODE = "N3", DY = 0. ,),)****CH = AFFE\_CHAR\_MECA (MODEL = Mo,****PRES\_REP = \_F (GROUP\_MA = "end", PRES= 100. ,),)**

#

**# FOURIER CALCULATION ON THE 2 FIRST SYMMETRICAL HARMONICS**

#

**resu = MACRO\_ELAS\_MULT (MODEL = Mo,****CHAM\_MATER = cm,****CHAR\_MECA\_GLOBAL= bloqu,****CAS\_CHARGE= (****\_F (MODE\_FOURIER = 1,****TYPE\_MODE = "SYME",****CHAR\_MECA = CH,****OPTION = "SIGM\_ELNO\_DEPL",****SOUS\_TITRE = "mode Fourier 1 SYME"),****\_F (MODE\_FOURIER = 2,****TYPE\_MODE = "SYME",**

```
CHAR_MECA = CH,  
OPTION = "SIGM_ELNO_DEPL",  
SOUS_TITRE = "Fourier mode 2 SYME"),),  
)  
#  
# CALCULATION OF THE NODAL REACTIONS BY CALC_NO  
#  
resu = CALC_NO (reuse = resu,  
RESULT = resu,  
OPTION = "REAC_NODA",  
angl1 = 45.  
angl2 = 135.  
#  
# RECOMBINATION OF FOURIER ON DISPLACEMENTS, REACTIONS AND FORCED  
FOR 45° AND 135°  
#  
co_four = COMB_FOURIER (RESULT = resu,  
NOM_CHAM = ("DEPL", "REAC_NODA",  
"SIGM_ELNO_DEPL"),  
ENG = (angl1, angl2),  
)  
END ()
```

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08/02/05

*Author (S):*

**Y. PONS, J. PIGAT, L. VIVAN** *Key*

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*Organization (S): EDF-R & D /AMA, CS IF*

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***Operator COMB\_SISM\_MODAL***

***1 Goal***



*To calculate a dynamic response to single or multiple imposed movements.*

*In the case of the multiple excitation, the supports are animated different movements for one direction given. These movements here are supposed to be décorrélés and independent.*

*These requests are represented by spectra of response of oscillator representing a seism or a shock. These spectra of oscillator can be given starting from a accélérogramme signal seismic (real signal or synthetic signal) by order CALC\_FONCTION with the key word factor SPEC\_OSCI [U4.32.04].*

*Operator COMB\_SISM\_MODAL allows to determine, in any point of the structure, the components maximum of relative displacement, relative pseudovelocity, absolute pseudo-acceleration, them maximum efforts generalized by element and maximum reactions to the supports.*

*These maxima of answer are calculated starting from the maximum answer of a simple oscillator, associated each real clean mode taken into account. Several rules of recombination of contributions of each clean mode and the contributions in each direction are available.*

*Product a concept of the mode\_stat type.*

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*2 Syntax*

*R [mode\_stat] = COMB\_SISM\_MODAL*

*(MODE\_MECA = mode [mode\_meca]*

*/TOUT\_ORDRE*

*=*

*“YES”*

*[DEFECT]*

*/*

*NUME\_ORDRE*

*=*

*l\_ordre [l\_I]*

*/*

*LIST\_ORDRE*

*=*

*lordre*

*[listis]*

*/*

*NUME\_MODE*

*=*

*l\_mode*

*[l\_I]*

*/*

*/*

*FREQ*

*=*

*l\_freq*

*[l\_R]*

*/*

*LIST\_FREQ*

*=*

*lfreqr8*

*[listr8]*

***I PRECISION***

=

/

***1.D-3***

***[DEFECT]***

/

***prec***

***[R]***

***I CRITERION***

=

/

***“RELATIVE”***

***[DEFECT]***

/

***“ABSOLUTE”***

***MODE\_CORR = acce [mode\_stat\_acce]***

/

***AMOR\_REDUIT***

=

***amor***

***[l\_R]***

/

***LIST\_AMOR***

=

***lamor***

***[listr8]***

/

## ***AMOR\_GENE***

=

***amogene***  
***[matr\_asse\_gene\_R]***

***MASS\_INER = mass\_iner [tabl\_mass\_iner]***

## ***EXCIT***

***=\_F (/MONO\_APPUI =/  
"YES"***

***/***

***NODE***

=

***lno***  
***[l\_noeud]***

***/***

***GROUP\_NO***

=

***lgrno [l\_gr\_noeud]***

***/AXIS = (c1, c2, c3) [l\_R]***

***SPEC\_OSCI = spec [tablecloth]***

***SCALE = echel***

***[R]***

***/***  
***TRI\_AXE = (p1, p2, p3)***  
***[l\_R]***

***SPEC\_OSCI = spec [tablecloth]***

***SCALE = echel***

**[R]**

/  
***TRI\_SPEC = "YES"***

**[KN]**

***SPEC\_OSCI= (spe1, spe2, spe3) [l\_fonction]***

***ECHELLE= (ech1, ech2, ech3) [l\_R]***

***NATURE***

=  
/

**“ACCE”**  
**[DEFECT]**

/

**“QUICKLY”**

/

**“DEPL”**

)

***CORR\_FREQ***

=

/

**“YES”**

**[DEFECT]**

/

**“NOT”**

***COMB\_MODE***

**=\_F (/STANDARD**

=

**/“SRSS”**

/

**“CQC”**

/

**“DPC”**

/

**“ABS”**

/

**“DSC”**

***DURATION***

=

***S***

***[R]***

)

***COMB\_DIRECTION =\_F (***

***/STANDARD***

=

***/"QUAD"***

***/***

***"NEWMARK"***

)

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**COMB\_MULT\_APPUI =\_F (**

**/ALL = “YES”**

**/**

**NODE**

**=**

**lno**

**[l\_noeud]**

**/**

**GROUP\_NO**

**=lgrno [l\_gr\_noeud]**

**/TYPE\_COMBI =/“QUAD”**

**/**

**“LINE”**

)  
*DEPL\_MULT\_APPUI = \_F (*

*NOM\_CAS = nomcas*

*NUME\_CAS = numcas*

*NOEUD\_REFE = noeu*  
*[node]*

***MODE\_STAT = stat [mode\_stat\_depl]***

***/NODE = lno***

***[l\_noeud]***

***/***

***GROUP\_NO***

***=***

***lgrno***

***[l\_gr\_noeud]***

***IDX = dx***

***[R]***

***IDY = Dy***

***[R]***

***IDZ = dz***

***[R]***

)  
***COMB\_DEPL\_APPUI =\_F (***

***/ALL = “YES”***

***/***

***LIST\_CAS***

***=***

***list***

***[l\_ume]***

***/TYPE\_COMBI =/“QUAD”***

/  
**“LINE”**

/  
**“ABS”**  
)

**OPTION =**  
**I**  
**“DEPL”**

**I “QUICKLY”**

*I “ACCE\_ABSOLU”*

*I “SIGM\_ELNO\_DEPL”*

*I “SIEF\_ELGA\_DEPL”*

*/ “SIPO\_ELNO\_DEPL”*

*I “EFGE\_ELNO\_DEPL”*

*I “EFGE\_ELNO\_CART”*

***I “REAC\_NODA”***

***I “FORC\_NODA”***

***TITRATE = tit***

***[l\_Kn]***

***INFORMATION =/1***

***[DEFECT]***

/ 2

= *\_F IMPRESSION (/ALL = "YES"*

*[DEFECT]*

/

*LEVEL*

=

*I "SPEC\_OSCI"*

*I "MASS\_EFFE"*

*I "MAXI\_GENE"*



)

)

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**Operator COMB\_SISM\_MODAL**

**Date:**

**08/02/05**

**Author (S):**

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### **3 Operands**

#### **3.1**

**Definition of the clean modes of the structure**

##### **3.1.1 Operand**

**MODE\_MECA**

**MODE\_MECA = mode**

**Name of the concept of the mode\_meca type produces by one of the operators of modal analysis**

**MODE\_ITER\_SIMULT [U4.52.03] or MODE\_ITER\_INV [U4.52.04].**

##### **3.1.2 Operands**

**TOUT\_ORDRE/NUME\_ORDRE/NUME\_MODE/LIST\_ORDRE**

**/TOUT\_ORDRE = "YES"**

**Default value which makes it possible to extract all the clean modes available in the concept mode.**

*/NUME\_ORDRE = l\_ordre*

*/NUME\_MODE = l\_mode*

*Extraction of the clean modes defined by a list l\_ordre of sequence numbers (NUME\_ORDRE) or a list l\_mode of numbers of modes (NUME\_MODE).*

*/LIST\_ORDRE = l\_ordre*

### **3.1.3 Operand**

**FREQ/LIST\_FREQ/PRECISION/CRITERION**

*/FREQ = l\_freq*

*Allows to extract the clean modes corresponding to a list from frequencies l\_freq.*

*/LIST\_FREQ = lfreqr8*

*Allows to extract the clean modes corresponding to a list of frequencies lfreqr8, definite by operator DEF1\_LIST\_REEL [U4.34.01] (lfreqr8 is thus a concept of the listr8 type).*

*I PRECISION = prec*

**I CRITERION**

=

*These operands make it possible to indicate that one seeks all the clean modes of which frequency is in the interval “inst ± prec”. By defect prec = 1.0D-3.*

*According to the CRITERION =*

*“RELATIVE” the interval of research is:*

*[inst (1 - prec), inst (1 + prec)]*

*“ABSOLUTE” the interval of research is:*

*[inst*

-

*prec,*  
*inst*  
+  
*prec].*

## 3.2

### *Definition of modal depreciation*

*Three possibilities exist to define modal depreciation: a list of reduced depreciation provided by the user in the form of list of realities (l\_R) or a concept of the listr8 type built by operator DEFI\_LIST\_REEL [U4.34.01] or a matrix of damping generalized (matrix of damping projected on the basis of real clean mode).*

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### *3.2.1 Operand*

*AMOR\_REDUIT*

*/AMOR\_REDUIT = amor*

*This operand makes it possible to provide the list of the depreciation reduced in the form of a list of realities*

*(l\_R). If the number of provided coefficients is lower than the numbers of clean modes taken in count, the last coefficient is allotted to the mode corresponding and the following modes.*

### *3.2.2 Operand*

## **LIST\_AMOR**

**/LIST\_AMOR = lamor**

*This operand makes it possible to provide the list of the depreciation reduced in the form of a concept of **listr8** type. If the number of reduced depreciation is lower than the number of clean modes taken into account, the last coefficient is affected with the following modes.*

*Example:*

**TOUT\_ORDRE = "YES" LIST\_AMOR = ("0.01", "0.02")**

*first mode = 0 0*

*. 1 and for all the other modes = 0 0*

*. 2*

### **3.2.3 Operand**

#### **AMOR\_GENE**

**/AMOR\_GENE = amogene**

*One gives the name of the matrix of damping generalized amogene produced by the operator **PROJ\_MATR\_BASE** [U4.63.12] or **MACRO\_PROJ\_BASE** [U4.63.11].*

### **3.3 Operand**

#### **MASS\_INER**

*To check the criterion of office plurality of the unit effective masses of the clean modes taken in count in each direction, it is necessary to know the total mass of the structure.*

*This one is calculated by order **POST\_ELEM** [U4.81.22] with key word **MASS\_INER**.*

*Operand **MASS\_INER** makes it possible to provide the name of the concept produced by this order.*

### **3.4**

*Description of the excitation: key word **EXCIT***

*The seismic excitation is defined by one or more spectra of oscillators. Those are calculated with precondition by order **CALC\_FONCTION** [U4.32.04] or read on a file by the order **LIRE\_FONCTION** [U4.32.02] with the format "SEISM". In both cases the produced concept is of function type with two variables (tablecloth).*

*One uses for that the key word factor*

## ***EXCIT***

*and possibly operand CORR\_FREQ.*

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### *3.4.1 Operands*

*MONO\_APPUI/NODE/GROUP\_NO*

*Two situations are possible:*

*.*

*the structure is studied with the same movement of drive in all the supports: one then use the operand MONO\_APPUI = "YES"*

*The key word factor EXCIT should appear only once in this case.*

*.*

*the structure is studied with several different movements of drive (excitation multi supports): one specifies with each occurrence of the key word factor the nodes or groups of nodes concerned with the described excitation*

*/NODE = lno*

***/GROUP\_NO = lgrno***

### ***3.4.2 Excitation along an axis***

***/***  
***CENTER = (c1, c2, c3)***

***SPEC\_OSCI = spec***

***SCALE = echel***

***In this case one provides:***

***.  
the cosine directors (c1 c2 c3) of the axis of excitation in the TOTAL reference mark of definition of the grid: the coefficients c1, c2, c3 are renormés by the order,  
.***

***operand SPEC\_OSCI awaits only one spectrum of oscillator where spec is the name of tablecloth to be used,  
.***

***the operand SCALE makes it possible to define a scale factor echel to be applied to all points of the spectrum spec.***

***Example:***

***For an excitation with 45° compared to the TOTAL reference mark, a spectrum of ground sol\_0\_1 fixed with 0.1g and a scale factor allowing to simulate a fixed spectrum with 0.25g:***

***CENTER***

***=(  
'1.'  
'1.'  
'0.'),***

***SPEC\_OSCI=sol\_0\_1,***

***ECHELLE=2.5,***

### ***3.4.3 Triaxial excitation with only one spectrum***

***/***  
***TRI\_AXE = (p1, p2, p3)***

***SPEC\_OSCI = spec***

**SCALE = echel**

**In this case one provides:**

.  
weighting coefficients ( $p_1$   $p_2$   $p_3$ ) to apply to the spectrum of oscillator  
for each direction X, Y and Z,

.  
operand SPEC\_OSCI awaits only one spectrum of oscillator where spec is the name of  
tablecloth to be used,

.  
the operand SCALE makes it possible to define a scale factor echel to be applied to  
all points of the spectrum spec, independently of the weighting coefficients  
of direction.

**Example:**

For an excitation with a weighting of 1. in X and Y (plane horizontal) and 0.66 in  
Z (vertical), a spectrum of fixed ground with 0.1g and a scale factor allowing to simulate one  
fixed spectrum with 0,25g:

TRI\_AXE= ("1. ", "1. ", "0.66"),

SPEC\_OSCI=sol\_0\_1,

ECHELLE=2.5,

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**3.4.4 Excitation**

***triaxial  
with three different spectra***

/  
*TRI\_SPEC = "YES"*

*SPEC\_OSCI = (spe1, spe2, spe3)*

*SCALE = (ech1, ech2, ech3)*

*In this case one provides:*

.  
*operand TRI\_SPEC: "YES",*

.  
*operand SPEC\_OSCI awaits three spectra of oscillators where (spe1 spe2 spe3)  
is the list of the names of the tablecloths to be used,*

.  
*the operand SCALE makes it possible to define three scale factors (ech1 ech2 ech3)  
to apply independently to all the points of each spectrum.*

***Example:***

*For an excitation spe1 in X, spe2 in Y and spe3 in Z, with three scale factors  
different:*

*TRI\_SPEC=' OUI',  
SPEC\_OSCI= (spe1 spe2 spe3),  
ECHELLE= (ech1 ech2 ech3),*

***3.4.5 Operand  
NATURE***

*NATURE*

*This operand makes it possible to specify the size of the spectrum of oscillator. By defect one uses one  
spectrum of acceleration "ACCE". It is possible to more rarely use of other sizes: speed  
"QUICKLY" or displacement "DEPL".*

***3.4.6 Operand  
CORR\_FREQ***

*CORR\_FREQ*



*To calculate the components of answer of speed or in acceleration starting from a spectrum of oscillator of the size displacement (NATURAL = "DEPL") one is led to multiply each value one or twice by R pulsation of the real clean mode (oscillating not deadened). In all rigour the oscillator R is deadened and its own pulsation is*

*R*  
*1*  
*2*  
*-*

*and R is only  
own pseudo-pulsation. By defect one thus obtains:*

*quickly  
= depl = pseudovelocity*

*max  
R  
read*

*acce  
= 2 depl = pseudo - acceleration*

*max  
R  
read*

*Operand CORR\_FREQ: "YES" allows to correct these values to take into account the damping of the clean mode:*

*quickly  
=  
1 - 2 depl  
= speed*

*max  
R  
read*

*acce  
= 2 1 - 2  
(  
) depl  
= acceleration*

*max  
R  
read*

*If one provides a spectrum of answer of speed (NATURAL = "QUICKLY") operand CORR\_FREQ will be necessary to correct deplmax and accemax so necessary. In the same way for a spectrum of response in acceleration (NATURAL = "ACCE") to correct deplmax and vitemax.*

*In all the cases, one will take care not to use like data SPEC a spectrum of pseudo-size.*

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### 3.5

#### **Rules of combination**

*To evaluate one raising of the response of the structure, one reasons size by size (internal displacement, speed or acceleration, efforts, constraints) starting from the modal values associated the clean modes taken into account. For each size, one will treat **independently** each degree of freedom (fields to the nodes of displacement, speed or acceleration), or each component of torque (internal efforts) or constraint. It is what us let us call the answer R in the statement of the rules of combination.*

*Several levels of combinations are necessary:*

- 
- combination of the clean modes,*
- 
- static correction by pseudo mode,*
-

combination according to the directions of seism.

In the case of an analysis multi-supports, the rules of combination are modified to hold account various excitations applied to groups of supports. It is also possible to calculate separately primary and secondary components of the answer.

### 3.6

#### **Rules of combination for an excitation mono-support**

**The total** response of the structure  $R$  is obtained by **combination of the directional answers**  $X$ -ray where  $X$  represents one of the directions of the TOTAL reference mark of definition of grid ( $X$ ,  $Y$ ,  $Z$ ) or

a particular direction (cf operand **CENTERS**). The directional answer is given by:

$$R = R_1 + R_2 + R_3$$

$X$

$D$

$T$

$E$

.

$R_d$  answer combined of the modal oscillators established by key word **COMB\_MODE** [§ 3.6.1]

.

$R_t$  represents the correction of the static effects of the neglected modes (pseudo mode) [§ 3.6.2]

.

$R_e$  contribution of the movement of drive ( $R_e = 0$  in mono support)

The rule of combination of the directional answers is defined by key word **COMB\_DIRECTION** [§ 3.6.3].

#### **3.6.1 Combination of the clean modes: key word COMB\_MODE**

##### **COMB\_MODE**

The response of the  $R_d$  structure, **in a direction of seism**, is obtained by one of possible combinations (defined by the **STANDARD** operand) of the contributions of each mode clean taken into account. Each clean mode is regarded as an oscillator independent of

$R_r$  answer defined by (,

$R$

$R$ ). The answer is read by interpolation in the spectrum of oscillator signal of excitation in this direction.

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*For an excitation mono support the  $R_r$  answer of the oscillator  $R$  is given by:*

$p$

$R$

$R$

=

$S$

$R$

$R$

2

**$R$**

$R$

.

*$R$  modal size (displacement, generalized effort, reaction) associated the mode clean of index  $R$*

.

*$Pr$  factor of modal participation associated the mode  $R$  in the studied direction*

.

*$Sr$  value of the spectrum of answer, for example in pseudo acceleration, for the oscillator  $R$*

*Several rules of combination of the clean modes are available. They are chosen by the STANDARD operand.*

### **3.6.1.1 Combination**

**quadratic**

**TYPE = "SRSS"**

*This combination (Public garden Root of Sum of Squares) corresponds to the assumption of strict independence*

*oscillators associated with each clean mode:*

*nmod*

*R =*

*R2*

*D*

*R*

*r=1*

*Let us note that this rule of combination, although very usually used, can be badly adapted when the assumption of independence is not checked for nearby clean modes or with important damping.*

***Quadratic 3.6.1.2 Combinaison supplements STANDARD = “CQC”***

*The quadratic combination (established by DER KIUREGHIAN [bib1]) makes a correction to the rule*

*the preceding one by introducing coefficients of correlation depending on depreciation and on distances between close clean modes (cf [R4.05.03]):*

***R = R R***

***D***

***R R***

***R***

***R***

***1 2***

***1***

***2***

***R***

***R***

***1***

***2***

***with the coefficient of correlation:***

***8***

***( + )***

***I J I***

***J***

***I I***

***J***

***J***  
***I***  
***J***  
***ij =***  
  
***2***  
***(***  
***- 2 2***  
***) +***  
***4 2***  
***(***  
***+ 2) + 4 2***  
***(***  
***+ 2 2***  
***)***  
***2***  
***I***  
***J***  
***I J I***  
***J***  
***I***  
***J***  
***I***  
***J***  
***I***  
***J***

***3.6.1.3 Summons absolute values TYPE = “ABS”***

***This combination corresponds to an assumption of complete dependence of the oscillators associated with each clean mode:***

***N MOD***  
***R =***  
***D***  
***rR***  
***R =1***

***Let us note that this rule of combination is to be disadvised, because it is too strongly preserving and conduit with a systematic oversizing.***

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*The close modes (of which the frequencies different from less than 10%) are initially combined by summation of the absolute values. The values resulting from this first combination are then combined quadratically. This method was proposed by American payment U.S. Nuclear Regulatory Commission (Regulatory Guides 1.92 - February 1976) to attenuate the conservatism of preceding method. It remains at fault for structures with an own frequency spectrum dense.*

**3.6.1.5 Combination of STANDARD ROSENBLUETH = "DSC"**

*This rule (proposed by E. ROSENBLUETH and J. ELORDY [bib2]) introduced a correlation enters modes, different from that of method CQC. The answers of the oscillators are combined by double nap (Double Sum Combination):*

 **$R = R R$** **D****R R****R****R****1 2****1****2****R****R****1****2**

*It requires an additional data, the duration  $S$  of the “strong” phase of the seism defined by the operand  $DURATION$ .*

*The coefficient of correlation is then:*

$-1$

,

$-'$

$2$

$I$

$J$

$I$

$ij =$

$+$

$' + '$

$I$

$I$

$J$

$J$

*where*

$2$

$' = 1 - 2$

,

*and*  $' =$

$I$

$I$

$I$

$I$

$I + S I$

### **3.6.2 Static correction by pseudo-mode: operand $MODE\_CORR$**

*The modal base used is in general incomplete. The evaluation of raising response to one seismic excitation requires, so a correction by a term representing the contribution statics of the neglected clean modes, in each direction of seism.*



*For each direction of the seism, one carries out this correction, while adding to the modal base, one pseudo-mode obtained starting from a static mode, field of displacement of the nodes of structure subjected to a constant acceleration in the direction considered defined by:*

$$K = M$$

.

*K stamps rigidity of the structure*

.

*M stamps of mass of the structure*

.

*unit field in the direction of the seism*

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*The pseudo-mode is obtained by withdrawing the static contributions of the modes taken into account:*  
 $n_{mod} Pr$

=-

*R with:*

2

 $R = 1 R$ · *R clean mode of index R*

·

*R**P factor of participation in the direction**In this direction, for each size, the contribution of the neglected modes is given by:* $N MOD$  $R = R - R$ *T**S**R* $r=1$ *Rs is the size associated with the static mode* $MODE\_CORR = acce$ 

*This key word makes it possible to provide it (S) field (S) of displacement of the nodes of the structure subjected to a constant acceleration in one (or several) direction (S), field (S) calculated (S) by operator MODE\_STATIQUE with key word PSEUDO\_MODE [U4.52.14]. For any direction of seism where the answer is calculated, one calculates a pseudo-mode if acce is provided.*

### **3.6.3 Combination according to the directions: key word COMB\_DIRECTION**

**COMB\_DIRECTION**

Two rules of combination of the directional answers are available. They are selected by the STANDARD operand.

**Quadratic 3.6.3.1 Combination: TYPE = "QUAD"**

This combination corresponds to the assumption of strict independence of the answers in each direction:

$$R = R2 + R2 + R2$$

X

Y

Z

**3.6.3.2 Combination of NEWMARK: TYPE = "NEWMARK"**

For each direction I (X, Y, Z), one calculates the 8 values:

$$R = \pm R$$

$$\pm 0.4$$

$$, R \pm 0.4$$

$$, R$$

I

X

Y

Z

What leads, by circular shift, with 24 values and

$$R = \max (IH)$$

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### 3.7

#### **Case of an excitation multi-supports**

Two treatments are envisaged [bib 3]:

.

*Calculation of the total answer*

.

*Calculation of the primary and secondary components of the answer*

*In the case of the multiple excitation, these supports are animated different movements for one direction given. These movements here are supposed to be décorrélés and independent.*

#### **3.7.1 Calculation of the total answer**

*Compared to the mono-support, an additional combination is necessary. The flow diagram for treatment becomes:*

.

*For each support or groups supports subscripted by I, subjected to a different excitation, one calculates directional answers of  $R_{xi}$  supports defined by:*

$R$

$$= R_1 + R_2 + R_3$$

$X$

$D$

$T$

*I.E.(internal excitation)*

-

*$R_{di}$  answer combined of the modal oscillators established by key word **COMB\_MODE** [§ 3.6.1]*

-

*$R_{ti}$  represents the correction of the static effects of the neglected modes. The term differs from case mono support. Calculation similar but is utilized the fields of displacement of structure subjected to a unit acceleration of support I in direction X [bib3].*

-

*$R_{ei}$  contribution of the movement of drive of support I ( $R_{ei} = 0$  in multi-support)*

established by key word *DEPL\_MULT\_APPUI* [§ 3.7.4]

One calculates directional answers X-ray by combination of the directional answers  $R_{xi}$  supports. The rule of combination is defined by key word *COMB\_MULT\_APPUI* [§ 3.7.3]. The total answer  $R$  of the structure is obtained by combination of directional answers X-ray. regulate combination is defined by key word *COMB\_DIRECTION* [§ 3.6.3].

### **3.7.2 Partition of the primary and secondary components of the answer**

For the seismic analysis of supported pipings multi, the partition of the inertial components and quasi static of the answer can prove to be necessary for a post treatment RCC-M [bib3].

#### **3.7.2.1 inertial primary Component**

It is about the inertial response induced by the accelerations imposed on anchorings (SRO). One renewed the treatment adopted for the total response by removing the contribution of the movement of drive.

For each support or groups supports subscripted by  $I$ , subjected to a different excitation, one calculates directional answers of supports primary education  $IH X I$  defined by:

$$IH X I = R_{di} + T_i$$

$R_{di}$  answer combined of the modal oscillators established by key word *COMB\_MODE* [§ 3.6.1]

$R_{ti}$  represents the correction of the static effects of the neglected modes. The term differs from case mono support. Calculation similar but is utilized the fields of displacement of structure subjected to a unit acceleration of support  $I$  in direction  $X$  [bib3].

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*One calculates directional answers X-ray by combination of the directional answers Rxi supports. The rule of combination is defined by key word COMB\_MULT\_APPUI [§ 3.7.3].*

*The total answer R of the structure is obtained by combination of directional answers X-ray. regulate combination is defined by key word COMB\_DIRECTION [§ 3.6.3].*

### **3.7.2.2 differential secondary Component**

*It is about the static response induced by seismic differential displacements of anchorings (movement of drive):*

*· Calcul of the Rei contribution of the movement of drive of support I established by the key word DEPL\_MULT\_APPUI [§ 3.7.4]*

*· Combinations of the various contributions of Rei support defined by the key word COMB\_DEPL\_APPUI [§ 3.7.5].*

*It is thus possible to reconstitute:*

*lawful loading cases corresponding to:*

*- an overall movement of part of the supports in a given direction  
- a displacement mentioned in a local reference mark different from the total reference mark of request seismic inertial*

*· answers directional by combining the adequate contributions of supports  
· the total secondary answer.*

*Examples are proposed in [§ 3.7.5.6].*

### **3.7.3 Key word COMB\_MULT\_APPUI**

*COMB\_MULT\_APPUI*

*The occurrences of this key word make it possible to define the directional combinations of support to form the total response of the structure.*

*If the occurrences of key word COMB\_DEPL\_APPUI are present, it is the primary component answer which is treated.*

*The combination of the contributions of each movement of support can be combined of various manners, defined by operand TYPE\_COMBI:*

.  
*quadratic combination*

.  
*linear combination*

### **3.7.3.1 Operands**

#### **ALL/NODE/GROUP\_NO**

*/ALL = "YES"*

*Allows to choose that all the supports are combined with the rule defined by TYPE*

*/*  
*NODE*

*=*  
*lno*  
*[l\_noeud]*

*/GROUP\_NO = lgrno*

*[l\_group\_no]*

*Allows to define the list of the supports (or groups of supports) which are combined with the rule defined by operand TYPE\_COMBI in the same occurrence of the key word*

*COMB\_MULT\_APPUI.*

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### **3.7.3.2 Combination**

*quadratic*

**TYPE = "QUAD"**

$R = R^2$

$X$

$X_j$

### **3.7.3.3 Combination**

*linear*

**TYPE = "LINE"**

$R = R$

$X$

$X_k$

### **3.7.3.4 different Rules of combination on the various supports**

*The rule of combination can be the same one for all the supports [§ 3.7.3.1] or differentiated according to*

*supports or groups of supports defined by an occurrence of the key word factor*

*COMB\_MULT\_APPUI. In this case the total answer - or the primary component of the answer if COMB\_DEPL\_APPUI is present - is obtained by:*

$R = 2$

$R +$

$X_j$

$(RX_k)^2$

*where J indicates the supports combined quadratically and K linearly combined supports.*

### **3.7.4 Word**

*key*

**DEPL\_MULT\_APPUI**

**DEPL\_MULT\_APPUI**



*The movement of drive of the structure not being uniform this key word makes it possible to define contribution to the total response of a list of supports or groups of supports. This one is established with to leave the static modes of the structure:*

*I*  
*E*  
*R = siimax*  
*with:*

*if*  
*static mode for support I*  
*imax maximum displacement of support I compared to a support of reference (for which I max = 0)*

### **3.7.4.1 Operand**

***NOM\_CAS/NUME\_CAS***

*NOM\_CAS = nomcas*  
*Character string defining the name of the loading case*

*NUME\_CAS = numecas*  
*Number of the loading case*

### **3.7.4.2 Operand**

***MODE\_STAT***

*MODE\_STAT = stat*

*Name of the static modes if, concept of the mode\_stat type produces by the operator*  
*MODE\_STATIQUE [U4.52.14]*

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### **3.7.4.3 Operand**

#### **NOEUD\_REFE**

*NOEUD\_REFE = noe*

*Node of reference per report/ratio to which relative displacements of the supports are defined. If this operand is present, the maximum displacement applied to support I is worth*

-

*imax*

*where*

*is affected displacement with the node of reference noe in the direction considered.*

### **3.7.4.4 Operands**

#### **NODE/GROUP\_NO**

*/NODE = lno*

*/GROUP\_NO = lgrno*

*List names of nodes (or groups of nodes) corresponding to the supports concerned with occurrence of the key word factor DEPL\_MULT\_APPUI.*

### **3.7.4.5 Operands**

#### **DX/DY/DZ**

*I DX = dx*

*I DY = Dy*

*I DZ = dz*

*Value of maximum relative displacement of the supports concerned, direction by direction.*

### **3.7.5 Word**

*key*

**COMB\_DEPL\_APPUI**

**COMB\_DEPL\_APPUI**

*The occurrences of this key word define the combinations of the lawful loading cases intervening in the secondary component of the answer.*

### **3.7.5.1 Operands**

#### **ALL/LISTE\_CAS**

*/ALL = "YES"*

*All the loading cases defined under the occurrences of DEPL\_MULT\_APPUI are combined with a single rule specified by TYPE*

*/LISTE\_CAS = list*

*Numbers of the loading cases combined with the rule specified by TYPE*

### **3.7.5.2 Combination**

*quadratic*

**TYPE = "QUAD"**

*R =*

*E*

*2nd*

*R J*

### **3.7.5.3 Combination**

*linear*

**TYPE = "LINE"**

*R =*

*E*

*E*

*R K*

### **3.7.5.4 Combination in STANDARD absolute value = "ABS"**

*R =*

*E*

*R it*

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### ***3.7.5.5 different Rules of combination on the various loading cases***

*The rule of combination can be the same one for all the cases of displacement of anchoring or differentiated according to the groups of cases defined by an occurrence of the key word factor COMB\_DEPL\_APPUI. In this case the secondary total answer is obtained by:*

*R =*

*II*

*2*

*R +*

*E J*

*(Rek) 2 + (Rel) 2*

*where J indicates the supports combined quadratically, K supports combined linearly and L supports combined in absolute value.*

### ***3.7.5.6 Examples of application***

*· Déplacement expressed in a local reference mark Rloc (X, y, Z) different from the total reference mark Rglob (X, Y, Z)*

*Axes X, y and Z of Rloc are built by 3 successive rotations of angle, and around axes X, Y and Z of Rglob.*

*To simplify the example, it is considered that Rloc results from Rglob by a single rotation around axis X and of angle and that local displacement ux of the support S located with the node NS is given along axis X of Rloc.*

*This loading case results from the linear combination of 2 static modes and results in algebraic summation of the 2 following loadings:*

- displacement  $DX=uxcos$  deplX along axis X
- displacement  $DY=uxsin$  deplY along the axis Y

The static modes of support following directions X and Y are calculated beforehand.  
The taking into account of the loading case is written with following syntax:

```
DEPL_MULT_APPUI= (  
_F (  
NOM_CAS=' uxcos',  
NUME_CAS=1,
```

```
MODE_STAT=modstat,  
NOEUD=' NS',
```

```
DX=deplX,
```

```
),  
_F (  
NOM_CAS=' uxsin',  
NUME_CAS=2,
```

```
MODE_STAT=modstat,  
NOEUD=' NS',
```

```
DY=deplY,
```

```
),
```

),  
*COMB\_DEPL\_APPUI* = (

*\_F* (  
*LIST\_CAS* = ("1", "2"),  
*TYPE\_COMBI*  
=  
"LINE")

),  
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· *Overall Mouvement in a direction*

*Let us consider a line anchored on 3 supports S1, S2 and S3. An overall movement U is applied to the S1 supports, S2 in direction X. the S3 support related to the crossing of a building is*

*presumedly fixed.*

*The static modes of support in direction X on the level of the supports S1 and S2 are calculated beforehand.*

*The taking into account of the loading case is written with following syntax:*

```
DEPL_MULT_APPUI= (  
_F (NOM_CAS=' depl_S1_X',  
NUME_CAS=1,
```

```
MODE_STAT=modstat,  
NOEUD=' NS1',
```

```
DX=U,
```

```
),  
_F (NOM_CAS=' depl_S2_X',  
NUME_CAS=2,
```

```
MODE_STAT=modstat,  
NOEUD=' NS2',
```

```
DX=U,
```

```
),  
),  
COMB_DEPL_APPUI= (
```

```
_F (  
LIST_CAS= ("1", "2"),  
TYPE_COMBI  
=
```

“*LINE*”

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· *Réponse by direction and total secondary office plurality*

*Let us consider a line anchored on 2 supports S1 and S2 and seismic differential displacements following:*

- *S1 support: U1, V1 and W1 in directions X, Y and Z*

- *S2 support: U2, V2 and W2 in directions X, Y and Z*

*The 6 static modes of support are calculated beforehand.*

*The seizure of the various loading cases is carried out under the occurrences of DEPL\_MULT\_APPUI:*

*DEPL\_MULT\_APPUI= (*

*#support S1 with node NS1*

*\_F (*

*NOM\_CAS=' depl\_S1\_X',*

*NUME\_CAS=1,*



*MODE\_STAT=modstat,*  
*NOEUD=' NS1',*

*DX=U1,*

*),*  
*\_F (*  
*NOM\_CAS=' depl\_S1\_Y',*

*NUME\_CAS=2,*

*MODE\_STAT=modstat,*  
*NOEUD=' NS1',*

*DY=V1,*

*),*  
*\_F (*  
*NOM\_CAS=' depl\_S1\_Z',*

*NUME\_CAS=3,*

*MODE\_STAT=modstat,*  
*NOEUD=' NS1',*

*DZ=W1,*

*),*  
*#support S2 with node NS2*

*\_F (*  
*NOM\_CAS=' depl\_S2\_X',*

*NUME\_CAS=4,*

*MODE\_STAT=modstat,*  
*NOEUD=' NS2',*

*DX=U2,*

*),*  
*\_F (*  
*NOM\_CAS=' depl\_S2\_Y',*

*NUME\_CAS=5,*

*MODE\_STAT=modstat,*  
*NOEUD=' NS2',*

*DY=V2,*

),  
\_F (  
NOM\_CAS='depl\_S2\_Z',  
  
NUME\_CAS=6,

MODE\_STAT=modstat,  
NOEUD='NS2',

DZ=W2,

),

),  
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*The directional answers are established under the occurrences of COMB\_DEPL\_APPUI:*

*COMB\_DEPL\_APPUI= (  
#cumul according to X*

*\_F (  
LIST\_CAS= ("1", "4"),  
TYPE\_COMBI  
=  
"QUAD",*

*),  
#cumul according to Y*

*\_F (  
LIST\_CAS= ("2", "5"),  
TYPE\_COMBI  
=  
"QUAD",*

*),  
#cumul according to Z*

*\_F (  
LIST\_CAS= ("3", "6"),*

*TYPE\_COMBI*

=

*“QUAD”*,

),

),

*The secondary total answer is formed by the quadratic office plurality of the directional answers. It is calculated automatically [§ 3.7.3.5].*

*If the impression of the directional answers is not necessary, the total answer can be calculated directly under only one occurrence of COMB\_DEPL\_APPUI:*

*COMB\_DEPL\_APPUI= (*

*#réponse total*

*\_F (*

*TOUT=' OUI',*

*TYPE\_COMBI*

=

*“QUAD”*,

),

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### **3.8**

#### ***Option of calculation: operand OPTION***

##### *OPTION*

*List sizes (options of calculation) modal which one wants to determine the combined answer:*

**“DEPL”**

*relative displacement*

**“QUICKLY”**

*relative speed*

**“ACCE\_ABSOLU”**

*absolute acceleration = relative acceleration + acceleration  
of drive*

**“SIGM\_ELNO\_DEPL”**

*constraints by elements with the nodes*

**“SIEF\_ELGA\_DEPL”**

*constraints by elements at the points of integration*

**“SIPO\_ELNO\_DEPL”**

*constraints in the section of beam broken up into  
contributions of each generalized effort*

**“EFGE\_ELNO\_DEPL”**

*efforts generalized by elements with the nodes*

**“EFGE\_ELNO\_CART”**

*efforts generalized by elements with the nodes in  
total Cartesian reference mark*

**“REAC\_NODA”**

*reactions to the supports*

**“FORC\_NODA”**

*internal efforts*

### **3.9 Operand**

**TITRATE**

*TITRATE = T*

*Titrate attached to the concept produced by this operator [U4.03.01].*

### **3.10 Operand**

**INFORMATION**

*INFORMATION*

*/1 :*

*impression on the file “message” of following information:*

- 
- name of the modal base used,*
- 
- a number of clean vectors selected,*
- 
- regulate selected modal combination,*
- 
- options of calculation requested.*

*/2 :*

*idem 1*

### **3.11 Word**

**key**

**IMPRESSION**

*IMPRESSION*

*Impression on the file “result” of following information:*

*/*

*ALL*

*=*

*“YES”*

*/LEVEL*

*=*

*“SPEC\_OSCI”*

*Values of the excitation corresponding to different modes*

*“MASS\_EFFE”*

*modal sizes in the direction of the excitation and  
office plurality of the effective mass*

*“MAXI\_GENE”*

*Maximum generalized contributions*

*With ALL = “YES”, one obtains the impressions corresponding to the whole of the 3 levels  
defined above.*

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*The impression in the file “result” of the computed fields is carried out via the orders IMPR\_RESU [U4.91.01] or POST\_RELEVE\_T [U4.81.21] by specifying the suitable sequence numbers.*

*For an excitation mono support following 3 directions X, Y and Z:*

*· directional answers [§3.6]:*

*sequence numbers 1, 2 and 3 for the answers according to X, Y and Z*

*· combination of the directional answers if COMB\_DIRECTION is present [§3.6.3]:*

*sequence number 4*

*For an excitation multi supports according to 3 directions X, Y and Z:*

*· If key word COMB\_DEPL\_APPUI misses, primary and secondary components of answer are cumulated:*

*- directional answers [§3.7.3]:*

*sequence numbers 1, 2 and 3 for the answers according to X, Y and Z*

*- combination of the directional answers if COMB\_DIRECTION is present [§3.6.3]:*

*sequence number 4*

*· If key word COMB\_DEPL\_APPUI is present, primary and secondary components of answer are separate:*

*- primary component:*

*- directional answers [§3.7.3]:*

*sequence numbers 1, 2 and 3 for the answers according to X, Y and Z*

*- combination of the directional answers if COMB\_DIRECTION is present [§3.6.3]:*

*sequence number 4*

*- secondary component*

*- fields resulting from the combinations of loading case of displacement indicated under N occurrences of COMB\_DEPL\_APPUI [§ 3.7.5.2, § 3.7.5.3, § 3.7.5.4]*

*sequence number 200 for occurrence 1*

*sequence number 200+i for occurrence I*  
*sequence number 200+n for occurrence N*  
*- total quadratic office plurality [§ 3.7.5.5]*  
*sequence number 200+n+1*

#### **4 Bibliography**

[1]

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[2]

*“Response of linear systems to some transient disturbances” Proceedings, Fourth World conference one earthquake engineering - Santiago of Chile (1969)*

[3]

*Seismic response by spectral method [R4.05.03].*

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*Organization (S): EDF-R & D /AMA, CS IF*

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Document: U4.84.02***

***Operator POST\_DYNA\_MODAL\_T***

***1 Goal***

***Post-to treat the results in generalized co-ordinates produced by DYNA\_TRAN\_MODAL. Two options are available: post treatment of nonthe linearities of shock or the relations effort-displacement. In the first case, one chooses a diagnosis of wear or a better knowledge of the shocks which have occurred during the transitory analysis. The contents of the produced table are printable on the file RESULT by order IMPR\_TABLE [U4.91.03].***

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**2 Syntax**

**count [table] = POST\_DYNA\_MODAL\_T (**

**RESU\_GENE**

=

**tg,**

**[tran\_gene]**

**/SHOCK**

**=\_F (**

**INST\_INIT = -1.0, [DEFECT]**

**/**

***t0,***  
***[R]***

***INST\_FIN =/999. , [DEFECT]***

***/***  
***T1,***  
***[R]***

***NB\_BLOC =/1,***  
***[DEFECT]***

***/***  
***Nb,***  
***[I]***

***SEUIL\_FORCE =/0.0 [DEFECT]***

***/S, [R]***

***DUREE\_REPOS =/0.0, [DEFECT]***

*/D, [R]*

*OPTION =/"WEAR", [DEFECT]*

*/"IMPACT",*

*NB\_CLASSE*

*= / 10,*

*[DEFECT]*

*/*

*nc,*

*[I]*



),

***/RELA\_EFFO\_DEPL***  
***=\_F (***

***NODE = noeu,***  
***[node]***

***NOM\_CMP = noncmp, [K8]***

),

***INFORMATION***

=

/

1,

***[DEFECT]***

/ 2,

**TITRATE**

= *title*,  
[*l\_Kn*]

)

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**3 Operands**

**3.1 Operand**

**RESU\_GENE**

**RESU\_GENE = tg**

**Result of a transitory calculation by modal recombination, produced by the operator**

## **DYNA\_TRAN\_MODAL [U4.53.21].**

### **3.2 Word**

**key**

**SHOCK**

**SHOCK**

***Key word factor allowing to specify that one wishes an analysis of non-linearities of shock takings into account in modal transitory calculation.***

#### **3.2.1 Operand**

**INST\_INIT**

**INST\_INIT = T**

**0**

***Moment of beginning of the average of the signals and analysis of the shocks. By defect T corresponds to***

**0**

***first moment of transitory calculation by modal recombination.***

#### **3.2.2 Operand**

**INST\_FIN**

**INST\_FIN = T**

**1**

***Moment of end of the average of the signals and analysis of the shocks.***

***(T1 = 999. default value),***

#### **3.2.3 Operand**

**NB\_BLOC**

**NB\_BLOC = Nb**

***A number of temporal blocks of division the interval [T,] for the average of the signals***

**0 T1**

***(1 per defect).***

***The key word is not used for the option “IMPACT”.***

### **3.2.4 Operand** **SEUIL\_FORCE**

**SEUIL\_FORCE = S**

**Threshold characterizing a phase of contact, ( $f_n > S$  established contact)**

**(S = 0. default value).**

### **3.2.5 Operand** **DUREE\_REPOS**

**DUREE\_REPOS = D**

**D**  
**minimal duration of rest characterizing the end of a shock,**

**T**  
**end of shock**

**T**

**,**  
**+**

**F,**

**C**

**[Tc Tc D]**

**S**

**N**

**D = 0.**  
**default value.**

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### **3.2.6 Operand**

**OPTION**

**OPTION =/“WEAR”**

**/**

**“IMPACT”**

*This key word makes it possible to choose between a postprocessing for a diagnosis of wear (key word “WEAR”) or of a better knowledge of the possible shocks which have occurred during the analysis transient (key word “IMPACT”). This last post treatment is adapted to the calculation of the interns of power stations REFERENCE MARK to see [§4].*

### **3.2.7 Operand**

**NB\_CLASSE**

**NB\_CLASSE = nc**

*A number of classes which the user wants to distinguish during the development of the describing histogram the maximum ones of forces of impact. By defect, nc = 10.*

### **3.3 Word**

**key**

**RELA\_EFFO\_DEPL**

**RELA\_EFFO\_DEPL**

*Key word factor allowing an analysis of the relations of non-linearity effort-displacement.*

*One files in the table result the name of the relation to the node observed, the moments of analysis and the maximum reached by the component observed during the analysis.*

*All the phases with nonlinear behavior are determined and one files in the table result*

*for each one:*

- *the initial moment and the final moment of the interval of the nonlinear phase,*
- *the maximum reached and the moment associated in this interval.*

### **3.3.1 Operand NODE**

**NODE = noeu**

*Name of the node of the structure on which the nonlinear relation to treat was defined.*

### **3.3.2 Operand NOM\_CMP**

**NOM\_CMP = noncmp**

*Name of the component treated with the node noeu.*

### **3.4 Operand INFORMATION**

**INFORMATION = imp, level of the impressions**

*/1 no impression on the file message (all is stored in the produced table)*

*/2 impression of the number of steps of computing time*

### **3.5 Operand TITRATE**

**TITRATE = title**

*title is the title of calculation. It will be printed at the head results. It is stored in the concept count.*

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## 4

***Checking - Execution***

### 4.1

***For the key word factor SHOCK***

***The value of INST\_FIN is compared with the final moment T F of the result***

***tran\_gene. The value of***

***INST\_FIN selected is***

***(***

***min T, T***

***F***

***1).***

***If the value of INST\_INIT t0 is higher than the value of INST\_FIN, one stops in error.***

***F shock***

***Block 1***

***Block 2***

***SEUIL\_FORCE***

***T***

***T***

***0***

***1***

***D***

***INST\_INIT***

***INST\_FIN***

***DUREE\_REPOS***

***Block 1: 1 shock***



**Block 2: 2 shocks**  
**: signal taken into account in the statistics**

**4.1.1 Execution with option "IMPACT"**

**For each nonlinearity of shock, one calculates and one files in the table result:**

**.  
shocks and associated sizes:**

**for each shock, one with the value of the moment when the force is maximum, the value of the force maximum and of the impulse, duration of the shock, impact speed and the number of rebounds,**

**.  
total data of the shock:**

**on the whole of the noted shocks, one specifies: the absolute maximum of force of shock, average value of maximum of forces of shock and the standard deviation of the extrema of force of shocks,**

**.  
the histogram describing the max of the forces of impact:**

**there is the number of classes of the histogram, the values of his X-coordinates (force min and max of each class) and density of probability of the maximum force of each class.**

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**Version**

**7.4**

**Titrate:**

**Operator POST\_DYNA\_MODA\_T**

**Date:**

**27/01/05**

**Author (S):**

**E. BOYERE, L. VIVAN Key**

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### 4.1.2 Execution with the option "WEAR"

For each nonlinearity of shock, one calculates and one files in the table result:

- average values min, max, standard deviation, RMS of relative displacements of the nodes of shocks in their total reference mark,
- average values and RMS (over the time of shock and total time) like min and max of normal and tangential forces of shock,
- the number of average shocks on each connection of shock, the time of average shock, time of average rebound,
- power of average wear calculated within the meaning of ARCHARD [bib1]:

$$\begin{aligned}
 & I T \\
 & P \\
 & = \\
 & F (T). V (T) dt \\
 & wear
 \end{aligned}$$

**T**  
**NR**  
**T**  
**0**

**4.2**  
**For the key word factor RELA\_EFFO\_DEPL**

*It is checked that the node noeu corresponds to a nonlinear relation.*

*One prints using order IMPR\_TABLE:*

-----

**ASTER 4.03.15 CONCEPT TABLE CALCULATES THE 03/02/98 A 12:08: 19 OF TYPE**  
**TABL\_POST\_DYNA**  
**RELATION**

**NODE**  
**CMP**  
**PHASE**  
**INST\_INIT**  
**INST\_FIN**

**MAXIMUM**  
**INST\_MAXI**  
**NON\_LIN**  
**N100**  
**DRY**

**1**  
**1.24000E+00**  
**1.26600E+00**

**1.80716E-05 1.25200E+00**  
**NON\_LIN**  
**N100**  
**DRY**

**2**  
**2.02600E+00**  
**2.09000E+00**

**-2.00433E-05 2.05800E+00**  
**NON\_LIN**  
**N100**  
**DRY**

**3**  
**3.00000E+00**  
**3.04000E+00**

**-1.89110E-05 3.02200E+00**  
**NON\_LIN**  
**N100**  
**DRY**

**4**

**3.10400E+00**

**3.20400E+00**

**3.50715E-05 3.15400E+00**

**NON\_LIN**

**N100**

**DRY**

**5**

**3.26000E+00**

**3.33600E+00**

**-2.91359E-05 3.30000E+00**

**NON\_LIN**

**N100**

**DRY**

**6**

**3.41400E+00**

**3.43200E+00**

**1.73099E-05 3.42400E+00**

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## **5 Examples of use**

### **5.1 Example with the option IMPACT: to launch of an oscillator with shock**

**Test SDND101 here is presented. It is a question of calculating the response of a system mass-arises from initial speed  $V_0$  nonnull, being able to impact on a thrust with shock. The initial play is null.**

**$K$   
 $m$   
 $K_{choc}$   
 $V_0$**

**One compares the values of the moments of maximum force, value of maximum force, duration of the time of shock, value of the impulse and impact speed as well as the number of elementary impacts for the first two oscillations of the system to the analytical values.**

### **Command file**

**CONTINUATION  
( )**

**# the system mass-arises east releases with an initial speed  $V_0$**

**#  
  
VITEPHYS = AFFE\_CHAM\_NO (  
MAILLAGE= beam,  
GRANDEUR=  
"DEPL\_R",  
CHAM\_NO  
=  
vectass,**

***AFFE=***  
(  
***TOUT=***  
***“YES”,***

***NOM\_CMP=***  
(  
***“DX”***  
)

***VALE\_R=***

***V0***

)

)

***#***  
***VITINI***  
***=***  
***PROJ\_VECT\_BASE***

***(BASE= MODES, VECT\_ASSE= VITEPHYS,***  
***NUME\_DDL\_GENE=***  
***NUMEGE,***  
***TYPE\_VECT=***  
***“QUICKLY”)***

***#***

***MASSEGEN = PROJ\_MATR\_BASE (BASE= MODES,***  
***NUME\_DDL\_GENE=***

**NUMEGE,**  
**MATR\_ASSE=**  
**MATRMASS,**

)

#

**RIGIDGEN = PROJ\_MATR\_BASE (BASE= MODES,**  
**NUME\_DDL\_GENE=**  
**NUMEGE,**  
**MATR\_ASSE=**  
**MATRRIGI,**

)

#

**PLANZ = DEFI\_OBSTACLE (TYPE= "PLAN\_Z")**

**PLAN\_Y = DEFI\_OBSTACLE (TYPE= "PLAN\_Y")**

#

**DYNAMODA**

=  
**DYNA\_TRAN\_MODAL**

**(METHOD = "EULER",  
MASSE\_GENE**

=  
**MASSEGEN,  
RIGI\_GENE**

=  
**RIGIDGEN,  
AMOR\_REDUIT=  
0.,  
ETAT\_INIT=\_F (VITE\_INIT\_GENE=VITINI),  
INCREMENT=\_F (  
INST\_INIT= 0. ,  
INST\_FIN=**

**0.5,  
PAS=  
0.0005**

**),  
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**CHOC=**



```
_F (  
NOEUD_1=  
“NOI”,  
OBSTACLE=  
PLANZ,  
ORIG_OBST=  
(-1.,  
0.,  
0.),  
NORM_OBST=  
(0.  
0.  
1.),  
JEU=  
1.00,  
RIGI_NOR=  
1000000.,  
RIGI_TAN=  
0.,  
COULOMB=  
0.  
)
```

)

*# Postprocessing of the efforts of shock*

```
TT  
=  
POST_DYNA_MODA_T  
(RESU_GENE = DYNAMODA,  
CHOC=  
_F (  
INST_INIT
```

=  
**0.,**  
**INST\_FIN**  
=  
**0.495,**  
**SEUIL\_FORCE**  
=  
**0.,**  
**DUREE\_REPOS**  
=  
**0.,**  
**OPTION**  
=  
**“IMPACT”,**  
**NB\_CLASSE**  
=  
**8**  
**),**  
**INFORMATION**  
=  
**1**

)

**IMPR\_TABLE (TABLE = TT,**  
**FILTER**  
=  
(  
**NOM\_PARA=**  
**“CALCULATION”,**  
**VALE\_K**  
=  
**“TOTAL”**  
**),**

```
NOM_PARA=  
(  
“NODE”,  
“F_MAX_ABS”,  
“F_MAX_MOY”,  
“F_MAX_ETYPE”  
)
```

## **6 Bibliography**

**[1]**

***ARCHARD: The wear of metals under unlubricated conditions Proc-Roy-Ploughshare. (1956).***

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*Date:*

04/02/05

*Author (S):*

**S. CAMBIER, A.M. DONORE** *Key*

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***Document: U4.84.03***

***Operator POST\_FATI\_ALEA***

***1 Goal***

*To calculate the damage of tiredness undergone by a structure subjected to a request of the random type.*

*With this intention POST\_FATI\_ALEA allows starting from the data of the spectral moments characterizing entirely the random signal:*

*to extract by a statistical method of counting of cycles (method of counting of peaks constraints or method of goings beyond of a level given) the number of cycles elementary of loading undergone by the structure,*

*to determine the elementary damage associated with each elementary cycle using curve of Wöhler of material,*

*to determine the average damage throughout signal.*

*In addition, it is possible to take account of the influence of the coefficient of concentration elastoplastic.*

*The average damage is stored in a table: tabl\_post\_f\_alea.*

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*2 Syntax*

*tabl\_post\_f\_alea = POST\_FATI\_ALEA*  
(

*# Introduction of the random loading*

*/MOMENT\_SPEC\_0*

=

*0*

,

*[R]*

*MOMENT\_SPEC\_2*

=

*2*

,

*[R]*

*MOMENT\_SPEC\_4*

=

*4*

,

*[R]*

*/*  
*TABL\_POST\_ALEA*

=

*count*

,

*[tabl\_post\_alea]*

*# Method of counting of cycles*

*COUNTING =/"PEAK",*

/  
**“LEVEL”**

,

**DURATION**

=

/

**duration**

,

**[R]**

/

**1.**

,

**[DEFECT]**

*# elastoplastic Coefficient of correction Ke*

**CORR\_KE = “RCCM”**

,

*# Calculation of the elementary damage*

**DAMAGE = “WOHLER”,**

**MATER**

=

**to subdue**

,

**[to subdue]**

**TITRATE**

=

**titrate**

,

**[l\_Kn]**

)  
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### **3 Operands**

#### **3.1 Operands**

**TABL\_POST\_ALEA/MOMENT\_SPEC\_0/MOMENT\_SPEC\_2/  
MOMENT\_SPEC\_4**

**These operands make it possible to introduce the three spectral moments value of order 0, 2 and 4 which can be determined by order POST\_DYNA\_ALEA [U4.84.04].**

**These values completely characterize the random signal for the statistical methods of counting of the cycles:**

.



*method of counting of peaks of constraints, which uses 0, 2 and 4,*

*method of counting of going beyond of a given level, which only requires data of 0 and 2.*

***/MOMENT\_SPEC\_0***

***=***

***0***

***,***  
***[R]***

***MOMENT\_SPEC\_2***

***=***

***2***

***,***  
***[R]***

***MOMENT\_SPEC\_4***

***=***

***4***

***,***  
***[R]***

*One provides the value of the spectral moment following the operand corresponding.*

***/***  
***TABL\_POST\_ALEA***

***=***

***count***

***,***  
***[tabl\_post\_alea]***

*Allows to specify the name of a table created by POST\_DYNA\_ALEA [U4.84.04], in which are stored values of spectral moments (0, 2, 4), for various modes or various nodes.*

*The values are read again and one calculates a value of average damage for each triplet of moments spectral met in the table.*

*However, method of calculation of the average damage being valid only for loadings homogeneous with constraints, one emits an alarm when the calculation of the average damage does not correspond to spectral concentrations of power homogeneous to constraints (DSP\_CONT).*

### ***3.2 Operand***

## **COUNTING**

**COUNTING** =

*To be able to calculate the damage undergone by a structure, the cycles should beforehand be extracted elementary of the history of loading.*

/  
"PEAK"

,  
*Allows to choose the method of counting of the peaks of constraints to determine them elementary cycles of the random loading [R7.04.02].*

/  
"LEVEL"

,  
*Allows to choose the method of counting of the goings beyond of a level given for to determine the elementary cycles of the random loading [R7.04.02].*

## **3.3 Operand DURATION**

**DURATION**

=  
/  
duration

,  
[R]

/  
1.

,  
[DEFECT]

*Allows to introduce the data of the duration of the signal which intervenes in the expression of the damage means [R7.04.02].*

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### ***3.4 Operand***

#### ***CORR\_KE***

*CORR\_KE =*

*“RCCM”,*

*This operand makes it possible to take account of an elastoplastic coefficient of concentration  $K_e$ , which is defined by the RCC-M as being the relationship between the amplitude of real deformation and the amplitude of deformation determined by an elastic analysis.*

*$K = 1$*

*if*

*$< 3S$*

*$E$*

*$m$*

*$K = 1 + (1 - N)$*

*$E$*

*$(/3Sm -) 1 (N (m) 1) \text{ if } 3S$*

*$< < 3m S$*

*$m$*

*$m$*

*$K = 1 N$*

*if  $3m S$*

*$E$*

*$m$*

*$<$*

*where  $S_m$  is the acceptable maximum constraint, and  $N$  and  $m$  two constants depending on material.*

*Values of  $S$*

*N*

*m*

*m,*

*and*

*are introduced into operator DEF1\_MATERIAU [U4.43.01] under key word TIRES and operands SM\_KE\_RCCM, N\_KE\_RCCM, and M\_KE\_RCCM.*

### **3.5 Operand TOO BAD**

*DAMAGE = "WOHLER",*

*This operand makes it possible to specify the method of calculation of the damage, which in the case of one request of the random type is the method of Wöhler.*

*To calculate the damage, the user must introduce into operator DEF1\_MATERIAU [U4.43.01], the curve of Wöhler of the material which can be given in three forms distinct mathematics [R7.04.02]:*

*·  
point by point discretized function (key word TIRES, operand WOHLER),*

*·  
analytical form of Basquin (key word TIRES, operands A\_BASQUIN and BETA\_BASQUIN),*

*·  
form "current zone" (key word TIRES, operands E\_REFE, A0, A1, A2, A3 and SL and key word ELAS operand E).*

#### **Notice on the curves of tiredness:**

*For the small amplitudes, the problem of the prolongation of the curve of tiredness can to pose: for example, for the curves of tiredness of the RCC-M beyond 106 cycles, corresponding constraint, 180 MPa is regarded as limit of endurance, i.e. that very forced lower than 180 MPa must produce a factor of null use or a number cycles acceptable infinite.*

*The method adopted here corresponds to this concept of limit of endurance: if the amplitude of constraint is lower than the first X-coordinate of the curve of tiredness, then one takes one factor of null use i.e. an infinite number of cycles acceptable.*

### **3.6 Operand MATER**

*MATER = to subdue,*

Allows to specify the name of the MATER material created by DEF1\_MATERIAU [U4.43.01].

The MATER material must at least contain the definition of the curve of Wöhler of material [R7.04.02].

If one wishes to take account of an elastoplastic coefficient of concentration  $K_e$ , it is necessary moreover to have specified the data material (NR, M and SM) necessary to calculation of  $K_e$ .

### **3.7 Operand**

#### **TITRATE**

*TITRATE = title,*

*Titrate associated with the table.*

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### **3.8 Count**

#### **produced**

*Operator POST\_FATI\_ALEA creates a table, TABL\_POST\_F\_ALEA, which includes/understands 1 parameter:*

*TOO BAD: value of the average damage over the duration of the signal.*

**Note:**

*If one used operand TABL\_POST\_ALEA to introduce the values of*

*spectral moments, one stores in the table, the value of the average damage over the duration of the signal,*

*for each triplet of spectral moments present in the table.*

*Order IMPR\_TABLE [U4.91.03] makes it possible to print the produced table.*

#### **4 Example**

**= DEF1\_MATERIAU subdue**

**(**

**TIRE = \_F (A\_BASQUIN**

**= 1.001730939 E14,**

**BETA\_BASQUIN**

**=**

**4.065 )**

**)**

**count = POST\_FATI\_ALEA (**

**MOMENT\_SPEC\_0**

**= 182.5984664 ,**

**MOMENT\_SPEC\_2**

**= 96098024.76 ,**

**MOMENT\_SPEC\_4**

**= 6.346193569E+13**

**,**

**COUNTING**

**=**

**“PEAK”**

**,**

**DAMAGE =**

**“WOHLER”**

,  
**MATER**

=  
**matt**

,

)

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***Author (S):***

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***Organization (S): EDF-R & D /AMA, EDF-Division Fuels, EDF-GDF/DIT-BEX***



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***Document: U4.84.04***

***Operator POST\_DYNA\_ALEA***

***1 Goal***

***Post-to treat results of the interspectre type statistically and to print them.***

***POST\_DYNA\_ALEA allows on functions selected in a concept of the type [tabl\_intsp]:***

***.  
to calculate statistical parameters: spectral moments, standard deviation, distribution of peaks, centre frequency,***

***.  
to calculate the function of probability of not exceeding of VANMARCKE used in analyze seismic.***

***The tables of interspectres are obtained by various operators: LIRE\_INTE\_SPEC [U4.36.01], CALC\_INTE\_SPEC [U4.36.03], DEF1\_INTE\_SPEC [U4.36.02], DYNA\_ALEA\_MODAL [U4.53.22], DYNA\_SPEC\_MODAL [U4.53.23] or REST\_SPEC\_PHYS [U4.63.22].***

***One will refer to [R7.10.01] for the description of the treatments carried out.***

***This operator produces a printable table of the tabl\_post\_alea type by IMPR\_TABLE [U4.91.03].***

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**Author (S):**

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## **2 Syntax**

**[tabl\_post\_alea] = POST\_DYNA\_ALEA**

**(**

**INTE\_SPEC**

**=**

**inter [tabl\_intsp]**

**NUME\_VITE\_FLUI**

**=**

**nume**

**[I]**

**TOUT\_ORDRE**

**=**

**“YES”**

**[DEFECT]**

**/**

**NUME\_ORDRE\_I**

**=**

**Inumi [l\_Kn]**

*NUME\_ORDRE\_J*

=

*lnumj [l\_Kn]*

*/NOEUD\_I = lnoeudi*

*[l\_Kn]*

*NOEUD\_J = lnoeudj*

*[l\_Kn]*

*NOM\_CMP\_I*

=

*lcmpi [l\_Kn]*

*NOM\_CMP\_J*

=

*lcmpj [l\_Kn]*

*/OPTION = "DIAG"*

*GOING BEYOND*  
*=\_F (*

*/VALE\_MIN= valmin*  
*[R]*

*VALE\_MAX= valmax*  
*[R]*

*NOT =*

*not*  
*[R]*

*DURATION*

=

/

1.

[DEFECT]

/

*duration*

[R]

)

*RAYLEIGH*

=\_F (

*/VALE\_MIN = valmin*

[R]

*VALE\_MAX = valmax*  
*[R]*

*NOT*  
*=*

*not*

*[R]*

)

*GAUSS =\_F (*

*VALE\_MIN = valmin*

*[R]*

*VALE\_MAX = valmax*

*[R]*

*NOT*

*=*

*not*

*[R]*

*)*

*VANMARCKE*

*=\_F (*

*VALE\_MIN =*

*valmin*  
[R]

*VALE\_MAX* =  
*valmax*  
[R]

*NOT*  
=

*not*

[R]

*DURATION* =

/ 10.  
[DEFECT]



/  
*duration*  
[R]

)

*MOMENT*  
=  
*lmom*  
[l\_I]

*INFORMATION*  
=  
/  
1  
[DEFECT]

/  
2

*TITRATE*  
= *title*  
[l\_Kn]

);  
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### **3 Operand**

#### **3.1 Word**

*key*

**INTE\_SPEC**

**INTE\_SPEC = inter**

*inter is the name user of the table of interspectres.*

**NUME\_VITE\_FLUI = nume**

*nume is the sequence number when the table of interspectres contains several matrices interspectrales (case of calculations of coupling fluid-structure parameterized by a speed of incidental fluid).*

**TOUT\_ORDRE = "YES"**

*All the tables are taken into account.*

*One defines then the terms of ( ) the matrix (S) whose functions will undergo the treatment.*

*/NUME\_ORDRE\_I = lnumi*

*NUME\_ORDRE\_J = lnumj*

*When the autospectres or the interspectres are calculated on the modes:*

*lnumi is the list of the sequence numbers of the modes "I". Example: (2,3,1).*

*lnumj is the list of the numbers of ordre modes "I. Example: (2,1,4)*

*The indices are appairés according to the same row.*

*(2,2) corresponds to the autospectre on mode 2,*

*(3,1) corresponds to the interspectre between mode 3 and mode 1.*

*lnumi and lnumj must contain the same number of terms.*

*/*  
*NOEUD\_I = lnoeudi*  
*NOEUD\_J = lnoeudj*  
*NOM\_CMP\_I = lcmipi*  
*NOM\_CMP\_J = lcmipj*

*When the autospectres or the interspectres are calculated on the nodes in one direction given:*

*lnoeudi is the list of the nodes according to "I": (NO92, NO95, NO98)*

*lnoeudj is the list of the nodes according to "J": (NO92, NO92, NO92)*

*lcmipi is the list of the components according to "I": (DX, DX, DY)*

*lcmipj is the list of the components according to "J": (DX, DX, DX)*

*The nodes and components are appairés according to the same row:*

*(NO92 DX, NO92 DX) corresponds to the autospectre with node NO92 in direction DX,*

*(NO98 DY, NO92 DX) corresponds to the interspectre between node NO92 in the direction DX and node NO95 in the direction DY.*

*lnoeudi, lnoeudj, lcmpi and lcpmj must contain the same number of terms.*

*/OPTION = "DIAG"*

*Calculations are carried out on the whole of the autospectres matrix and only for these.*

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*Operator POST\_DYNA\_ALEA*

*Date:*

*08/02/05*

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**3.2 Word**

**key**

**GOING BEYOND**

**GOING BEYOND**

**=**

*Key word factor indicating that the selected treatment will consist in seeking the average number of goings beyond of a threshold given for a given length of time.*

*/*

*VALE\_MIN = valmin*

*VALE\_MAX = valmax*

*[valmin  
;  
valmax]*

*is the field on which the threshold varies. By defect this interval is:*

*[0. ; 6.x]*

*where X is the standard deviation of the treated answer.*

*NOT = not*

*not is the step of discretization for the expression of the result.*

*valmax*

*- valmin*

*By defect: not =*

*200.*

*DURATION = duration*

*duration is the duration of the phenomenon and is worth 1. second by defect.*

### **3.3 Word**

**key**

**RAYLEIGH**

*RAYLEIGH =*

*Key word factor indicating that the selected treatment will consist in seeking the density of probability of the positive peaks according to a law of RAYLEIGH. This law is adapted to the signals to narrow band.*

*The key words under this key word factor have the same direction as for GOING BEYOND.*

### **3.4 Word**

*key*

**GAUSS**

GAUSS

=

*Key word factor indicating that the selected treatment will consist in seeking the density of probability of the positive peaks according to a normal law. This law is adapted to the signals with band broad.*

*The key words under this key word factor have the same direction as for GOING BEYOND.*

### **3.5 Word**

*key*

**VANMARCKE**

VANMARCKE

=

*Key word factor indicating that the selected treatment will consist in calculating a probability of not going beyond of threshold according to the law of VANMARCKE (analyzes seismic stochastic).*

*Key words VALE\_MIN, VALE\_MAX and NOT have the same direction as for GOING BEYOND.*

*DURATION = duration*

*duration is the duration of the phenomenon. It is worth 10 seconds per defect (lasted average commonly allowed of the strong phase of a seism).*

*In this case, the operator also provides the factors of peaks P and Q of the signal.*

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### **3.6 Operand**

#### **MOMENT**

*MOMENTS = lmom*

*lmom is the list of the orders of the spectral moments which will be calculated. By defect, moments spectral of orders 0, 1, 2, 3 and 4 are always calculated. It is thus advisable to mention in this list moments of a nature higher than 4. Example: (5,7,8).*

### **3.7 Operand**

#### **INFORMATION**

*INFORMATION*

=

*1  
impression of the results requested.*

*2  
like 1 with in more the statistical functions calculated for the selected interspectre.*

### **3.8 Operand**

#### **TITRATE**

*TITRATE = title*

*title is the title of calculation. It will be printed at the head results. See [U4.03.01].*

## **4 Results provided**

*For each function chosen in the interspectre, POST\_DYNA\_ALEA stores in an accessible table by IMPR\_TABLE [U4.91.03]*

.  
*spectral moments,*  
.  
*statistical parameters:*  
*- standard deviation,*  
*- factor*  
*of irregularity,*  
*-*  
*average extrema numbers a second,*  
*-*  
*a number of passages by zero a second,*  
*- frequency*  
*power station,*  
.  
*other results requested.*

*If INFORMATION = 1 one prints in the file MESSAGE*

.  
*the name user of the table,*  
.  
*the two indices (2 nodes or 2 modes) of the selected function,*  
.  
*the type of calculated result,*  
.  
*options of calculations selected or taken by defect,*  
.  
*values of the selected functions.*

## **5 Phase of checking**

*In addition to the checks of the supervisor is carried out in a preliminary way:*

*the comparison length of the lists (indices, node, component), nume\_ordre or*



*the existence of the key word OPTION.*

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## **6 Example**

**First example:**

```
POSTALEA =POST_DYNA_ALEA (  
INTE_SPEC= INTERS,  
TOUT_ORDRE=' OUI',  
OPTION=' DIAG'  
)
```

**Second example:**

```
POSTALEA=POST_DYNA_ALEA (INTE_SPEC=INTERS,  
NOEUD_I=' NI',  
NOM_CMP_I=' DX',  
NOEUD_J=' NI',  
NOM_CMP_J=' DX',  
GAUSS=_F (  
)
```

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**Organization (S): EDF-R & D /AMA**

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**Document: U4.84.05**

**Operator POST\_USURE**

**1 Goal**

*To calculate volume and depth of wear according to the power of wear.*

*The power of wear is given or calculated by operator **DYNA\_TRAN\_MODAL** [U4.53.21]. It is necessary to provide a law of wear, a geometry of contact and a list of moments.*

*The figure of play can be cut out to calculate the sizes related to wear by sectors. In it case, the table created can be used by operator **MODI\_OBSTACLE** [U4.44.22] to calculate evolution of the figures of plays due to wear.*

*Product a structure of data of the **tabl\_post\_usur** type.*

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## **2 Syntax**

**tresu** [**tabl\_post\_usur**] =

**POST\_USURE**

(

**resu** = **tresu**,

*# definition of the Node of impact or a power of wear*

**/RESU\_GENE = tg,**  
**[tran\_gene]**

**NODE**

=  
**noeu,**  
**[node]**

**INST\_INIT**  
= /0.,

**[DEFECT]**

/  
**t0,**

**[R]**

***INST\_FIN***

***= T1,***

***[R]***

***NB\_BLOC =/1,  
[DEFECT]***

***/  
Nb,***

***[I]***

***/  
PUIS\_USURE  
= *been able,****

**[R]**

*# definition of the law of wear*

*/LOI\_USURE = "ARCHARD",*

**[KN]**

*/  
MOBILE  
= \_F (*

*COEF\_USURE = k\_t, [R]*

),

***OBSTACLE = \_F (***

***COEF\_USURE = k\_o, [R]***

),

/  
***MATER\_USURE = "mat1\_mat2",***  
***[KN]***

***USURE\_OBST =/"NOT",  
[DEFECT]***

***/  
"YES",  
# division the figure of play in sectors***

***/  
SECTOR  
=  
\_F (***

***COEF\_USURE\_MOBILE  
=  
k\_t, [R]***

***COEF\_USURE\_OBST = k\_o  
,  
[R]***



***CONTACT =***  
***“standard”, [kN]***

***ANGL\_INIT***  
***=***  
***ang\_i,***  
***[R]***

***ANGL\_FIN***  
***=***  
***ang\_f,***  
***[R]***

***),***

/

***LOI\_USURE***

=

***“KWU\_EPRI”,  
[KN]***

/

***MOBILE***

= ***\_F (***

***COEF\_FNOR = k1\_t, [R]***

***COEF\_VTAN = k2\_t, [R]***

***COEF\_USURE = k3\_t, [R]***

***COEF\_K***

=

***/k\_t, [R]***

***/5., [DEFECT]***

***COEF\_C***

=

*/c\_t, [R]*

*/10. , [DEFECT]*

),  
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***OBSTACLE = \_F (***

***COEF\_FNOR = k1\_o, [R]***

***COEF\_VTAN = k2\_o, [R]***

***COEF\_USURE= k3\_o, [R]***

***COEF\_K***  
=  
***/k\_o,***  
***[R]***  
***/***  
***5.,***  
***[DEFECT]***

***COEF\_C***  
=  
***/c\_o,***  
***[R]***  
***/***  
***10.,***  
***[DEFECT]***

)

/  
***MATER\_USURE = “mat1\_mat2”,***  
***[KN]***

***USURE\_OBST =/“NOT”,***  
***[DEFECT]***

/  
***“YES”,***

***FNOR\_MAXI = fn,***

***[R]***

***VTAN\_MAXI = vg,***

**[R]**

/

**LOI\_USURE**  
=  
**“EDF\_MZ”**,  
**[KN]**

/

**MOBILE**  
= **\_F (**

**COEF\_USURE=/a\_t,**  
**[R]**

/

**1.E-13,**  
**[DEFECT]**



***COEF\_B =/b\_t,***  
***[R]***

***/***  
***1.2,***  
***[DEFECT]***

***COEF\_N =/n\_t,***  
***[R]***

***/2.44E-08,***

***COEF\_S =/s\_t,***  
***[R]***

***/1.14E-16,***

***),***

***OBSTACLE = \_F (***

***COEF\_USURE*** = /a\_o,  
**[R]**

/

***1.E-13,***  
**[DEFECT]**

***COEF\_B*** = /b\_o,  
**[R]**

/

***1.2,***  
**[DEFECT]**

***COEF\_N*** = /n\_o,  
**[R]**

***/2.44E-08,***

***COEF\_S =/s\_o,  
[R]***

***/1.14E-16,***

),

/  
*MATER\_USURE* = “*mat1\_mat2*”,  
*[KN]*

*USURE\_OBST* =/“*NOT*”,  
*[DEFECT]*

/  
“*YES*”,

*# definition of the moments of calculation depth of wear*

/  
*INST* =  
*l\_inst, [l\_R]*  
/  
*LIST\_INST*  
=  
*linst,*  
*[listr8]*

/  
**COEF\_INST**  
=  
*coef*,  
**[R]**

*# definition of a title*

**TITRATE**  
= “*montitre*”,  
**[l\_Kn]**

*#*  
*impression*  
*information*

**INFORMATION =/I,**

**[I]**  
/  
**2,**  
**[DEFECT]**  
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**# definition of the table to enrich calculation with evolution # in the case of plays**

**ETAT\_INIT**

**= \_F (**

**TABL\_USURE**

**=**

**tresu,**

**[tabl\_post\_usur]**

**INST\_INIT**

**=**

**tt,**

**[R]**

),

*# definition of the contact*

*/CONTACT = "GRAPPE\_ALESAGE",*

*[KN]*

*RAYON\_MOBILE*

*= r\_t, [R]*

*RAYON\_OBST*

*= r\_o, [R]*

*/*  
*CONTACT = "GRAPPE\_1\_ENCO",*

*[KN]*



/  
**CONTACT = "GRAPPE\_2\_ENCO",**

**[KN]**

/  
**CONTACT = "TUBE\_BAV",**

**[KN]**

**RAYON\_MOBILE**

**= r\_t**

,

**[R]**

**LARGEUR\_OBST**

**= l\_o**

,

**[R]**

**ANGL\_INCLI**

**= Eng,**

**[R]**

**/**  
**CONTACT = "TUBE\_ALESAGE",**

**[KN]**

**RAYON\_MOBILE**

**= r\_t, [R]**

**RAYON\_OBST = r\_o,**

**[R]**

***LARGEUR\_OBST***

***= l\_o***

,

***[R]***

***ANGL\_INCLI***

***= Eng,***

***[R]***

/

***CONTACT = "TUBE\_3\_ENCO",***

***[KN]***

***RAYON\_MOBILE***

***= r\_t, [R]***

***RAYON\_OBST = r\_o,***

**[R]**

**LARGEUR\_OBST**

= *l\_o*

,

**[R]**

**ANGL\_ISTHME**

= *angli*,

**[R]**

**ANGL\_INCLI**

= *Eng*,

**[R]**

/

**CONTACT = "TUBE\_4\_ENCO",**

**[KN]**

**RAYON\_MOBILE**  
**= r\_t, [R]**

**RAYON\_OBST = r\_o,**

**[R]**

**LARGEUR\_OBST**  
**= l\_o**  
**,**

**[R]**

**ANGL\_ISTHME**  
**= angli,**

**[R]**

**ANGL\_INCLI**

= **Eng,**  
**[R]**

/

**CONTACT =**  
**“TUBE\_TUBE”,**  
**[KN]**

**RAYON\_MOBILE**

=  
**r\_t, [R]**  
**ANGL\_INCLI**  
=  
**Eng,**  
**[R]**

**# loading of a new tube**

/

**TUBE\_NEUF**

=  
**“YES”**  
**[DEFECT]**

)  
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### **3 Operands**

***We draw here the attention to some delicate points of the use of POST\_USURE.***

- The result of POST\_USURE does not depend on the final mechanical state of calculation but of all the history of the shocks. It is thus very important to take into account every moment of calculations, i.e. not to ask selective filing in DYNA\_TRAN\_MODAL.***
- The result of POST\_USURE is very sensitive to the parameters of calculations, in particular with richness of the modal base, and with the step of time. It is thus strongly advised to test various modal bases (increasingly rich) and various steps of time (more and more small). For example, for the step of time, one will be able to test various values spaced from one factor 10, then 2, in order to determine a beach of step of time over which the result is stable.***
- Dans le cas d'un calcul vibratoire, on peut avoir un résultat qui n'est pas représentatif de l'usure réelle si l'expérience n'est pas assez longue. De la même manière, dans le cas d'excitations générées par hasard, il est conseillé de réaliser plusieurs tirages avant de tirer des conclusions de dimensionnement.***

### **3.1**

#### ***Node of impact and power of wear***

##### **3.1.1 Operand**

###### ***PUIS\_USURE***

***PUIS\_USURE = been able***

***The power of wear is:***

***· resulting from the result of a transitory calculation by modal recombination, produced by the operator***

***DYNA\_TRAN\_MODAL [U4.53.21] (operands following),***

***· or given by the user who uses operand PUIS\_USURE then.***

##### **3.1.2 Operand**

###### ***RESU\_GENE***

***RESU\_GENE = tg***

***Result of a transitory calculation by modal recombination, produced by the operator***

***DYNA\_TRAN\_MODAL [U4.53.21].***

##### **3.1.3 Operand**

###### ***NODE***

***NODE = noeu***

***Definition of the node of shock post-to be treated.***

##### **3.1.4 Operand**

###### ***INST\_INIT***

***INST\_INIT = t0***

***Moment of beginning of the average of the signals (cf [§4]).***

***(t0 = 0. default value).***

##### **3.1.5 Operand**

###### ***INST\_FIN***

***INST\_FIN = T1***

***Moment of end of the average of the signals.***

##### **3.1.6 Operand**



***NB\_BLOC***

***NB\_BLOC = Nb***

***A number of temporal blocks of division the interval [T,] for the average of the signals***

***0***

***T1***

***(1 per defect).***

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***3.2 Law***

***of wear***

***“ARCHARD” [bib5]***

***3.2.1 Operand***

***LOI\_USURE***

***LOI\_USURE = “ARCHARD”***

***Defines the law of wear in order to calculate worn volume.***

***The coefficient of wear of the law of Archard [bib5] is provided by the user or is taken in a base data.***

***3.2.2 Word***

***key***

## ***MOBILE***

## ***MOBILE***

***Definition of the coefficient of wear of the mobile.***

### ***3.2.2.1 Operand***

***COEF\_USURE***

***COEF\_USURE***

***= k<sub>t</sub>***

***Value of the coefficient of wear of the mobile.***

### ***3.2.3 Word***

***key***

***OBSTACLE***

***OBSTACLE***

***Definition of the coefficient of wear of the obstacle.***

### ***3.2.3.1 Operand***

***COEF\_USURE***

***COEF\_USURE***

***= k<sub>o</sub>***

***Value of the coefficient of wear of the obstacle.***

### ***3.2.4 Operand***

***MATER\_USURE***

***MATER\_USURE = "mat1\_mat2"***

***Recovery of the coefficients in a bank of data:***

***mat1: being the material of the bunch or tube (the mobile),***

***mat2: being the material of the obstacle.***

### ***3.2.5 Operand***

***USURE\_OBST***

***USURE\_OBST***

=  
/“YES”  
/  
“NOT”  
[DEFECT]

*Indicate if one wants to take into account the wear of the obstacle.*

### 3.3

*Law of wear “KWU\_EPRI” [bib5]*

#### 3.3.1 Operand

*LOI\_USURE*

*LOI\_USURE = “KWU\_EPRI”*

*Defines the law of wear in order to calculate worn volume.*

#### 3.3.2 Word

*key*

*MOBILE*

*MOBILE*

*Definition of the coefficient of wear of the mobile (provided by the user or taken in the base of data).*

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### **3.3.2.1 Operands**

**COEF\_\***

**COEF\_FNOR**

**= k1\_t**

*Definition of the dimensional coefficient of correction in the case of pure impacts.*

**COEF\_VTAN**

**= k2\_t**

*Definition of the dimensional coefficient of correction in the case of slips.*

**COEF\_USURE= k3\_t**

*Definition of the coefficient of wear of reference.*

**COEF\_K**

**=/k\_t**

**/**

**5.**

**[DEFECT]**

*Definition of the constant.*

**COEF\_C**

**=/c\_t**

**/**

**10.**

**[DEFECT]**

*Definition of the constant.*

### **3.3.3 Word**

**key**

**OBSTACLE**

**OBSTACLE**

*Definition of the coefficient of wear of the obstacle (provided by the user or taken in the base of data).*

### **3.3.3.1 Operands**

**COEF\_\***

**COEF\_FNOR**

=  $k1_o$

*Definition of the dimensional coefficient of correction in the case of pure impacts.*

**COEF\_VTAN**

=  $k2_o$

*Definition of the dimensional coefficient of correction in the case of slips.*

**COEF\_USURE=  $k3_o$**

*Definition of the coefficient of wear of reference.*

**COEF\_K**

=  $k_o$

/

5.

[DEFECT]

*Definition of the constant.*

**COEF\_C**

=  $c_o$

/

10.

[DEFECT]

*Definition of the constant.*

### **3.3.4 Operand**

**MATER\_USURE**

**MATER\_USURE = "mat1\_mat2"**

*Recovery of the coefficients in a bank of data =*

*mat1 = being the material of the bunch or the tube (the mobile),*

*mat2 = being the material of the obstacle.*

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### **3.3.5 Operand**

**USURE\_OBST**

**USURE\_OBST**

**=**

**/“YES”**

**/**

**“NOT”**

**[DEFECT]**

*Indicate if one wants to take into account the wear of the obstacle.*

### **3.3.6 Operands**

**FNOR\_MAXI/VTAN\_MAXI**

**FNOR\_MAXI = fn**

*Definition of the maximum normal force to take into account for the distribution of the 5 classes for the law of wear KWU\_EPRI.*

**VTAN\_MAXI**

**= vg**

*Definition the speed of slip maximum to take into account for the distribution of the 5 classes for the law of wear KWU\_EPRI.*

## **3.4**

**Law of wear “EDF\_MZ” [bib5]**

### **3.4.1 Operand**

**LOI\_USURE**

**LOI\_USURE = “EDF\_MZ”**

*Defines the law of wear in order to calculate worn volume.*

### **3.4.2 Word**

**key**

**MOBILE**

**MOBILE**

*Definition of the coefficient of wear of the mobile (provided by the user or taken in the base of data).*

#### **3.4.2.1 Operands**

**COEF\_\***

**COEF\_USURE**

**=/a\_t**

**/**

**1.E-13**

**[DEFECT]**

*Definition of the coefficient of wear A.*

**COEF\_B**

**=/b\_t**

**/**

**1.2**

**[DEFECT]**

*Definition of the exhibitor of the power of wear B.*

**COEF\_N**

**=/n\_t**

**/**

**2.44E-08**

**[DEFECT]**

*Definition of the rate of deceleration N.*

**COEF\_S**

**=/S\_t**

**/**

**1.14E-16**

**[DEFECT]**

***Definition of the threshold S.***

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### **3.4.3 Word**

**key**

**OBSTACLE**

**OBSTACLE**

*Definition of the coefficient of wear of the obstacle (provided by the user or taken in the base of data).*

#### **3.4.3.1 Operands**

**COEF\_\***

**COEF\_USURE**

**=/a\_o**

**/**

**1.E-13**

**[DEFECT]**

*Definition of the coefficient of wear A.*

**COEF\_B**

**=/b\_o**

**/**

**1.2**

**[DEFECT]**

*Definition of the exhibitor of the power of wear B.*

**COEF\_N**  
=*n\_o*  
/  
2.44E-08  
[DEFECT]

*Definition of the rate of deceleration N.*

**COEF\_S**  
=*s\_o*  
/  
1.14E-16  
[DEFECT]

*Definition of the threshold S.*

### **3.4.4 Operand** **MATER\_USURE**

*MATER\_USURE = "mat1\_mat2"*

*Recovery of the coefficients in a bank of data =*

*mat1 = being the material of the bunch or the tube (the mobile),*

*mat2 = being the material of the obstacle.*

### **3.4.5 Operand** **USURE\_OBST**

**USURE\_OBST**  
=  
/"YES"  
/  
"NOT"  
[DEFECT]

*Indicate if one wants to take into account the wear of the obstacle.*

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### **3.5 Operand**

#### **CONTACT**

*CONTACT*

=

*géom*

*Definition of the geometry of contact.*

*According to the type of contact, various geometrical relations between worn volumes and them worn depths.*

#### **3.5.1 Operand**

**CONTACT = "GRAPPE\_ALESAGE"**

*The bunch is centered in a boring. The trace of wear has a section in the shape of lunule. Volume used is brought back to a surface used in a section.*

#### **3.5.2 Operand**

**CONTACT = "GRAPPE\_1\_ENCO"**

*The bunch is centered compared to the obstacle.*

*The chart of guidance is made of a notch. Worn volume is brought back to a surface used in one section.*

*The coefficients are founded at the same time on the experimental results and those of the return of experiment. They apply only to the control rods.*

#### **3.5.3 Operand**

## **CONTACT = "GRAPPE\_2\_ENCO"**

*The bunch is centered compared to the obstacle.*

*The chart of guidance is made of two notches diametrically opposite. Worn volume is brought back to a surface used in a section.*

*The coefficients are founded at the same time on the experimental results and those of the return of experiment. They apply only to the control rods.*

### **3.5.4 Operand**

## **CONTACT = "TUBE\_BAV"**

### **Case 1:**

*The tube is presented vertically, the bar impacts perpendicular to the tube, one supposes that bar does not wear (USURE\_OBST = "NOT").*

### **Case 2:**

*The bar is presented tilted (operand ANGL\_INCLI) compared to the tube, the bar impacts perpendicular to the tube, it is supposed that the bar does not wear.*

### **Case 3:**

*The tube is presented vertically, the bar impacts perpendicular to the tube, one takes into account the wear of the bar (USURE\_OBST = "YES").*

### **Case 4:**

*The bar is presented tilted (operand ANGL\_INCLI) compared to the tube, the bar impacts perpendicular to the tube, one takes into account the wear of the bar.*

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### **3.5.5 Operand**

**CONTACT = "TUBE\_ALESAGE"**

#### **Case 1:**

*The tube is centered perfectly in an animated boring of a pure orbital movement and wears of uniform manner on all the periphery in contact with the obstacle.*

#### **Case 2:**

*The tube is centered in an animated boring of a movement of impact-slips of the elliptic type who leads to the formation of traces of wear of the cylindrical type diametrically opposite on the tube and having a section in the shape of lunule.*

#### **Case 3:**

*The tube, animated of a movement of impact-slips, presents this time a slope by report/ratio with the support (operand ANGL\_INCLI). One obtains two symmetrical traces of wear in the shape of V on tube.*

### **3.5.6 Operand**

**CONTACT = "TUBE\_3\_ENCO"**

#### **Case 1:**

*The initial contact is carried out against an edge of one of the isthmuses of a trifoliate boring. The tube is supposed centered perfectly compared to its obstacle. The trace of wear does not extend to the entire isthmus. One does not take into account the wear of the obstacle.*

#### **Case 2:**

*Same assumptions as for case 1 except the position of the tube compared to the obstacle. One supposes this time that the tube presents an angle of inclination (operand ANGL\_INCLI).*

### **3.5.7 Operand**

**CONTACT = "TUBE\_4\_ENCO"**

### **Case 1:**

*The initial contact is carried out against an edge of one of the isthmuses of quadrifoliate boring. It is supposed tube perfectly centered compared to its obstacle. The trace of wear does not extend to the isthmus all entirety. One does not take into account the wear of the obstacle.*

### **Case 2:**

*Same assumptions as for case 1 except the position of the tube compared to the obstacle. One supposes this time that the tube presents an angle of inclination (operand ANGL\_INCLI).*

### **3.5.8 Operand**

**CONTACT = "TUBE\_TUBE"**

*Following the rupture of a stopped tube, there can be contact between this tube and one of its neighbors. Wear of the two tubes by accommodation of surfaces in contact led to the creation of two surfaces plane.*

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### **3.6 Operand**

**RAYON\_MOBILE**

RAYON\_MOBILE

=  
*r\_t*

*Definition of the ray of the mobile (obligatory parameter).*

### **3.7 Operand** **RAYON\_OBST**

*RAYON\_OBST = r\_o*

*Definition of the ray of the obstacle (parameter obligatory if the wear of the obstacle is taken in count).*

### **3.8 Operand** **LARGEUR\_OBST**

*LARGEUR\_OBST*  
=  
*l\_o*

*Definition of the width of the obstacle (obligatory parameter for operands TUBE\_\*).*

### **3.9 Operand** **ANGL\_INCLI**

*ANGL\_INCLI = Eng*

*Definition of the angle of inclination mobile/obstacle (optional parameter = value 0. is taken by defect).*

### **3.10 Operand** **ANGL\_ISTME**

*ANGL\_ISTHME = angli*

*Definition of the angle of the isthmus of the geometry of contact (parameter obligatory for operands TUBE\_3\_ENCO and TUBE\_4\_ENCO).*

### **3.11 Operands** **INST/LIST\_INST/COEF\_INST**

*INST*  
=  
*l\_inst*

*Definition of the moments of calculation in the shape of a list of values.*

*LIST\_INST = linst*

*Definition of the moments of calculation in the form of a concept of the listr8 type.*

*COEF\_INST = coef*

*The moments given are to be multiplied by a given coefficient coef, which makes it possible to pass easily units IF with the natural units for a calculation of wear (the month of the year).*

### **3.12 Operand**

**ETAT\_INIT**

#### **3.12.1 Key word TABL\_USURE**

**TABL\_USURE**

=

*tresu*

*[tabl\_post\_usure]*

*Definition of the table which one wishes to reactualize.*

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#### **3.12.2 Key word INST\_INIT**

**INST\_INIT**



=

*tt*

**[R]**

*Definition of the moment from which one wishes to reactualize the table.*

### **3.13 Operand**

#### **SECTOR**

#### **SECTOR**

=

*Definition of the various quantities necessary to cut out the figure of play in sectors angular.*

#### **3.13.1 Key word COEF\_USURE\_MOBILE**

**COEF\_USURE\_MOBILE =**

***K<sub>t</sub>***

**[R]**

*Definition of the coefficient of wear of the mobile within the meaning of the law of Archard for the sector.*

#### **3.13.2 Key word COEF\_USURE\_OBST**

**COEF\_USURE\_OBST = *K<sub>o</sub>***

**[R]**

*Definition of the coefficient of wear of the obstacle within the meaning of the law of Archard for the sector.*

#### **3.13.3 Key word CONTACT**

***CONTACT = “standard”***  
***[KN]***

***Definition of the geometry of the contact for the sector considered.***

### ***3.13.4 Key word ANGL\_INIT***

***ANGL\_INIT***  
***= ang\_i***  
***[R]***

***Definition of the initial angular value of the sector.***

### ***3.13.5 Key word ANGL\_FIN***

***ANGL\_FIN = ang\_f***  
***[R]***

***Definition of the final angular value of the sector.***

## ***3.14 Operands***

***TITRATE/INFORMATION***

***TITRATE = “montitre”***

***Titrate that one wants to give to the result [U4.03.01].***

***INFORMATION***

***=***  
***/ 1***

***/***  
***2***

***Level of impression***

***1***  
***no impression.***

***2***  
***impression of volumes and depths of wear at the specified moments***

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**3.15 Count**

**produced**

**Order POST\_USURE generates a concept of the type counts, whose contents are:**

**INST:**

**moments to which the user wishes to know the volume and the depth of wear,**

**V\_usur\_tube:**

**volume used on the level of the tube (for each moment specified by the user),**

**V\_usur\_obst:**

**volume used on the level of the obstacle (for each moment specified by the user),**

**P\_usur\_tube:**

**depth of wear on the level of the tube (for each moment specified by the user).**

**Order IMPR\_TABLE [U4.91.03] makes it possible to print the results.**

**Operator MODI\_OBSTACLE [U4.44.22] uses a structure of data of the tabl\_post\_usur type to take into account the evolution of the shapes of the parts in contact because of wear.**

**3.16 Loading of a new tube**

*For the treatment of the wear of the control rods, the user with the possibility of taking in count the change of a tube by a new tube by informing the key word TUBE\_NEUF = "YES"*

*If the user informs this key word, the operator modifies the values of wear of tube (V\_USUR\_TUBE, P\_USUR\_TUBE, V\_USUR\_TUBE\_SECT, P\_USUR\_TUBE\_SECT, V\_USUR\_TUBE\_CUMU = 0) in count resulting from POST\_USURE.*

*After restoring of certain values, the user must call upon MODI\_OBSTACLE [U4.44.22] to recompute the new figures of play.*

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*Checking - Execution*

*4.1 Operand*

*MATER\_USURE*

*It is checked that the material couple provided by the user is in the data base.*

*4.2 Operands*

*RESU\_GENE/INST\_INIT/INST\_FIN/NB\_BLOC*

*The value of INST\_FIN is compared with the final moment T F of the result*

*tran\_gene. The value of*

***INST\_FIN selected is  
(  
min T, T  
F  
1).***

***If the value of INST\_INIT t0 is higher than the value of INST\_FIN, one stops in error.***

***shock  
F  
Block 1  
Block 2  
SEUIL\_FORCE  
INST\_INIT  
INST\_FIN  
DUREE\_REPOS  
Block 1: 1 shock  
Block 2: 2 shocks  
: signal taken into account in the statistics***

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***5 Example***

***dateu = DEFI\_LIST\_REEL (BEGINNING = 0.25,  
INTERVAL = \_F (JUSQU\_A = 1. , A NUMBER = 20),***

```

_F (JUSQU_A = 5. , A NUMBER = 10),
_F (JUSQU_A = 10. , A NUMBER = 5)
)
#
us1 = POST_USURE (
  PUIS_USURE = 0.312,
  LOI_USURE = "ARCHARD",
  NB_BLOC = 4,
  MOBILE = _F (COEF_USURE = 30.e-15),
  OBSTACLE = _F (COEF_USURE = 20.e-15),
  CONTACT = "GRAPPE_1_ENCO",
  RAYON_MOBILE = 0.00485,
  RAYON_OBST = 0.00545,
  LIST_INST = dateu,
  COEF_INST = 31557600. ,
  TITRATE = "NO1 = Usure per years",
  INFORMATION = 2
)
#
us2 = POST_USURE (
  RESU_GENE = dynamoda,
  NODE = "NO1",
  LOI_USURE = "EDF_MZ",
  MOBILE = _F (
    COEF_USURE = 1.e-13,
    COEF_B = 1.2,
    COEF_N = 2.44e-08,
    COEF_S = 1.14e-16,
  ),
  OBSTACLE = _F (
    COEF_USURE = 1.e-13,
    COEF_B = 1.2,
    COEF_N = 2.44e-08,
    COEF_S = 1.14e-16
  ),
  USURE_OBST = "YES",
  CONTACT = "GRAPPE_1_ENCO",
  RAYON_MOBILE = 0.00485,
  RAYON_OBST = 0.00545,
  LIST_INST = dateu,
  COEF_INST = 31557600. ,
  TITRATE = "NO1 = Usure per year",
  INFORMATION = 2
)

```

)

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***Document: U4.85.01***

***Operator CALC\_META***

## ***1 Goal***

***Calculate the metallurgical evolution associated with a thermal history.***

***The operator functions as a postprocessing of the result of thermal calculation in the direction where it the last is a data “entering” of metallurgical calculation and that there is no coupling between thermal metallurgy and it. Two models of evolution are available:***

***.  
a model dedicated to the austenite-ferritic transformations of steel,***

***.  
a model dedicated to the transformations of zirconium alloys.***

***Calculation is done with the nodes.***

***The result obtained could be used thereafter in data of loading of a calculation thermomechanical with taking into account of the metallurgy. One also can at the end of a calculation of metallurgy to carry out a calculation of postprocessing of hardness.***

***Réentrant operator, enriches a structure of data evol\_ther.***

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## **2 Syntax**

***temper = CALC\_META (***

***reuse = temper,***

***MODEL***

***=***

***Mo***

***,***

***[model]***

***CHAM\_MATER =***

***chmat***

***,***

***[cham\_mater]***

***RESULT***

***=***

***temper***

***,***

***[evol\_ther]***

***ETAT\_INIT***

***= \_F***

***(***

*/EVOL\_THER= temper,*

*[evol\_ther]*

*/NUME\_INIT= nuini\_temper, [I]*

*/INST\_INIT= to,*

*[R]*

*PRECISION= PREC,*

*[R]*

*“RELATIVE” CRITERE=/,*

*[DEFECT]*

*“ABSOLUTE”,*

*/*

*META\_INIT\_ELNO*

*=*

*phasinit,*

*[carte\_VAR2\_R]*

*)*

**COMP\_INCR**

**= \_F**

(

**RELATION =/"STEEL",**

**/"ZIRC",**

**/ALL = "YES", [DEFECT]**

/

/

**GROUP\_MA**

=

**lgrma**

,

**[l\_gr\_maille]**

/

**NET**

=

**lma**

,

**[l\_ma]**

)

**OPTION**  
**= ' META\_ELNO\_TEMP',**

)

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**3 Operands**

**3.1 Operands**

**MODEL/CHAM\_MATER**

**MODEL = Mo,**

**Name of the model whose elements are the subject of metallurgical calculation.**

**CHAM\_MATER = chmat,**

**Name of the field of affected material on the model Mo.**

**3.2 Operand**

**RESULT****RESULT = temper,**

*Name of the evol\_ther result resulting from a thermal calculation from which one makes a calculation of metallurgy. This result will be at the end of the calculation enriched by the metallurgical evolution of field, fields of variables intern of which the number and the significance depend on the model on transformation used (cf [§3.3.1]).*

**3.3 Word****key****COMP\_INCR****COMP\_INCR =**

*Inform the metallurgical model of evolution used. One can use in same calculation various models of evolution on different parts.*

**3.3.1 Operand****RELATION****RELATION =/“STEEL”,****/“ZIRC”****,****/****“STEEL”**

*Is used to specify the execution of the calculation of the metallurgical transformations of steel, with surroundings of 800°C, ferritic phase (ferrite, pearlite, bainite, martensite) to a phase austenitic (and conversely with cooling). The model with the heating and with cooling are different (for more detail on the models, to see [R4.04.01]).*

*This relation of behavior comprises 7 internal variables:*

*V1: proportion of the phase ferrite,*

*V2: proportion of the phase pearlite,*

*V3: proportion of the phase bainite,*

*V4: proportion of the phase martensite,*

*V5: cut austenitic grain,*

*V6: martensitic temperature of transformation,*

*V7: temperature at the points of Gauss.*

*The data materials necessary must be indicated in DEF1\_MATERIAU under key word META\_ACIER.*

/

**“ZIRC”**

*Is used to specify the execution of calculation for the metallurgical transformation (with cooling) alloys of zirconium, of a hexagonal phase compacts with a centered cubic phase around 800°C (for more detail on the model, to see [R4.04.01]).*

*The relation of behavior comprises 3 internal variables:*

*V1: proportion of the cold phase, at the pure state,*

*V2: proportion of the cold phase, mixed with the phase,*

*V3: temperature at the points of Gauss.*

*The data materials necessary must be indicated in **DEFI\_MATERIAU** under key word **META\_ZIRC**.*

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### **3.3.2 Operands**

**ALL/GROUP\_MA/MESH**

**/ALL = “YES”,**

**/**

**GROUP\_MA**

**=**

**lgrma**

**,**



/  
**NET**  
 =  
*lma*  
 ,

*The meshes specify on which the model is used and makes it possible to affect calculation that on under part of the total grid.*

### **3.4 Word**

**key**  
**ETAT\_INIT**

**ETAT\_INIT =**

**/META\_INIT\_ELNO = phasinit,**

**/EVOL\_THER = temper**

*Initial metallurgical State.*

#### **3.4.1 Operand**

**META\_INIT\_ELNO**

**/META\_INIT\_ELNO = phasinit**

*The assignment of the field of internal variables initial constant by element starting from a chart defines defined by CREA\_CHAMP. Only the variables whose initial assignment has a direction are with to inform. One thus informs only the variables corresponding to a proportion of phase, more possibly that corresponding to the austenitic size of grain if it is not null.*

#### **3.4.2 Operands**

**EVOL\_THER/NUME\_INIT/INST\_INIT/PRECISION/CRITERION**

**/EVOL\_THER**

**= temper**

**/NUME\_INIT= nuini\_temper,**

**INST\_INIT=**

**to,**

**PRECISION= PREC,**

*“RELATIVE” CRITERE=/  
/“ABSOLUTE”,*

*The concept evol\_ther defines in which one will extract the initial state from which calculation will be carried out. This concept must contain metallurgical sizes.*

*The definition of the initial state can be done by stored sequence number or moment associated with calculation.*

*NUME\_INIT allows the definition starting from the stored sequence number and INST\_INIT allows definition as from the moment of calculation.*

*In this case, PRECISION and CRITERION make it possible to define the precision and the criterion according to which the extraction will be carried out.*

### **3.5 Operand OPTION**

*OPTION  
= ' META\_ELNO\_TEMP'*

*This option, which calculates the metallurgical proportion of phase to the nodes, is not necessary because it is calculated by defect.*

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*Version*

8.2

*Titrate:*

*Operator CALC\_META*

*Date:*

31/01/06

*Author (S):*

**V. CANO** Key

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## **4 Example in the case of a steel**

*# CREATION OF THE FIELD OF INTERNAL VARIABLES INITIAL (FERRITE 70% AND 30% OF BAINITE)*

*phasinit = CREA\_CHAMP (OPERATION = 'AFFE',  
TYPE\_CHAM*

*=*

*“CART\_VAR2\_R”,  
GRID*

*=*

*email,  
AFFE*

*=\_F (  
ALL*

*=*

*“YES”,  
NOM\_CMP*

*=*

*(“V1”, “V2”, “V3”, “V4”, “V5”),  
VALE*

*=*

*(0.7,0.0,0.3,0.0,0.)),*

*# CALCULATION OF THE THERMAL EVOLUTION*

*temple = THER\_LINEAIRE (MODEL = moth,  
CHAM\_MATER*

*=*

*chmat*

*,*

*EXCIT*

*=*

*\_F (LOAD =  
chth1),  
INCREMENT*

*=*

*(LIST\_INST=  
lr8),  
TEMP\_INIT*

*= (VALE*

*= 700),)*

## # CALCULATION OF THE EVOLUTION OF THE METALLURGICAL PHASES

```
temple = CALC_META (reuse = temple,  
MODEL  
=  
moth,  
CHAM_MATER  
=  
chmat,  
RESULT  
=  
temple,  
ETAT_INIT  
=_F (META_INIT_ELNO  
=  
phasinit),  
COMP_INCR  
= (RELATION  
= 'ACIER',  
ALL  
=  
"YES"))
```

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*Author (S):*

*Key **COURTEOUS Mr.***

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*Organization (S): EDF-R & D /AMA*

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***Document: U4.91.01***

***Procedure IMPR\_RESU with the formats “RESULT”  
and “ASTER”***

***1 Goal***

***To write the grid or the results of a calculation in a file with the format “RESULT” or the grid with format “ASTER”.***

***Currently this procedure makes it possible to write with the choice:***

- .  
a grid,***
- .  
fields with the nodes (of displacements, temperatures, clean modes, modes  
statics,...),***
- .  
fields by elements with the nodes or the points of GAUSS (of constraints, efforts  
generalized, of variables intern...).***

***Procedure IMPR\_RESU also makes it possible to write a grid and/or results on a file in  
sight, in particular of their graphic visualization (cf documents [U7.05.01] (format “IDEAS”),  
[U7.05.11] (format “CASTEM”), [U7.05.21] (format “MED”) and [U7.05.31] (format “ENSIGHT”).***

***For the concepts of the result type, one can print only part of information, in  
selecting the fields and the sequence numbers which one wishes to exploit.***

***For the impressions with the format “RESULT”, it is possible to select the topological entities  
(nodes, meshes, groups of nodes and groups of meshes) on which one wants to print them  
results. One can also reduce the number of the information printed while asking only***

*impression of certain components, values included/understood in an interval chosen by the user or of extreme values. One can combine all the possibilities, for example to obtain the value maximum of a component given, on a particular topological entity and in an interval of values chosen by the user.*

*The format “RESULT” should not be used as a basis to store or exchange results, its format is not fixed.*

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*2 Syntax*

*IMPR\_RESU*

*(*

*MODEL*

*=*

*Mo,*

*[model]*

*UNIT = links, [I]*

*FORMAT =/“RESULT”, [DEFECT]*

*/“ASTER”,*

*RESU = (\_F (*

**# Syntax of procedure *IMPR\_RESU* to the format “*RESULT*”**

**/**  
**GRID =**  
**MA, [grid]**

**//**  
**CHAM\_GD =**  
**CH\_GD,**  
**[cham\_gd]**

**/**  
**RESULT**  
**=**  
**RESU,**  
**[result]**

**SENSITIVITY**  
**=**  
**(... to see [U4.50.02])**

**# Extraction of a field of size of resu**

**/**  
**TOUT\_CHAM**  
**=**  
**/"YES", [DEFECT]**

**/"NOT",**

**/**



**NOM\_CHAM**

=

**L\_NOMSYMB, [l\_K16]**

/

**TOUT\_ORDRE =**

**“YES”,**

**[DEFECT]**

/

**NUME\_ORDRE =**

**LORDRE,**

**[l\_I]**

/

**LIST\_ORDRE =**

**LENTI,**

**[listis]**

/

**NUME\_MODE**

=

**LMODE,**

**[l\_I]**

/

**NOEUD\_CMP**

=

**LNOECMP,**

**[l\_K16]**

/

**NOM\_CAS =**

**NCAS,**

**[l\_K16]**

/  
**ENG**  
=  
**LANGL,**  
**[L\_K16]**  
/  
/  
**FREQ**  
=  
**LFREQ,**  
**[L\_R]**  
/  
**LIST\_FREQ**  
=  
**LREEL,**  
**[listr8]**  
/  
**INST**  
=  
**LINST,**  
**[L\_R]**  
/  
**LIST\_INST**  
=  
**LREEL,**  
**[listr8]**

**/PRECISION**  
=  
/  
**PREC, [R]**  
/  
**1.0D-3,**  
**[DEFECT]**

/  
**CRITERION =/“RELATIVE”,**

**[DEFECT]**  
/  
**“ABSOLUTE”**  
,

**INFO\_RESU**  
**=/“YES”,**

**/“NOT”, [DEFECT]**

**# Parameters**

/  
**TOUT\_PARA**  
**=**  
**/“YES”,**

**/“NOT”, [DEFECT]**

/  
**NOM\_PARA**  
**=**  
**L\_NOMPARA, [l\_K16]**

***FORM\_TABL***

=

***/"YES",***

***/"EXCEL",***

***/"NOT", [DEFECT]***

***# Selection of the components***

/

***TOUT\_CMP***

=

***"YES",  
[DEFECT]***

/

***NOM\_CMP =***

***L\_NOMCMP,***

***[I\_K8]***

## ***# Selection of the topological entities***

***/***  
***ALL***  
***=***  
***“YES”,***  
***[DEFECT]***

***/|***  
***NODE***  
***=***  
***L\_NOEU, [l\_noeud]***

***/***  
***GROUP\_NO***  
***=***  
***L\_GRNO,***  
***[l\_gr\_noeud]***

***/***  
***NET***  
***=***  
***L\_MAILLE,***  
***[l\_maille]***

***/***  
***GROUP\_MA***  
***=***  
***L\_GRMA, [l\_gr\_maille]***  
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**# Selection on the values**

**VALE\_MAX**

**=**

**/“YES”,**

**/“NOT”, [DEFECT]**

**VALE\_MIN**

**=**

**/“YES”,**

**/“NOT”, [DEFECT]**

**BORNE\_SUP**

**=**

**VSUP,**

**[R]**

**BORNE\_INF**

**=**

**VINF,**

**[R]**

**# Impression of the co-ordinates**

**IMPR\_COOR**

=  
/“YES”,  
/“NOT”, [DEFECT]

**# Choice of the format of writing of the actual values**

**FORMAT\_R =/FORM,**  
/  
“1PE12.5”, [DEFECT]

**SOUS\_TITRE = L\_ST,**  
[l\_Kn]

**# Syntax of procedure IMPR\_RESU to the format “ASTER”**

/  
**GRID = MA,**  
/  
[grid]  
/  
[skeleton]

**SOUS\_TITRE = L\_ST,**  
[l\_Kn]

)

))

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***3***

***Print in documentation IMPR\_RESU***

***For including/understanding the documentation of IMPR\_RESU well, it should be noted that the term “RESULT”***

***gather in Code\_Aster three rather different concepts:***

***.***

***a type of concept,***

***.***

***a type of file,***

***.***

***a format of writing.***

***Indeed, on the one hand, one indicates by result, the quantities produced by an operator of Aster calculation***

***producing several fields (evolutionary calculation, calculation of clean modes, etc...).***

***These data (results) are contained in a structure of Aster data of the generic type said***

***result. This generic type is declined in under types, for example mode\_meca, evol\_elas, etc,***

***whose mode of storage differs somewhat. A concept of the result type has only one under type.***

***In Aster documentation the names of the types of concept are in small letters Courier.***

***In addition, the results intended for the impression, in particular those resulting from IMPR\_RESU,***



*are versed*

*in a file indicated by file RESULT (associate with unit 8, standard resu in astk). The format of writing associated with this file intended for the impression is him also baptized RESULT.*

*In short:*

*result*

*data resulting from the resolution of the system,*

*result*

*generic designation of the type of concept (of the structure of data) which the result contains,*

*evol\_ther*

*name of under type of the result of the result type,*

*mode\_meca*

*FILE*

*(without quote) designation of the file which contains the results, independently format of its contents,*

*“RESULT”*

*(with quotes) designation of the format (Aster) of the file which contains the results.*

*4 Operands*

*FORMAT and UNIT*

*Procedure IMPR\_RESU makes it possible to write a grid and/or values of results in different formats in sight, in particular, of a graphic visualization [U7.05.01], [U7.05.11], [U7.05.21] and [U7.05.31].*

*The operand FORMAT makes it possible to specify the format of impression of a result.*

*The format “RESULT” is taken by defect. It makes it possible to print the grid and/or the results under form listing.*

*One specifies in which file the data will be written via the key word UNIT (cf orders DEF1\_FICHER). By defect, UNIT = 8 with the format “RESULT” and UNIT = 26 with the format “ASTER”.*

*5 Word*

*key*

## ***RESU***

***This key word factor makes it possible to specify the results to print and the format according to which one wants them to print.***

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### **6 Operands**

#### **CHAM\_GD and RESULT**

*The values of the computed fields are stored in structures of data called fields of size. These fields of size can be directly accessible (concept *cham\_gd*) or to find in a structure of data gathering several fields of size (concept *result*).*

.

*a field of size is a structure of data which makes it possible to store definite fields with the nodes (*cham\_no\_\**) or fields defined by elements (*cham\_elem\_\**). For the fields by elements, one distinguishes the fields defined in the nodes from the elements and the fields defined in points of GAUSS of the elements,*

.

*a concept result is composed of one or more fields of size. For example, with each step of calculation one stores in the structure of data result, the field of size displacement. This structure is thus indexed by a matrix structure of order 2, including one index is, for example, the list of the moments of calculation and the other the whole of the computed fields (displacements, constraints, deformations,...).*

*One reaches in this case a field of size by specifying the value of a variable of access (sequence number, moment, frequency, number of mode...) and a field name (“DEPL”, “SIGM\_ELNO\_DEPL”,...). There are several types of concept result: *evol\_elas*, *evol\_noli*, *mode\_meca*,.... With each one corresponds a list of fields and a list of variables licit accesses (cf [U5]).*

*In addition, with a concept result a certain number of results is also associated complementary (for example generalized mass or modal factors of participation*

*in a modal calculation (concept result of the mode\_meca type)), different for each value from the variable of access. These complementary results are called parameters.*

*Taking into account the structure of data result, one understands easily that the possibilities of impression which one lays out are those of the fields of size, supplemented by specific possibilities:*

- *information on the structure of data (for example: list variables of access, lists actually calculated fields,...),*
- *direct access to a field of size (for example, impression of the field of displacements at the moment t=15.),*
- *impression of the values of parameters.*

*The operand RESULT makes it possible to print the fields contained in a concept result. One can for example choose to print only certain fields (cf the following key word: NOM\_CHAM) on certain components of certain nodes (cf NOEUD\_CMP).*

## **7 Operand SENSITIVITY**

*SENSITIVITY = list of the significant parameters*

*The use of this operand will mean that one is not interested in the result in itself, but with derived from this result compared to significant parameters.*

*Example:*

*RESULT = RESU,  
NOM\_CHAM = "DEPL"*

*This sequence prints the field of displacement contained in the resu result.*

*RESULT  
=  
RESU,  
SENSITIVITY = (PS1, PS2),  
NOM\_CHAM  
=  
"DEPL"*

*This sequence prints the derivative of the field of displacement of result RESU compared to parameter PS1, then the derivative compared to PS2.*

*Cf document [U4.50.02].*

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***Extraction of a field of size***

***8.1 Operands***

***TOUT\_CHAM/NOM\_CHAM***

*Cf document [U4.71.00].*

***8.2 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/***

***NUME\_MODE/INST/LIST\_INST/FREQ/LIST\_FREQ/***

***NOEUD\_CMP/NOM\_CAS/ENG/PRECISION/CRITERION***

*Cf document [U4.71.00].*

***9 Operand***

***INFO\_RESU***

*During the impression of a concept result, one can have forgotten the exact contents of the structure of data. Operand INFO\_RESU makes it possible to print these contents (a number of sequence numbers, lists*

*reference symbols of the actually calculated fields, list of the reference symbols of actually calculated parameters,...).*

*For example:*

*IMPR\_RESU (FORMAT=' RESULTAT', RESU= (\_F (RESULTAT=resu, INFO\_RESU= "YES")))*

*Impression in the file RESULT in the case of a concept result of name RESU of the type mode\_meca:*

*Structure of concept RESU calculated for 2 sequence numbers.*

*List reference symbols:*

*DEPL  
of type DEPL\_R*

*List names of variables of access:*

*NUME\_MODE  
FREQ*

*List names of parameters:*

*NORMALIZES  
METHOD  
ITER\_QR  
ITER\_BATHE  
ITER\_ARNO  
ITER\_JACOBI  
ITER\_SEPARE  
ITER\_AJUSTE  
ITER\_INVERSE  
OMEGA2  
AMOR\_REDUIT  
ERROR  
MASS\_GENE  
RIGI\_GENE  
AMOR\_GENE  
MASS\_EFFE\_DX  
MASS\_EFFE\_DY  
MASS\_EFFE\_DZ  
FACT\_PARTICI\_DX  
FACT\_PARTICI\_DY  
FACT\_PARTICI\_DZ  
MASS\_EFFE\_UN\_DX  
MASS\_EFFE\_UN\_DY  
MASS\_EFFE\_UN\_DZ*

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## **10 Parameters**

### **10.1 Operand**

**TOUT\_PARA**

*This key word indicates if one wants or not to print all the values of the parameters attached to concept of the result type.*

*Example:*

**IMPR\_RESU (RESU= (\_F (RESULTAT= resu,  
TOUT\_PARA= “YES”, NUME\_ORDRE= 3)))**

*One prints in the file RESULT the values of all the parameters but only for third step of calculation of a concept result of the mode\_meca type:*

*Impression of the parameters of the concept resu for the sequence number 3:*

**NOM\_MODE**

**3**

**FREQ**

**1.09787E+4**

**OMEGA2**

**4.75843E+09**

**AMOR\_REDUIT**

**0.00000E+00**

**ERROR**

**2.76853E-10**  
**MASS\_GENE**  
**1.50009E-07**  
**RIGI\_GENE**  
**7.13806E+02**

.....

.....

**NORMALIZES**  
**SANS\_CMP:**  
**LAGR**

### **10.2 Operand** **NOM\_PARA**

*This key word makes it possible to choose a list of reference symbols of parameters among the whole of possible (cf [U5] or INFO\_RESU).*

*Key words TOUT\_PARA and NOM\_PARA cannot be used simultaneously.*

*Example:*

**IMPR\_RESU (RESU= (\_F (RESULTAT= resu, NOM\_PARA= ("STANDARD"), NUME\_ORDRE= 3)))**

*One prints in the file RESULT the value of the parameter of name "NORMALIZES" but only for the third step of calculation of a concept result of the mode\_meca type:*

*Impression of the parameters of the concept resu for the sequence number 3:*

**NORMALIZES**  
**SANS\_CMP:**  
**LAGR**

### **10.3 Operand** **FORM\_TABL**

*This key word makes it possible to choose the format of impression of the values of the parameters. Maybe in form*

*of a table whose each line is limited to 80 characters (FORM\_TABL = "YES"), that is to say in form of a table whose each line can reach 2000 characters (FORM\_TABL = "EXCEL"), that is to say in the form of a list (a parameter by line) (FORM\_TABL = "NOT").*

*By defect the parameters are printed in the form of a table.*



**Example:**

**1 FORM\_TABL = "YES"**

**NUME\_ORDRE NUME\_MODE  
ITER\_QR ITER\_BATHE  
FREQ  
OMEGA2  
AMOR\_REDUIT  
MASS\_GENE  
RIGI\_GENE  
AMOR\_GENE  
MASS\_EFFE\_DY  
MASS\_EFFE\_DZ  
FACT\_PARTICI\_DX  
FACT\_PARTICI\_DZ  
MASS\_EFFE\_UN\_DX  
MASS\_EFFE\_UN\_DY  
NORMALIZES  
METHOD**

**2 FORM\_TABL = "EXCEL"**

**NUME\_ORDRE NUME\_MODE  
ITER\_QR ITER\_BATHE...  
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## ***11 Selection on the components***

***Another manner of reducing the volume of the impressions is to print only the values of certain components (for example that displacement following axis X: component DX).***

### ***11.1 Operand***

***TOUT\_CMP***

***This key word makes it possible to indicate that one wishes to print all the components of the field.***

### ***11.2 Operand***

***NOM\_CMP***

***This key word makes it possible to choose the list of the components of the cham\_gd or all the fields of the concept result which one wishes to print.***

***Key words TOUT\_CMP and NOM\_CMP cannot be used simultaneously.***

***These components are described in the specific documentation of the elements.***

## ***12 Selection of the topological entities***

***In order to reduce the volume of the impressions, it is sometimes necessary to print only part of result. With this intention one can print a field with the nodes only in certain nodes, or a field by element that in certain elements.***

### ***12.1 Operand***

***ALL***

***This key word indicates that one wishes to print the field on all the structure (all the nodes for one field with the nodes, all the elements for a field by element).***

### ***12.2 Operand***

***NODE***

***This key word makes it possible to indicate the list of the nodes on which one wishes to print a cham\_no. If it key word is used in the case of the impression of a cham\_elem, it is ignored, and the cham\_elem is printed in all the meshes specified in addition.***

### ***12.3 Operand***

***GROUP\_NO***

*This key word makes it possible to indicate the list of the groups of nodes on which one wishes to print one*

*cham\_no. If this key word is used in the case of the impression of a cham\_elem, it is ignored, and it cham\_elem is printed in all the meshes, specified by ailleurs.*

#### **12.4 Operand**

##### **NET**

*This key word makes it possible to indicate the list of the meshes on which one wishes to print a cham\_elem.*

*For a cham\_no, it makes it possible to indicate the list of the nodes, tops of the meshes to which one wishes to print the cham\_no.*

#### **12.5 Operand**

##### **GROUP\_MA**

*This key word makes it possible to indicate the list of the groups of meshes on which one wishes to print one*

*cham\_elem. For a cham\_no, it makes it possible to indicate the list of the nodes, tops of the meshes to which one wishes to print the cham\_no.*

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#### **13 Selection on the values**

*It is also interesting to print only the extreme values of all or some components, on whole or part of the structure.*

### **13.1 Operand VALE\_MAX**

*This key word indicates that one wishes to print the maximum value of each component of the field, possibly in a given interval specified by arguments BORNE\_SUP and/or BORNE\_INF.*

### **13.2 Operand VALE\_MIN**

*This key word indicates that one wishes to print the minimal value of each component of the field, possibly in a given interval specified by arguments BORNE\_SUP and/or BORNE\_INF.*

### **13.3 Operand BORNE\_SUP**

*This key word indicates the upper limit of the interval on which one wishes to print the field. One print all the values of the field lower than this upper limit.*

### **13.4 Operand BORNE\_INF**

*This key word indicates the lower limit of the interval on which one wishes to print the field. One print the values of the field higher on this lower terminal.*

### **14 Impression of the co-ordinates: operand IMPR\_COOR**

*This key word makes it possible to specify if one wishes to print the co-ordinates of a node at the time of the writing of one cham\_no with the format “RESULT”.*

### **15 Operand FORMAT\_R**

**FORMAT\_R =/FORM,  
/  
“1PE12.5”  
[DEFECT]**

*The format of writing of the actual values to the format “RESULT makes it possible to specify”.*

### **16 Remark**

*In Aster, there are cham\_elem with under points (as well for cham\_elem with nodes that for cham\_elem at the points of Gauss). The format “RESULT”, IMPR\_RESU allows impression of the cham\_elem with under points.*

*If same a cham\_elem has under points on certain meshes and not on others, the impression of the cham\_elem will be done in two times:*

*.  
initially impression of the cham\_elem on all the meshes on which there is not under points,  
.*

*then impression of the cham\_elem on all the meshes on which there is under points.*

*A specific format is used for each one of these impressions.*

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*HT-66/05/004/A*

---

*Code\_Aster ®*

*Version*

*7.4*

*Titrate:*

*Procedure IMPR\_RESU with the formats “RESULT” and “ASTER”*

*Date:*

*18/02/05*

*Author (S):*

*Key COURTEOUS Mr.*

*:*

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*17 Operand*

*SOUS\_TITRE*

*This argument makes it possible to print under title of comment, for more details to consult it document [U4.03.01].*

*The SOUS\_TITRE by defect is:*

*.  
for a champ\_gd*

*- for*

*one*  
*cham\_no*  
*SOUS\_TITRE*  
=  
(*FIELD*  
*WITH*  
*NOEUDS'*  
)  
- *for*  
*one*  
*cham\_elem*

*SOUS\_TITRE =*  
(*"FIELD BY ELEMENT &LOC (cham\_elem)"*)

*Example: 'FIELD BY ELEMENT AT THE POINTS OF GAUSS "*

*.*  
*for a result*

- *for*  
*one*  
*cham\_no*

*SOUS\_TITRE = ("FIELD WITH THE NODES",*

*'OF*  
*NAME*  
*SYMBOLIC SYSTEM*  
*&NOM\_SYMB (Result*  
*cham\_no) &RL',*

*'NUMBER*  
*D " ORDER*  
*&NUM\_ORDRE (Result*  
*cham\_no) ',*

*'&ACCES (Result*  
*cham\_no)*  
*'*

*Example of impression:*

*FIELD*

**WITH**  
**NODES**  
**OF**  
**NAME**  
**SYMBOLIC SYSTEM**  
**DEPL**  
**NUMBER**  
**Of ORDER:**  
**2**  
**NUME\_MODE:**  
**3**  
**FREQ**  
**:**  
**5.52739E+00**

**- for**  
**one**  
**cham\_elem**  
**SOUS\_TITRE**  
**=**  
**('FIELD**  
**BY**  
**ELEMENT**  
**&LOC (Result**  
**cham\_elem) '**,

**'OF**  
**NAME**  
**SYMBOLIC SYSTEM**  
**&NOM\_SYMB (Result**  
**cham\_elem) &RL'**,

**'NUMBER**  
**D " ORDER**  
**&NUM\_ORDRE (Result**  
**cham\_elem)**  
**'**,

**'&ACCES (Result**  
**cham\_elem)**  
**'**

**Example of impression:**

***FIELD BY ELEMENT WITH THE NODES OF REFERENCE SYMBOL***

***EPSI\_ELNO\_DEPL***

***NUMBER***

***Of ORDER:***

***1***

***INST***

***:***

***0.00000E+00***

***18 Impression of the grid: operands GRID/MODEL***

***This argument makes it possible to print the grid with the FORMAT = “ASTER” and/or “RESULT”.***

***One***

***then find the format used for LIRE\_MAILLAGE [U4.21.01] and defined in [U3.01.00].***

*By defect, one prints all the grid.*

*Concept of the model type is optional in the majority of the impressions. However, it can be used in the case of the impression of a grid to the formats “ASTER” and/or “RESULT”, in order to print only the part of the grid whose meshes are affected in the model.*

*If one chooses format “ASTER”, the grid is written in a file of the .mail type which can then be read again by LIRE\_MAILLAGE.*

*If one chooses format “RESULT”, the grid is written, by defect, in the file .resu and cannot to be read again by LIRE\_MAILLAGE just as it is because the file .resu contains titles in addition, under titles and possibly of other information.*

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***Code\_Aster*** ®

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*Titrate:*

*Procedure IMPR\_GENE*

*Date:*

*22/02/06*

*Author (S):*

*E. BOYERE, J. PIGAT Key*

*:*

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*Organization (S): EDF-R & D /AMA, EDF-Division Fuels*

*Instruction manual*

*U4.9- booklet: Impression/Test*

*Document: U4.91.02*

*Procedure IMPR\_GENE*

*1 Goal*

*To write the result of a dynamic calculation in variables generalized on a file, with the format*

**“RESULT”.**

*Currently this procedure makes it possible to write results in generalized variables resulting from following concepts:*

.  
*tran\_gene,*  
.  
*vect\_asse\_gene,*  
.  
*harm\_gene,*  
.  
*mode\_gene.*

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***Version***

***8.2***

***Titrate:***

***Procedure IMPR\_GENE***

***Date:***

***22/02/06***

***Author (S):***

***E. BOYERE, J. PIGAT Key***

***:***

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***2 Syntax***

***IMPR\_GENE (***

***FORMAT***

***=***

***/***

***“RESULT”,***

***[DEFECT]***

**FILE**

=  
/

**links,**  
**[I]**

/ 8,  
**[DEFECT]**

**GENE = \_F (**

/

**RESU\_GENE**

=

**tg,**

/

**[vect\_asse\_gene]**

**/TOUT\_CMP\_GENE**

=

/

**“YES”,**  
**[DEFECT]**

/

**“NOT”,**

/  
**NUME\_CMP\_GENE**  
=  
**lordre**  
,  
**[l\_I]**

/  
**RESU\_GENE**  
= **tg,**

/  
**[harm\_gene]**

/  
**[mode\_gene]**

/  
**TOUT\_CHAM**  
=/"NOT",

/  
**“YES”,**  
**[DEFECT]**

/  
**NOM\_CHAM**

=  
**l\_cham, [l\_Kn]**

/  
**TOUT\_PARA**  
**=/“YES”,**  
**[DEFECT]**

**/“NOT”,**

**/**  
**NOM\_PARA**

**=**  
**lnomsymb,**  
**[l\_Kn]**

**/**  
**TOUT\_CMP\_GENE**

**=**  
**/**  
**“YES”,**  
**[DEFECT]**

**/“NOT”,**

/  
**NUME\_CMP\_GENE = lordre,**

**[l\_I]**

/

/

**TOUT\_ORDRE =**  
**“YES”,**  
**[DEFECT]**

/

**NUME\_ORDRE =**  
**lordre,**

**[l\_I]**

/

**LIST\_ORDRE =**  
**slow,**  
**[listis]**

/

**/TOUT\_MODE**  
**=**  
**“YES”,**  
**[DEFECT]**

/  
**NUME\_MODE**  
=  
**lmode,**  
**[l\_I]**

/  
**/FREQ = lfreq,**  
**[l\_R]**  
/  
**LIST\_FREQ**  
=  
**lreel,**  
**[listr8]**

**CRITERION**  
=/"ABSOLUTE",  
/  
"RELATIVE", [DEFECT]

**PRECISION**  
=



/  
**prec,**  
**[R]**  
/  
**1.E-03, [DEFECT]**

/  
**RESU\_GENE**  
**= tg,**

**/[tran\_gene]**

/  
**TOUT\_CHAM**  
**=**  
**“YES”,**  
**[DEFECT]**

/  
**NOM\_CHAM**  
**=**  
**l\_cham, [l\_Kn]**

/  
**TOUT\_CMP\_GENE**  
=  
**“YES”,**  
**[DEFECT]**

/  
**NUME\_CMP\_GENE = lordre,**  
  
**[I\_I]**

/  
**/TOUT\_ORDRE = “YES”,**  
**[DEFECT]**

/  
**NUME\_ORDRE =**  
**lordre,**

**[I\_I]**

/  
**LIST\_ORDRE =**  
**slow,**  
**[listis]**

/

*/INST = linst,*

*[l\_R]*

/

*LIST\_INST*

=

*lreel,*

*[listr8]*

/

*TOUT\_INST*

=

*“YES”,*

*[DEFECT]*

*CRITERION*

*=/“ABSOLUTE”,*

/

*“RELATIVE”, [DEFECT]*

*PRECISION*

=

/

*prec,*

*[R]*

/

*“1.E-03”,*

*[DEFECT]*

*INFO\_CMP\_GENE*

=  
/  
"YES",  
[DEFECT]  
/  
"NOT",

*SOUS\_TITRE*

=  
*lst,*  
[*l\_Kn*]

*INFO\_GENE*

= "YES",  
  
"NOT",  
[DEFECT]

),

)

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*Procedure IMPR\_GENE*

*Date:*

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*Author (S):*

**E. BOYERE, J. PIGAT** Key

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### **3 Word**

**key**

**GENE**

*This key word factor makes it possible to specify the results to print. At least a block factor of the key word is necessary for each result which one wishes to print.*

### **4 Operand**

**RESU\_GENE**

*This key word makes it possible to specify the name user of the concept of the tran\_gene type, vect\_asse\_gene, harm\_gene or mode\_gene to be printed.*

### **5**

**Variables of access if concept of the vect\_asse\_gene type**

#### **5.1 Operands**

**TOUT\_CMP\_GENE/NUME\_CMP\_GENE**

*Key word TOUT\_CMP\_GENE indicates that one wants or not to print the fields for all the numbers generalized components (except those which correspond to ddl of Lagrange).*

*Key word NUME\_CMP\_GENE indicates that one wants to print the fields which correspond to a list numbers of generalized components.*

## **6 Variables of access if concept of the mode\_gene type or harm\_gene**

### **6.1 Extraction of a field of result: operands TOUT\_CHAM/NOM\_CHAM**

*Key word TOUT\_CHAM indicates that one wants to print all the actually calculated fields.*

*Key word NOM\_CHAM makes it possible to choose a list of reference symbols of fields among the unit the possible ones.*

### **6.2**

#### **Extraction of a parameter: operands TOUT\_PARA/NOM\_PARA**

*Key word TOUT\_PARA indicates that one wants or not to print all the values of the parameters attaches with the concept considered.*

*Key word NOM\_PARA makes it possible to choose a list of reference symbols of parameters among the whole of the possible ones.*

*These key words are available only for the concept of the mode\_gene type.*

### **6.3 Operands**

#### **TOUT\_CMP\_GENE/NUME\_CMP\_GENE**

*Key word TOUT\_CMP\_GENE indicates that one wants to print the fields for all the numbers of generalized components (except those which correspond to ddl of Lagrange).*

*Key word NUME\_CMP\_GENE indicates that one wants to print the fields which correspond to a list numbers of generalized components.*

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## *Procedure IMPR\_GENE*

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### **6.4 Operands**

#### **TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE**

*Key word TOUT\_ORDRE indicates that one wants to print the fields for all the sequence numbers.*

*Key words NUME\_ORDRE and LIST\_ORDRE make it possible to print only the fields corresponding with a list of sequence numbers lordre or slow defined by DEFI\_LIST\_ENTI [U4.34.02] (slow is thus a concept of the listis type).*

### **6.5 Operands**

#### **TOUT\_MODE/NUME\_MODE**

*Key word TOUT\_MODE indicates that one wants to print the fields for all the numbers of mode.*

*Key word NUME\_MODE indicates that one wants to print the fields corresponding to a list of numbers of lmode mode. These numbers are those affected by the calculation algorithm.*

*This key word is usable only for one concept of the mode\_gene type.*

### **6.6 Operands**

#### **FREQ/LIST\_FREQ**

*Key word FREQ indicates that one wants to print the fields corresponding to a list of frequency lfreq.*

*Key word LIST\_FREQ indicates that one wants to print the fields corresponding to a list of frequencies lreel, defined by operator DEFI\_LIST\_REEL [U4.34.01] (lreel is thus one concept of the listr8 type).*

*This key word is usable for a concept of the harm\_gene type, and possibly mode\_gene.*

### **6.7 Operands**

#### **CRITERION/PRECISION**

*The key word PRECISION indicates with which precision one must carry out the research of the frequency of calculation.*

*The key word CRITERION indicates with which type of interval of precision the research of the frequency of interpolation must be carried out:*

*“ABSOLUTE”:*

*interval of research  $[Fr-prec, fr+prec]$*

*“RELATIVE”:*

*interval of research  $[(1-prec) Fr, (1+prec) Fr]$*

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7

**Variables of access if concept of the *tran\_gene* type**

7.1

**Extraction of a field of result**

.

Operands *TOUT\_CHAM/NOM\_CHAM*

See [§6.1].

.

Operands *TOUT\_CMP\_GENE/NUME\_CMP\_GENE*

See [§6.3]

.

Operands *TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE*

See [§6.4].

**7.2 Operands**

***INST/LIST\_INST/CRITERION/PRECISION***

Key word *INST* indicates that one wants to print the fields corresponding to a list of moments *linst*.

Key word *LIST\_INST* indicates that one wants to print the fields corresponding to a list of moments *lreel*, defined by operator *DEFI\_LIST\_REEL* [U4.34.01] (*lreel* is thus a concept of the type

*listr8*).

For *CRITERION/PRECISION* to see [§6.7] (by replacing frequency per moment).

## **8** ***Parameters of impression of the results***

### **8.1 Operand** ***SOUS\_TITRE***

*This argument makes it possible to print a title of comments.*

### **8.2 Operand** ***FORMAT***

*Format of impression of the results in the output file.*

*For the moment only the format *RESULT* is available.*

### **8.3 Operand** ***FILE***

*The results are written, by defect, on the file *RESULT*. But the user can define another output file of which it stipulates the name under the operand *FILE* and a logical number of unit by order *DEFUFI* [U4.12.01].*

### **8.4 Operand** ***INFO\_GENE***

*During the impression of a generalized concept, one can have forgotten the exact contents of the structure of data. Operand *INFO\_GENE* makes it possible to print these contents (a number of sequence numbers, lists reference symbols of the actually calculated fields, list of the reference symbols of actually calculated parameters,...).*

### **8.5 Extraction of a genealogy of the generalized model: operand** ***INFO\_CMP\_GENE***

*This key word indicates that one wants or not to print for each generalized component the name of concept *base\_modale* or *mode\_meca* from which the mode corresponding to this component results, sound type (clean or constrained), its frequency and the node of application of this mode if it is constrained.*  
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Author (S):

**E. BOYERE, J. PIGAT** Key

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## **8.6 Phase of execution**

*For the concepts `tran_gene` and `harm_gene`, one checks that the moments (frequencies) of extraction asked by operands `NUME_ORDRE`, `LIST_ORDRE`, `INST`, `LIST_INST`, (`FREQ`, `LIST_FREQ`) are in the field of definition of the concept. It is also checked that the fields stipulated by key words `TOUT_CHAM`, `NOM_CHAM`, were indeed calculated.*

*For the concept `mode_gene`, one checks that the names of the parameters specified by the key word `NOM_PARA` are quite acceptable. If the number of the mode is selected by operand `NUME_MODE`, it is checked that this number is lower than the total number of modes which define the `mode_gene`.*

## **9 Examples**

### **9.1 Impression of one**

*vect\_asse\_gene*

**IMPR\_GENE**

(**GENE =**

**\_F (**

**RESU\_GENE**

**= fgen,**

**NUME\_CMP\_GENE**

= "YES"

),  
\_F (  
RESU\_GENE  
= fgen,  
INFO\_CMP\_GENE  
= "NOT",  
NUME\_CMP\_GENE  
= 1

)

)

*The following impression is obtained:*

**CONCEPT FGEN  
OF  
TYPE  
VECT\_ASSE\_GENE**

**NUME\_CMP  
VALUE  
BASE\_MODALE  
TYPE\_MODE  
FREQUENCY  
APPLICATION**

**1  
1.00000E+00**

**BAM01\_CL  
CLEAN**

**2.25079E-01  
2**

**5.00000E-01  
BAM01\_CL  
CONSTRAINED**

**0.00000E+00**

**N03  
DX**

3

0.00000E+00

BAM02\_CL

CLEAN

2.25079E-01

4

0.00000E+00

BAM02\_CL

CONSTRAINED

0.00000E+00

N01

DX

CONCEPT FGEN

OF

TYPE

VECT\_ASSE\_GENE

NUME\_CMP VALUE

1

1.00000E+00

## **9.2 Impression**

**of one**

**mode\_gene**

IMPR\_GENE

(GENE = \_F (

RESU\_GENE

= resgen,

INFO\_GENE

=

“YES”,

NUME\_ORDRE =

1,

NOM\_PARA

=

(“FREQ”, “MASS\_GENE”, “RIGI\_GENE”),

INFO\_CMP\_GENE

= “NOT”

),

\_F (

*RESU\_GENE*  
= *resgen*,  
*NUME\_CMP\_GENE*  
= (1, 3),  
*NUME\_ORDRE*  
=  
1,  
*NOM\_PARA*  
=  
(“*FREQ*”, “*MASS\_GENE*”, “*RIGI\_GENE*”),  
*INFO\_CMP\_GENE*  
= “*YES*”  
)  
  
)

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***Code\_Aster*** ®

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7.4

*Titrate:*

*Procedure IMPR\_TABLE*

*Date:*

15/02/05

*Author (S):*

***Key COURTEOUS Mr.***

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*Organization (S): EDF-R & D /AMA*

***Instruction manual***  
***U4.9- booklet: Impression/Test***  
***Document: U4.91.03***

***Procedure IMPR\_TABLE***

***1 Goal***

***To print the contents of a table in a file.***

***The order makes it possible to print a subset of the table under various formats. The format by defect (TABLE) is practical for an examination by software of the type spreadsheet, others formats allow a direct visualization with a graph plotter (for example xmgrace or agraf).***

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***Titrate:***  
***Procedure IMPR\_TABLE***

***Date:***

**15/02/05**

**Author (S):**

**Key COURTEOUS Mr.**

**:**

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**2 Syntax**

**IMPR\_TABLE**

**(**

**COUNT**

**= matable,**

**[tabl\_\*]**

**TITRATE**

**=**

**titrate**

**[l\_Kn]**

**SENSITIVITY = (... to see [U4.50.02])**

**UNIT**

**=**

**/**

**8,**

**[DEFECT]**

**/**

**links, [I]**

**# 1. choice of the lines to be printed:**

**FILTER = (\_F (**



***NOM\_PARA***

=

***para, [kN]***

/

***CRIT\_COMP***

=

***/"EQ",  
[DEFECT]***

***/"",***

***/"LT",***

***/"WP",***

***/"IT",***

***/"GE",***

***/VALE\_I***

=

***ival,***

***[I]***

/  
**VALE\_K**

=  
*kval,*  
**[KN]**

//  
**VALE**

=  
*rval,*  
**[R]**

/  
**VALE\_C**

=  
*cval,*  
**[C]**

/  
**PRECISION** =/prec,  
**[R8]**  
/  
**1.0D-3,**  
**[DEFECT]**

/  
**CRITERION** =/"RELATIVE", **[DEFECT]**  
/  
**"ABSOLUTE",**  
/  
**CRIT\_COMP**  
=

/"MAXIMUM",  
/"ABS\_MAXI",  
/"MINI",  
/"ABS\_MINI",  
/"VACUUM",  
/"NON\_VIDE",  
),),

**# 2. choices of the columns to be printed:**

**NOM\_PARA**  
=  
**will lpara,**  
**[l\_Kn]**

**# 3. choices about the lines to be printed:**

***SORTING*** = (***\_F*** (  
***NOM\_PARA***  
=  
***will lpara,***  
***[l\_Kn]***

***ORDER***  
=  
***/"GROWING"***  
,  
***[l\_Kn]***

***/"DECREASING",***  
***),)***

**# 4. choices of the formats of impression:**

***FORMAT***  
=  
/

**“TABLE”,**  
**[DEFECT]**

/

**“ASTER”,**

**/“XMGRACE”,**

**/“AGRAF”,**

**/“TABLEAU\_CROISE”,**

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**Titrate:**

**Procedure IMPR\_TABLE**

**Date:**

**15/02/05**

**Author (S):**

**Key COURTEOUS Mr.**

**:**

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## **PAGINATION**

=  
*lpagi,*  
*[l\_Kn]*

## **FORMAT\_R**

=  
/  
**“E12.5”,**  
**[DEFECT]**  
/  
*form,*

**FORMAT\_C =/“MODULE\_PHASE”,**

**[DEFECT]**  
/  
**“REEL\_IMAG”,**

## **IMPR\_FONCTION**

=  
/  
**“NOT”,**  
**[DEFECT]**  
/  
**“YES”,**

***INFORMATION***

= /  
***1,***  
***[DEFECT]***

***/ 2,***

***# If FORMAT = “XMGRACE”***

***PILOT***

=  
/  
***“XMGRACE”,***  
***[DEFECT]***  
/  
***“POSTSCRIPT”,***  
***[KN]***

***/“EPS”,***

***/“MIF”,***

***/“SVG”,***

***/“PNM”,***

***/“Png”,***

***/“JPEG”,***

***/“Pdf”,***

***/“INTERACTIVE”,***

***# Mise in form if FORMAT = “XMGRACE”***



**CAPTION =**  
*leg,*  
**[KN]**

**STYLE**  
=  
*sty,*  
**[I]**

**COLOR =**  
*coul,*  
**[I]**

**MARKER**  
=  
*marq,*  
**[I]**

**FREQ\_MARQUEUR**  
= *Fm,*  
**[I]**

**BORNE\_X = (xmin,**  
*xmax),*  
**[l\_R]**

**BORNE\_Y = (ymin,**  
*ymax),*  
**[l\_R]**

**ECHELLE\_X**

=  
/  
**“FLAX”**,  
**[KN]**

**/“LOG”**,

**ECHELLE\_Y**

=  
/  
**“FLAX”**,  
**[KN]**

**/“LOG”**,

**GRILLE\_X**

=  
**pasx**,  
**[R]**

**GRILLE\_Y**

=  
**pasy**,  
**[R]**

**LEGENDE\_X**

=  
*legx*,  
*[KN]*

*LEGENDE\_Y*

=  
*legy*,  
*[KN]*

)

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*Titrate:*  
*Procedure IMPR\_TABLE*

*Date:*  
*15/02/05*  
*Author (S):*  
*Key COURTEOUS Mr.*  
*:*  
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*3 Operands*

*3.1 What is this*  
*that one*  
*counts?*

*A table is a structure of data of data-processing nature making it possible to store one together of whole values, real, complex or character strings.*

*A table is comparable with the worksheet of a spreadsheet, i.e. one can see it like one list columns in opposite. Each column has a field name, which we call parameter, and contains similar data of type: I, R, C, K8, K16, K24 or K32.*

*Example:*

**NUME\_ORDRE INST NODE G\_LOCAL**

1 10.

**N1**

5.

1 10.

**N2**

6.

1 10.

**N3**

7.

1 10.

**N4**

8.

2 20.

**N1**

9.

2 20.

**N2**

9.

2 20.

**N3**

8.

2 20.

**N4**

8.

3 30.

**N1**

7.

3 30.

**N2**

6.

3 30.

**N3**

5.

*One can also see the table as a succession of recordings (which we will call lines). All the lines do not have inevitably the same structure (i.e. same parameters). For example:*

***ACTION NUME\_ORDRE INST NODE DX***

***DY NET SIXX***

***ENTITLE***

*1*

*1*

***10. N1 3. 5.***

***ENTITLE***

*1*

*1*

***10. N2 6. 7.***

***ENTITLE***

*1*

*1*

***10. N3 8. 9.***

***ENTITLE 1***

*2*

*20.*

***N1***

*11.*

*12.*

***ENTITLE 1***

*2*

*20.*

***N2***

*15.*

*13.*

***ENTITLE 1***

*2*

*20.*

***N3***

*19.*

*18.*

***ENTITLE***

*2 2 20.*

***MAI***

-12.

## **ENTITLE**

2 2 20.

## **MA2**

-14.

*To print the contents of a table, the user will be able:*

.

*to select the columns and the lines which he wants to print [§3.6]*

.

*to choose a criterion of order of impression of the lines [§3.7]*

.

*to choose the “format” of impression: in lines, tables,... [§3.8]*

### **3.2 Operand**

#### **COUNT**

**COUNT** = *matable*

*Name of the table which one wants to print*

### **3.3 Operand**

#### **TITRATE**

**TITRATE** = *title*

*Character string which will be printed before the table (and the title possibly attached to count). This chain can make it possible to better distinguish from the impressions of tables put end at boils in the same file.*

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### **3.4 Operand UNIT**

*Allows to choose in which file, one prints the table.*

*By defect, UNIT = 8 what corresponds to the file .resu.*

*With format "XMGRACE", the default value is 29, standard dat in astk.*

### **3.5 Operand SENSITIVITY**

*SENSITIVITY = par\_sensi*

*Name of the associated significant parameter (see [U4.50.01])*

### **3.6 To select what one wants to print: the key words FILTERS and NOM\_PARA, TOUT\_PARA**

*The user chooses the columns to be printed thanks to key words NOM\_PARA and TOUT\_PARA. He chooses*

*lines to print thanks to the key word factor (répétable at will) FILTER.*

#### **3.6.1 Word key FILTER**

*The key word factor FILTER makes it possible to retain in the table only the lines checking certain criteria*

*imposed by the user. **The occurrences** of the key word are added the ones to the others like **successive filters**. For each occurrence of this key word, one specifies the name of the parameter for which one imposes a condition, the type of condition (equality, not-equality, smaller,...) as well as value associated with the condition.*

#### **3.6.1.1 Operand NOM\_PARA**

*NOM\_PARA = para*

*para is the name of the parameter to which the constraint of filtering relates.*

#### **3.6.1.2 Operand CRIT\_COMP**

**CRIT\_COMP** = *crit*

*crit* is the type of the constraint of filtering.

**EQ**

“equality” for the entireties, the texts, realities or the complexes.

For the floating numbers (real or complex), this equality is evaluated with a certain tolerance given by the key words **PRECISION** and **CRITERION**.

“not-equality” (cf **EQ**)

**LT**

“smaller than”

Relations of order:

- natural for the entireties and realities

- alphabetical for the texts

- **invalid** for the **complexes**

**WP**

“larger than” (cf **LT**)

“smaller or equal to” (cf **LT**)

**GE**

“larger or equal to” (cf **LT**)

**VACUUM**

blank cell

**NON\_VIDE**

nonempty cell

**MAXIMUM**

the line selected will be that which will have the maximum value

**ABS\_MAXI**

the line selected will be that which will have the maximum absolute value

**MINIS**

the line selected will be that which will have the minimal value

**ABS\_MINI**

the line selected will be that which will have the minimal absolute value

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### **3.6.1.3 Operands**

**VALE/VALE\_I/VALE\_C/VALE\_K**

*These various key words are used according to the type of the column associated with the parameter on which carries the constraint: entirety, reality, complex or text.*

*One gives in argument the value associated with the constraint; for example 12 if one is interested only in sequence number 12.*

*This operand is useless when the types of constraint are used: "VACUUM", "NON\_VIDE", "MAXIMUM", "MINI",...*

### **3.6.1.4 Operands**

**CRITERION/PRECISION**

*When the constrained parameter is of floating type (real or complex) and that the type of constraint is the equality (or not-equality), this equality is evaluated with a certain tolerance.*

*PRECISION = eps,*

*eps is the tolerance*

*"RELATIVE" CRITERE=/,*

*|x-xref| < eps\*|xref|*

*/"ABSOLUTE"*

*,*

*|x-xref|*

*<*

*eps*

### **3.6.1.5 Example**

***of use of the key word FILTERS***

*If one specifies:*

```
FILTRE= (_F (NOM_PARA= "NODE", VALE_K = "N7"),
_F (NOM_PARA= "INST", CRIT_COMP= "WP", VALE= 3.0),
_F (NOM_PARA= "INST", CRIT_COMP= "LT", VALE= 13.0),
),
```

*One thus selects the lines of the table such as the parameter NODE is worth "N7" and such as parameter INST lies between 3. and 13.*

### **3.6.2 Operand**

#### **NOM\_PARA**

*If key word NOM\_PARA misses, **all the** columns of the table will be printed.*

*If the user uses the key word NOM\_PARA = will lpara, only the specified parameters will be printed in the list will lpara and the order of the list.*

### **3.7**

*To order the lines of a table: the key word TRI factor*

*Only one occurrence is accepted for the key word TRI factor.*

#### **3.7.1 Operand NOM\_PARA = will lpara**

*This key word is used to specify the list of the parameters which will be used to order the lines of the table (it can y to need several parameters). In the event of equality on the first parameter, one uses it according to...*

*Note:*

*One can use for the sorting of the parameters which one does not print.*

#### **3.7.2 Operand ORDER**

*This key word is used to specify if one must use an order ascending or decreasing. By defect, one sorts by ascending order.*

*The relations of order used are:*

*.  
the natural order for the entirities and realities,  
.*

*the alphabetical order for the texts and the names of concepts.*

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*Note:*

*One cannot be useful oneself of a parameter complexes to classify the lines of a table.*

*For the parameters of the NODE type (or NETS), the order is alphabetical because these parameters contain the name of the nodes (or meshes).*

### *3.7.3 Example of use of the TRI key word*

*If one specifies:*

*TRI=\_F (NOM\_PARA= (“NODE”, “INST”), ORDRE= “GROWING”),*

*One will print the lines of the table in the alphabetical order of the nodes. If there are several lines correspondent with a given node, the second sort criterion (INST) will be used to classify these lines.*

## *3.8*

*Choice of the format of impression: key words FORMAT, PAGINATION,...*

*By defect the format of impression is the format “TABLE”, i.e. presentation in columns of various selected parameters (as for the examples of this document). Software EXCELTM offer a whole of tools allowing to exploit this type of file: dynamic sorting, filtering, tables,*

*...*

### 3.8.1 *FORMAT = "TABLE" or "AGRAF"*

*An example of table printed with the format "TABLE":*

*NUME\_ORDRE INST NODE DX DY*

1  
**4. N7 3.4**  
 3.8  
 1  
**4. N4 2.4**  
 2.8  
 1  
**4. N2 1.4**  
 1.8  
 4  
**8. N7 3.4**  
 3.8  
 4  
**8. N4 2.4**  
 2.8  
 4  
**8. N2 1.4**  
 1.8  
 7 20.  
**N7**  
 3.4  
 3.8  
 7 20.  
**N4**  
 2.4  
 2.8  
 7 20.  
**N2**  
 1.4  
 1.8

*The only difference between the format "TABLE" and format "AGRAF" is that for this last, the columns of "text" (for example NODE above) are preceded by a" \ ".*

*Note:*

*With format AGRAF, any directive (file .digr) is not produced, only the values (file .dogr) is it.*

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### **3.8.2 FORMAT = "ASTER"**

**The difference between the format "ASTER" and the format "TABLE" is the heading of the table and its last**

**line. This difference is justified by fact qu`a table printed with the format "ASTER" can be read again by Code\_Aster (order LIRE\_TABLE [U7.02.03]).**

**Example:**

**#DEBUT\_TABLE**

**#TITRE ASTER 6.03.11 CONCEPT TAB\_REAC CALCULATES THE 12/07/2002**

**#TITRE TABL\_POST\_RELE**

**ENTITL RESU NOM\_CHAM NUME\_ORD INST DY**

**K8 K8 K16 I R R**

**MESSAGE RESU REAC\_NODA 1 2.50000E-01 -2.25146E+00**

**MESSAGE RESU REAC\_NODA 2 5.00000E-01 -4.44089E+00**

**MESSAGE RESU REAC\_NODA 3 7.50000E-01 -6.59515E+00**

**MESSAGE RESU REAC\_NODA 4 1.00000E+00 -8.65972E+00**

**MESSAGE RESU REAC\_NODA 5 1.25000E+00 -1.06742E+01**

**MESSAGE RESU REAC\_NODA 6 1.50000E+00 -1.26438E+01**

**MESSAGE RESU REAC\_NODA 7 1.75000E+00 -1.45569E+01**

**#FIN\_TABLE**

### **3.8.3 FORMAT = "TABLEAU\_CROISE"**

***Format “TABLEAU\_CROISE” is reserved for the tables at double entry. The impression is done under form of a table which one documented the names of columns and the names of lines. This impression relates to the tables having 3 parameters. One represents the values of the one of the 3 parameters according to the 2 others.***

***Example: DX according to NODE and INST:***

***DX FUNCTION OF NODE AND INST***

***4.  
8.  
20.  
NOEUD/INST N7  
3.4  
3.4  
3.4  
N4  
2.4 2.4  
2.4  
N2  
1.4 1.4  
1.4***

***NOM\_PARA = (“NODE”, “INST”, “DX”)***

***The parameter “filling out” the table is 3rd list indicated by single-ended spanner word NOM\_PARA. The parameter “X-coordinate” is 2nd list indicated by single-ended spanner word NOM\_PARA. The parameter “ordered” is 1st list indicated by single-ended spanner word NOM\_PARA.***

***Note:***

***If the table contains more than 3 parameters, one can use the key word PAGINATION for “to shell” the values taken by the other parameters (see example 3).***

***3.8.4 FORMAT = “XMGRACE”***

***This format makes it possible to produce a directly displayable file in xmgrace in the form of curve.***

***One has the same functionalities of working as in IMPR\_FONCTION.***

***If PILOT is not specified, one produces a data file for xmgrace; if PILOT is informed and if the selected pilot is indeed available on the machine, one can produce directly a file postscript, png,...***

***Key words of working of the graph: to see IMPR\_FONCTION [U4.33.01].***

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### **3.8.5 Operand PAGINATION**

*This key word is used to print a table per pieces (like a whole of smaller tables). One give a parameter list (lpagi) which will be shelled and printed like titles of small tables.*

*The list of the parameters of pagination (lpagi) must be included in the complete list of the parameters that one wants to print (will lpara).*

*If one wants to use the pagination and format “TABLEAU\_CROISE”, one needs that the list will lpara, once that the parameters of lpagi were withdrawn to him is made of 3 residual parameters. These 3 parameters will be used for the presentation in table [§3.4.3].*

*Example: FORMAT= `TABLEAU', PAGINATION = “NODE”*

*NODE: N7*

*NUME\_ORDRE INST*

*DX*

*DY*

*1 4.*

*3.4*

*3.8*

*4 8.*

*3.4*



3.8  
7 20.  
3.4  
3.8

*NODE: N4*

*NUME\_ORDRE INST*  
*DX*  
*DY*  
1 4.  
2.4  
2.8  
4 8.  
2.4  
2.8  
7 20.  
2.4  
2.8

*NODE: N2*

*NUME\_ORDRE INST*  
*DX*  
*DY*  
1 4.  
1.4  
1.8  
4 8  
1.4  
1.8  
7 20.  
1.4  
1.8

### **3.8.6 Operand** **FORMAT\_C**

*For the complexes, two formats of impression are available (module/phase by defect or part real/left imaginary).*

### **3.8.7 Operand** **FORMAT\_R**

*This key word makes it possible to choose the number of decimals printed for each floating number: (reality or complex).*

*One uses for that the syntax of FORTRAN.*

*For example, for the default value: “E12.5”, one will print each floating number on 12 characters, with 5 decimals and in scientific notation (with an exhibitor).*

### **3.8.8 Operand**

#### **IMPR\_FONCTION**

*For the tables containing in their cells of the names of function, this key word makes it possible to indicate that one wants to also print the **contents** of the functions referred in the table.*

*One prints initially the table (as it was seen above) then one “buckles” on all the functions contained in the printed part of the table and one these functions (like does it the order prints IMPR\_FONCTION).*

### **3.9 Operand**

#### **INFORMATION**

*INFORMATION = inf*

*Print in the file “message” of additional information if inf=2. Nothing occurs if inf=1.*

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## **4 Examples**

**Example 1: to discover the structure of a table**

```
IMPR_TABLE (TABLE = POST_REL)
```

**Example 2: to print some parameters with filter and sorting**

```
IMPR_TABLE (TABLE = POST_REL,  
FILTRE=_F (NOM_PARA=' INST', VALE= 0. ,  
CRITERION = "ABSOLUTE"),  
TRI=_F (NOM_PARA= ("ABS_CURV", "COOR_X"), ORDRE= ("GROWING"),  
NOM_PARA = ("COOR_X", "TEMP"),  
)
```

**Example 3: to use the pagination and format TABLEAU\_CROISE**

```
IMPR_TABLE (TABLE = POST_REL,  
NOM_PARA = ("COOR_X", "TEMP", "ABS_CURV", "INST", "COOR_Y"),  
PAGINATION= ("INST", "COOR_X"),  
FORMAT = "TABLEAU_CROISE",  
)
```

**Example 4: to print the contents of derived from the G1 table compared to the significant parameter YOUNG:**

```
IMPR_TABLE (TABLE = G1, SENSITIVITY = YOUNG)
```

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**Author (S):**

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***U4.9- booklet: Impression of the results and tests***

***Document: U4.91.11***

***Procedure IMPR\_CO***

***1 Goal***

***To print all the objects JEVEUX which constitute an existing concept.***

*This order is intended above all for the “debugage”. Contents of objects JEVEUX that one print comprehensible in theory only by developers is not provided with their documentation D.*

*In particular, the format of these objects can change without dialogue with the users. It is thus very be likely to use these writings in “postprocessings” or “chainings” towards other codes.*

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**2 Syntax**

***IMPR\_CO*** (

***/CO***

=

***concept,***

***[l\_nom\_concept]***

***/CHAINS =***

***chain,***

***[K24]***

***POSITION***

***=/ipos, [I]***

***/I, [DEFECT]***

***ATTRIBUTE***

***=/"NOT"***

***,***  
***[DEFECT]***

***/"YES"***

***,***

***CONTENTS***

=

***/“YES”***

,

***[DEFECT]***

***/“NOT”***

,

***BASE***

=

***/“G”***

,

***[DEFECT]***

***/bases,***

***[K1]***

**LEVEL**

= / 2

,  
**[DEFECT]**

/ 1 ,

/ 0 ,

**FILE**

=  
/“**RESULT**”, **[DEFECT]**



*/nomfi*

,  
*[K8]*

*UNIT*

= / 8

,  
*[DEFECT]*

*/numfi,*

)

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### **3 Operands**

#### **3.1 Operand**

**CO**

**/CO**

**=**

**List names of concepts “user” to print.**

#### **3.2 Operands**

**CHAINS/POSITION**

**/CHAINS**

**The user can give a text (between “quotes”) length lower than 24 characters: order will then print all the objects having in their name the character string: chain in position ipos (see key word POSITION).**

**Examples:**

**1) CHAINS = “TOTO1234”, POSITION = 1**

**to CO = TOTO1234 is equivalent**

**2) CHAINS = “.DESC”**

**, POSITION = 20,**

*allows to print all the objects whose name ends in “.DESC”.*

***POSITION = ipos,***

*This entirety defines the position of the beginning of the chain to be sought in the name of the objects existing.*

***3.3 Operand  
ATTRIBUTE***

***ATTRIBUTE***

***=***

*One can choose to print (or not) the attributes of selected objects JEVEUX.*

***3.4 Operand  
CONTENTS***

***CONTENTS***

***=***

*One can choose to print (or not) the contents of the selected objects.*

***3.5 Operand  
BASE***

***BASE = bases***

*One will not print that objects JEVEUX found on the basis bases. If one wants to obtain the objects finding on the whole of the bases (“G”, “V”, “It), one will use **BASE = ’**(“white” character).*

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**3.6 Operand**

**LEVEL**

**LEVEL**

**=**

**0: only the names of the objects are printed,**

**1: one prints only the first 5 objects of each collection of objects JEVEUX,**

**2: all is printed.**

**3.7 Operand**

**UNIT**

**UNIT**

**=**

**Logical number of unit associated the file on which must be printed the selected objects (this name must be a name already defined by the orders BEGINNING, CONTINUATION or DEFI\_FICHER).**

**By defect, the impression is carried out on the logical unit 8 which is associated the file "RESULT".**

**4 Examples**

**Example 1**

**IMPR\_CO**

**(CO = (my, Mo, ch1))**

*Impression of the concepts: my, Mo, ch1. The attributes of the objects will not be written.*

*Example 2*

```
IMPR_CO  
(CHAINS = "&", POSITION = 1, LEVEL = 0  
, = "V BASES",  
FILE  
=  
"MESSAGE"  
,)
```

*Impression of the names of the objects of the volatile base starting with "&".*

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*04/01/05*

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*Key J.P. LEFEBVRE*

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***U4.9- booklet: Impression of the results and tests***

***Document: U4.91.21***

***Procedure IMPR\_JEVEUX***

***1 Goal***

***To print the contents of the objects created by the Manager of memory JEVEUX. Useful for maintenance and the debugging of the new developments.***

***To print the contents of objects JEVEUX, to reach the system objects of JEVEUX, to print it repertory of the objects associated with a base, to print the segmentation memory or to reach the contents of a base stored on disc.***

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**Key J.P. LEFEBVRE**

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**2 Syntax**

**IMPR\_JEVEUX**

**(ENTITY**

**=/"OBJECT"**

**NOMOBJ**

**=**

**nomobj**

**,**

**[K24]**

**/NOMOC = nomoc, [K24]**

**/**

**NUMOC**

**=**

**numoc**

**,**

**[I]**

/  
“*ATTRIBUTE*”

*NOMOBJ*  
=  
*nomobj*  
,  
[K24]

*NOMATR*  
=  
*nomatr*  
,  
[K8]

/  
“*SYSTEM*”

*CLASSIFY*



=  
***nomclass***  
,  
***[K1]***

***NOMATR***  
=  
***nomatr***  
,  
***[K8]***  
  
/  
***“MEMORY”***

/  
***“REPERTORY”***

***CLASSIFY***  
=  
***nomclass***  
,  
***[K1]***  
  
/  
***“DISC”***

**CLASSIFY**

=

**nomclass**

,

**[K1]**

**IMPRESSION = \_F (/NAME**

=

**nomfic**

,

**[K8]**

/

**UNIT**

=

**numfis**

,

**[I]**

),

**COMMENT**

=

**cmt**

,

**[l\_Kn]**

)

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***Code\_Aster*** ®

***Version***

***7.4***

***Titrate:***

***Procedure IMPR\_JEVEUX***

***Date:***

***04/01/05***

***Author (S):***

***Key J.P. LEFEBVRE***

***:***

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***3 Operands***

***3.1 Operand***

***ENTITY***

***ENTITY***

***=***

***/“OBJECT”,***

***Call to JEIMPO, JEPRAT (values of an object,...),***

***/“ATTRIBUTE”,***

***Call to JEIMPA (attributes of an object or a collection),***

***/“SYSTEM”,***

***Call to JEPRAT (attributes of a collection or system objects),***

***/“MEMORY”,***

***Call to JEIMPM (state of the memory),***

***/“REPERTORY”, Call to JEIMPR (repertory of one or more classes),***

***/“DISC”,***

***Call to JEIMPD (objects written on disc).***

***The possibilities offered by the various routines of impression are described in the booklet:  
Management memory JEVEUX [D6.02.01].***

***NOMOBJ = nomobj,***

*Simple name of object or collection.*

***NOMOC =***

***nomoc,***

*Name of object of collection.*

***NUMOC =***

***numoc,***

*Number of object of collection.*

***NOMATR = nomatr,***

*Name of attribute on 8 characters for:*

.

*a collection:*

***\$\$DESO, \$\$IADD, \$\$IADM, \$\$NOM, \$\$LONG, \$\$LONO,  
\$\$LUTI, \$\$NUM.***

.

*the system:*

***\$\$CARA, \$\$IADD, \$\$GENR, \$\$TYPE, \$\$MARQ, \$\$DOCU, \$\$ORIG, \$\$RNOM,  
\$\$LTYP, \$\$LONG, \$\$LONO, \$\$DATE, \$\$LUTI, \$\$HCOD, \$\$INDX,  
\$\$TLEC, \$\$TECR, \$\$IADM, \$\$ACCE, \$\$USADI.***

***CLASSIFY = nomclass,***

*Name of the class associated with one or more bases with values (“G”, “V”, “It). For the entity “SYSTEM” this word key is obligatory. For the entities “REPERTORY” and “DISC” one prints by defect what relates to all the open bases.*

### ***3.2 Operand***

#### ***IMPRESSION***

*By defect the impressions are directed towards the file “MESSAGE”*

***IMPRESSION***

=

*NAME*

=

*nomfic*

*Internal name of file, is worth "MESSAGE" or "RESULT".*

*UNIT = numfis*

*Logical number of unit.*

### **3.3 Operand**

#### **COMMENT**

*COMMENT = text seeming titrates required impressions.*

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#### **Code\_Aster ®**

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#### **4 Example**

*of use*

*IMPR\_JEVEUX (ENTITY = "OBJECT" NOMOBJ = "MA .NOMMAI")*

*% -----*

*% ORDERS NO: 0003*

*% -----*

*%*

*IMPR\_JEVEUX (*

ENTITY = "OBJECT"

NOMOBJ = "MA .NOMMAI"

)

WRITING OF THE SUBJECT: "MA .NOMMAI"

<X> <JEIMPA> IMPRESSION OF THE ATTRIBUTES OF >MA .NOMMAI <  
> <

CLAS STANDARD >G< GENR >N< >K< LTY 8 DOCU > < DATE 0 ORIG > <  
NOMMAX 283 NOMUTI 283 LONO 479 IADM 1790069 IADD 0 LADD 0 USE  
>X D<

CONTENTS OF THE SUBJECT: "MA .NOMMAI"

SEGMENT IMPRESSION OF VALUES >MA .NOMMAI <

>>>>

1 - >M286 <>M287 <>M288 <>M289 <>M290 <>M291 <>M292 <

8 - >M293 <>M294 <>M295 <>M296 <>M297 <>M298 <>M299 <

15 - >M300 <>M301 <>M302 <>M303 <>M304 <>M305 <>M306 <

22 - >M307 <>M308 <>M309 <>M310 <>M311 <>M312 <>M313 <

29 - >M314 <>M315 <>M316 <>M317 <>M318 <>M319 <>M320 <

36 - >M321 <>M322 <>M323 <>M324 <>M325 <>M326 <>M327 <

43 - >M328 <>M329 <>M330 <>M331 <>M332 <>M333 <>M334 <

50 - >M335 <>M336 <>M337 <>M338 <>M339 <>M340 <>M341 <

57 - >M342 <>M343 <>M344 <>M345 <>M346 <>M347 <>M348 <

64 - >M349 <>M350 <>M351 <>M352 <>M353 <>M354 <>M355 <

71 - >M356 <>M357 <>M358 <>M359 <>M360 <>M361 <>M362 <

78 - >M363 <>M364 <>M365 <>M366 <>M367 <>M368 <>M369 <

85 - >M370 <>M1 <>M2 <>M3 <>M4 <>M5 <>M6 <

92 - >M7 <>M8 <>M9 <>M10 <>M11 <>M12 <>M13 <

99 - >M14 <>M15 <>M31 <>M32 <>M33 <>M34 <>M35 <

106 - >M36 <>M37 <>M38 <>M39 <>M40 <>M41 <>M42 <

113 - >M43 <>M44 <>M45 <>M46 <>M47 <>M48 <>M49 <

120 - >M50 <>M51 <>M52 <>M53 <>M54 <>M55 <>M56 <

127 - >M57 <>M58 <>M59 <>M60 <>M61 <>M62 <>M63 <

134 - >M64 <>M65 <>M66 <>M67 <>M68 <>M69 <>M70 <

141 - >M71 <>M72 <>M73 <>M74 <>M75 <>M76 <>M77 <

148 - >M78 <>M79 <>M80 <>M81 <>M82 <>M83 <>M84 <

155 - >M85 <>M86 <>M87 <>M88 <>M89 <>M90 <>M91 <

162 - >M92 <>M93 <>M94 <>M95 <>M96 <>M97 <>M98 <

169 - >M99 <>M100 <>M101 <>M102 <>M103 <>M104 <>M105 <

176 - >M106 <>M107 <>M108 <>M109 <>M110 <>M111 <>M112 <

183 - >M113 <>M114 <>M115 <>M116 <>M117 <>M118 <>M119 <

190 - >M120 <>M121 <>M122 <>M123 <>M124 <>M125 <>M126 <

197 - >M127 <>M128 <>M129 <>M130 <>M131 <>M132 <>M133 <

204 - >M134 <>M135 <>M136 <>M137 <>M138 <>M139 <>M140 <

211 - >M141 <>M142 <>M143 <>M144 <>M145 <>M146 <>M147 <

218 - >M148 <>M149 <>M150 <>M151 <>M152 <>M153 <>M154 <  
225 - >M155 <>M156 <>M157 <>M158 <>M159 <>M160 <>M161 <  
232 - >M162 <>M163 <>M164 <>M165 <>M166 <>M167 <>M168 <  
239 - >M169 <>M170 <>M171 <>M172 <>M173 <>M174 <>M175 <  
246 - >M176 <>M177 <>M178 <>M179 <>M180 <>M181 <>M182 <  
253 - >M183 <>M184 <>M185 <>M186 <>M187 <>M188 <>M189 <  
260 - >M190 <>M191 <>M192 <>M394 <>M395 <>M396 <>M397 <  
267 - >M398 <>M399 <>M400 <>M401 <>M402 <>M403 <>M1999 <  
274 - >M2000 <>M2001 <>M2002 <>M2003 <>M2004 <>M2005 <>M2006 <  
281 - >M2007 <>M2008 <>M2009 <

*END OF THE SUBJECT: "MA .NOMMAI"*

*% FINE ORDERS: IMPR\_JEVEUX TOTAL DURATION: 0.00 S. (SYST: 0.00 S.)*

*% -----*

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**Code\_Aster** ®

*Version*

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*Titrate:*

*Procedure TEST\_RESU*

*Date:*

31/01/06

*Author (S):*

**J. Key PELLET**

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*Organization (S): EDF-R & D /AMA*

***Instruction manual***

***U4.9- booklet: Impression/Test***

***Document: U4.92.01***

***Procedure TEST\_RESU***

***1 Goal***



*To compare a value extracted from a structure of data with a value of reference provided by the user.*

*This order makes it possible to test a numerical value: entirety, reality or complex extracted from one concept already calculated. Today, one can test a component of a `cham_no_*` or one `cham_elem_*`, a component of a field extracts from a result, a parameter of a result, a “total” value extracted from a field or contents from an unspecified object from a concept user.*

*The procedure writes a conventional message then:*

.  
“OK” (if it is good),  
.  
“NOOK” (if not).

*follow-up of the found value, the value of reference and percentage of error.*

*Orders TEST\_FONCTION [U4.92.02] and TEST\_TABLE [U4.92.03] make it possible to test them values extracted from the functions and the tables.*

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*2 Syntax*

*TEST\_RESU (*

**UNIT**

=

/

8

,

**[DEFECT]**

/

**iunit,**

,

**[I]**

/

**CHAM\_NO= (\_F (**

**CHAM\_GD**

=

**chno,**

**[cham\_no\_\*]**

/

**TYPE\_TEST =/"SOMM\_ABS",**

/

**"SOMM"**

,

/

**"MAX"**

,

/

**"MIN"**

,

***NOM\_CMP***

=

***lcmp,***  
***[l\_K8]***

***//NODE =***

***No,***

***[node]***

/

***GROUP\_NO***

= ***grno,***

***[group\_no]***

***NOM\_CMP =***

***nomcmp,***

***[K8]***

***# See definition of the value of reference***

),)

/  
**CHAM\_ELEM**= (\_F  
(  
**CHAM\_GD**  
=  
**chel**,  
**[cham\_elem\_\*]**

/  
**TYPE\_TEST** =/"SOMM\_ABS",  
/  
**"SOMM"**  
,  
/  
**"MAX"**  
,  
/  
**"MIN"**  
,

**NOM\_CMP**  
=

**lcmp,**  
**[l\_K8]**

**/**  
**NET**

**=**  
**my**  
**,**  
**[mesh]**

**/NOT = nupoint,**

**[I]**  
**/**  
**NODE**

**=**  
**No**  
**,**  
**[node]**  
**/**  
**GROUP\_NO**  
**=**  
**grno,**  
**[group\_no]**

***NOM\_CMP = nomcmp,***

***[K8]***

***# See definition of the value of reference***

***),),***

***/  
RESU = (\_F (RESULT  
= LMBO  
,  
[resultat\_\*]***

***SENSITIVITY = (... to see [U4.50.02])***

***/  
NUME\_ORDRE***

=  
**nuor,**  
**[I]**  
/  
**NUME\_MODE**

=  
**numo,**  
**[I]**  
/  
**INST**

=  
**inst,**  
**[R]**  
/  
**FREQ**

=  
**freq,**  
**[R]**  
/  
**NOEUD\_CMP**

=  
**(node,**  
**cmp),**  
**[l\_Kn]**  
/  
**NOM\_CAS**

=  
**nocas,**  
**[KN]**

/

**ENG**

=

,

**[R]**

**/PARA = para, [K16]**

/

**NOM\_CHAM**

=

**nosymb,**

**[K16]**

/

**TYPE\_TEST =/"SOMM\_ABS",**

/

**"SOMM"**

,

/

**"MAX"**

,

/



**“MIN”**

,

***NOM\_CMP =  
lcmp,***

***[l\_K8]***

***//NODE = No,***

***[node]***

***/***

***GROUP\_NO***

***=***

***grno, [group\_no]***

***/MESH = my,***

***[mesh]***

***/NOT = nupoint, [I]***

***/***

***NODE***

***=***

***No,***

***[node]***

***/***

***GROUP\_NO***

***=***

***grno,***

***[group\_no]***

***NOM\_CMP = nomcmp,***

***[K8]***

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**# See definition of the value of reference**

**),),**

**/**  
**GENE = (\_F (/RESU\_GENE**  
**= LMBO**

**,**  
**[VECT\_ASSE\_GENE]**

**NUME\_CMP\_GENE**

**=**  
**ncmp,**  
**[I]**

**/RESU\_GENE**  
**= LMBO**

**,**

**[HARM\_GENE]**

**[MODE\_GENE]**

**/PARA = para, [K16]**

**/**

**NOM\_CHAM**

**=**

**nosymb,**

**[K16]**

**NUME\_CMP\_GENE = ncmp,**

**[I]**

**/NUME\_ORDRE = nuor,**

**[I]**

**/**

**NUME\_MODE**

**=**

**numo, [I]**

/  
**FREQ**

=  
**freq,**  
**[R]**

**/RESU\_GENE**  
**= LMBO**

,  
**[TRAN\_GENE]**  
**NOM\_CHAM**

=  
**nosymb,**  
**[K16]**

**NUME\_CMP\_GENE**  
**=**  
**ncmp,**  
**[I]**

**/NUME\_ORDRE = nuor,**

**[I]**  
**/**  
**INST**

=  
*inst*,  
*[R]*

*# See definition of the value of reference*

),),

/  
*OBJECT = (\_F (*

*NAME*  
=  
*nomobj*  
,  
*[K24]*  
/  
*S\_I*  
=  
*vali*  
,

**[I]**  
/  
**S\_R**  
=  
**valr**  
,  
**[R]**

**PRECISION**  
=  
/  
**1.D-3**  
,  
**[DEFECT]**  
/  
**prec**  
,  
**[R]**

**CRITERION =/"RELATIVE",**

**[DEFECT]**  
/  
**"ABSOLUTE"**  
,

*# See definition of the value of reference*

),),

)

*# Definition of the value of reference*

**REFERENCE** =/“ANALYTICAL”,  
/  
“NON\_REGRESSION”  
,

**VERSION** = towards,  
[KN]  
/  
“SOURCE\_EXTERNE”  
,

/  
“AUTRE\_ASTER”  
,

/  
**VALE**

=  
**valley**  
,



**[R]**  
/  
**VALE\_C**  
=  
**valley**  
,  
**[C]**  
/  
**VALE\_I**  
=  
**valley**  
,  
**[I]**

**VALE\_ABS**  
=  
/  
**“NOT”**  
,  
**[DEFECT]**  
/  
**“YES”**  
,

**// PRECISION**  
=  
/  
**1.0D-3**  
,  
**[DEFECT]**  
/  
**prec**  
,  
**[R]**

**/ CRITERION**

=

/

**“RELATIVE”**

,

**[DEFECT]**

/

**“ABSOLUTE”**

,

/|

**PRECISION =/(prec1, prec2),**

**[l\_R]**

/

**CRITERION =/(crit1, crit2),**

**[l\_Kn]**

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**Note:**

*The type of the concepts which one can test is not checked by the order. A priori, the key word CHAM\_NO makes it possible to test all the types of cham\_no, in the same way for key words CHAM\_ELEM and RESU (for the concepts of the result type).*

### **3 General information**

*This order makes it possible to test a scalar numerical value recovered in a concept of the type cham\_no\*, cham\_elem\_\* or result, compared to a value of reference provided by the user.*

*Three types of numerical values can be tested:*

.  
*a component of a field (cham\_no or cham\_elem or field belonging to one result),*

.  
*a parameter contained in a concept of result (see booklet [U5.01]),*

.  
*a total value of a field [§4.5].*

*To test a component of field, it is necessary to choose a field [§4.2] then to choose a component [§4.3].*

*To test a parameter, it is necessary to choose a sequence number [§4.2.4] and to choose the name of the parameter.*

*The awaited numerical value (real, complex or whole) is provided in accordance with [§4.7].*

*Remarks concerning the tests in the structures of “generalized” data:*

*One can test the generalized components (displacements, speeds or accelerations of one transient in modal space). It is advisable nevertheless to be circumspect with this type of test. In effect the value of a generalized component depends entirely on the standard of the mode. However this one is given in an arbitrary way. Thus without preliminary standardization of the standards, value of a generalized size is arbitrary. Lastly, it there not of possibility in Code\_Aster*

*to fix the direction of a mode. For a multiple mode, that wants to say that, even once them normalized modes, a generalized size can take an unspecified value. In the case of one simple mode, it can be directed in a direction or the opposite direction. One obtains then a generalized value or its opposite.*

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## **4 Operands**

### **4.1 Operand**

**UNIT**

**UNIT = iunit**

***Number of the logical unit of the file where the impression (by defect will be done: RESULT).***

### **4.2**

***Selection of a field***

***In order to test a field which can be a simple field (cham\_no or cham\_elem), or a field extracted from a result, or will use the key words factors: CHAM\_NO, CHAM\_ELEM or RESU.***

#### **4.2.1 "Simple" fields**

**CHAM\_GD = field**

***Name of the cham\_no or the cham\_elem which one wants to extract a value.***

#### **4.2.2 Operand**

##### **RESULT**

**RESULT = LMBO**

*Name of the concept treated result.*

#### **4.2.3 Operand**

##### **SENSITIVITY**

**SENSITIVITY = par\_sensi**

*Name of the significant parameter. See [U4.50.22] for the details*

#### **4.2.4 Operand**

##### **NOM\_CHAM**

**/NOM\_CHAM = nosymb**

*Reference symbol of the field to be selected (see booklet [U5.01]).*

#### **4.2.5 Selection**

*of a sequence number*

**/NUME\_ORDRE = nuor,**

*Sequence number of the field (or the parameter) required.*

**/NUME\_MODE = numo,**

**/INST = inst,**

**/FREQ = freq,**

**/NOEUD\_CMP = (node, cmp),**

**/NOM\_CAS = nocas,**

**/ENG =,**

*These key words make it possible to identify a sequence number in a result [U4.71.00].*

*They are called “variables of access”.*

*They all are not valid for all the types of result.*

*For a type of result given, its variables of access are given in [U5] documentation of use.*

*When the access is not made an actual value (ENG, FREQ, INST) the value given does not have not to be ambiguous (cf [§4.7]).*

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*4.3*

*Selection of a parameter in a result*

*To select a parameter in a result (see booklet [U5.01]), the number should be specified of a desired nature [§4.2.4] and to give the name of the parameter.*

*PARA = para*

*Name of the sought parameter. This name is attached to the type of the concept treated result.*

*4.4*

*Selection of a component of a field*

*The access to a size is done for a cham\_no by:*

*.*  
*the name of the node which carries this size.*

*The access to a size is done for a cham\_lem by:*

*.*

*the name of the mesh which supports the element,*

*something which specifies:*

*- that is to say the name of a node of this mesh for the cham\_elem “with the nodes” (\_ELNO\_).*

*- that is to say the number of the point of GAUSS for the cham\_elem “at the points of GAUSS” (\_ELGA\_).*

*NET = my*

*Name of the mesh where one wants to test the cham\_elem.*

*/NODE = No*

*Name of the node which one wants to check a component.*

*/GROUP\_NO = grno*

*To facilitate the use of this order, one can replace the key word NODE by GROUP\_NO.*

*In this case, it is necessary that the group is reduced to only one node.*

*/NOT = nupoint*

*The entirety nupoint specifies the number of the point of GAUSS which one wants to test the value (case cham\_elem “at the points of GAUSS”).*

*NOM\_CMP = nomcmp*

*Name of the component which one wants to test [U2.01.04].*

**4.5**

*To test a field “overall”*

*Once a selected field [§4.2], one can test a quantity calculated overall on all it field. One can restrict the field on certain components (key word NOM\_CMP):*

*NOM\_CMP*

*=*

*lcmp*

[l\_K8]

*If NOM\_CMP is not indicated, the whole of the components will be taken. If not, one will not take in account that components of lcmp.*

*/TYPE\_TEST = "SOMM\_ABS"*

*The sum of the absolute values of the components of the field.*

*/TYPE\_TEST = "SOMM"*

*The sum of the values of the components of the field.*

*/TYPE\_TEST = "MAX"*

*The maximum of the values of the components of the field.*

*/TYPE\_TEST = "MIN"*

*Minimum of the values of the components of the field.*

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*4.6*

*To test the contents of an object JEVEUX*

*This functionality is reserved for the developers of the Code. To use it, the names should be known objects JEVEUX composing the concepts of the user. It is intended to check not regression of the structures of data other than the RESULT, FIELDS, TABLE and FUNCTION.*



#### **4.6.1 Operand**

##### **NAME**

**NAME = nomobj**

**Name of the jeveux object which one wants to test.**

#### **4.6.2 Operands**

##### **S\_I/S\_R**

**S\_I = vali**

**For the objects of the whole type, summons values contained in the object.**

**S\_R = valr**

**For the objects of the type real (or complex), nap of the values of the numbers contained in the object.  
For the complex numbers, one makes the sum of the parts real and imaginary.**

**Note:**

**The objective of this type of test (NAME + S\_I or S\_R) is to test a whole vector overall.  
“nap” which is tested is unfortunately a bad “check sum” of the object: one  
permutation within the vector does not change this sum. A more careful test consists with  
to print the object in a file (IMPR\_CO) then to test the contents of this file with a truth  
“check sum” (TEST\_FICHER).**

#### **4.6.3 Operands**

##### **CRITERION and PRECISION**

**See below [§4.7].**

#### **4.7**

**Definition of the value of reference**

**REFERENCE =**

**/“ANALYTICAL”:**

**the provided value of reference is “analytical”**

**/“NON\_REGRESSION”:**

**the provided value of reference was obtained at the time of a precedent  
calculation by Code\_Aster**

**VERSION =**

*towards*

*worms is the number of the version of Aster which made it possible to obtain value of reference (ex: "5.3.4")*

**/“SOURCE\_EXTERNE”:**

*the provided value of reference comes from a different program that Aster (or of a bibliographical reference)*

**/“AUTRE\_ASTER”:**

*the provided value of reference is that obtained by another way Aster (another order, option of calculation,...)*

**/VALE = valley**

*Actual value awaited for the component nomcmp, the parameter para or the nomobj object.*

**/VALE\_C = valley**

*Complex value awaited for the component nomcmp or the parameter para.*

**/VALE\_I = valley**

*Whole value awaited for the parameter para or the nomobj object.*

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## **VALE\_ABS**

=

= **“NOT”**

*the value of reference and the computed value by Aster are compared just as they are.*

= **“YES”**

*the value of reference and the computed value by Aster are compared in values absolute.*

## **PRECISION**

=

*Precision requested (by defect 1.D3) to accept the computed value.*

## **CRITERION**

=

*Type of test to be carried out.*

*If v are the extracted value, the test will carry for:*

.

**“RELATIVE” on:**

.

**“ABSOLUTE” on:**

.

**Note:**

*When the definition of the sequence number of a RESULT is done by a real variable of access (FREQ, INST, ENG), it is not necessary that there is ambiguity on this sequence number. For that the user defines a small interval around the value requested thanks to the key words CRITERION and PRECISION.*

*In this case (“real” access) the key words CRITERION and PRECISION will thus await 2 values each one: (crit1, crit2) and (prec1, prec2).*

*crit1 and prec1 relate to the value of reference.*

*crit2 and prec2 make it possible to choose the interval of research of the sequence number.*

*The default values of crit1 and prec1 are “RELATIVE” and 1.D-3.*

*The default values of crit2 and prec2 are “RELATIVE” and 1.D-3.*

*One cannot explicitly define crit2 and prec2 without defining crit1 and prec1.*

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*5 Examples*

*TEST\_RESU*

*(  
CHAM\_NO = \_F (CHAM\_GD = F,  
NODE*

*=  
"N2",  
NOM\_CMP*

*=  
"DX"*

*,  
REFERENCE*

*=*

**“ANALYTICAL”**

,  
**VALE**

=  
**1.2E-5**

,  
**PRECISION**

=  
**1D-4**

,),

**CHAM\_ELEM= (\_F**  
**(CHAM\_GD = SIGGA,**  
**NET**

=  
**“M3”,**  
**NOT**

=  
**3,**  
**NOM\_CMP**

=  
**“SIXX”**

,  
**REFERENCE**

=  
**“NON\_REGRESSION”**  
**VERSION='5.3.3'**

,  
**VALE**

=  
**3.4E6,**  
)  
  
**\_F**  
(  
**CHAM\_GD**

=  
**SIGNO,**  
**NET**

=  
**“M5”,**  
**NODE**

=  
**“N1”,**  
**NOM\_CMP**

=  
**“SIXX”**  
,  
**VALE**

=  
**3.4E6,**  
) , )

**TEST\_RESU**  
(  
**RESU**

= (*\_F*  
(  
*RESULT*

=  
*mo\_meca,*  
*NUME\_ORDRE=*  
*2,*  
*PARA*

=  
*“FREQ”*  
,  
*VALE*

=  
*1.5782,*  
)

*\_F*  
(  
*RESULT*

=  
*evolth,*  
*SENSITIVITY*

=  
*PS,*  
*NOM\_CHAM*

=  
*“TEMP”*  
,  
*INST*

=  
**12.0,**  
**NODE**

=  
**“N37”,**  
**NOM\_CMP**

=  
**“TEMP\_R”**  
**,**  
**VALE**

=  
**0.0,**  
**CRITERION**

=  
**“ABSOLUTE”**  
**,),**

**\_F**  
**(**  
**RESULT**

=  
**evolth,**  
**NOM\_CHAM**

=  
**“FLUX\_ELGA\_TEMP”**

**,**  
**TYPE\_TEST**

=  
**“MAX”**

**,**



**VALE**

=  
**154.35,)**  
  
**OBJECT**  
= **\_F**  
(  
**NAME**  
=  
**“CHI .CHME.LIGREL.LIEL”**  
,  
**IF**  
  
=  
**1278484**  
,),  
  
)

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*Organization (S): EDF-R & D /AMA, CS IF*

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***Document: U4.92.02***

***Procedure TEST\_FONCTION***

## **1 Goal**

**To extract a numerical value or an attribute from a function for comparison with a value from reference. The function is either a structure of data of the function type, tablecloth, or contained in a structure of data of the tabl\_intsp type.**

**This procedure writes then a conventional message “OK” (if it is good) or “NOOK” (if not).**

**It does not stop the execution if the test is not checked; this makes it possible to use it is systematically for the tests of validation, that is to say to extract and print a value of a function or a tablecloth for a particular value of a parameter.**

**This order is used primarily by the cases tests to validate the not-regression of results.**

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## **2 Syntax**

**TEST\_FONCTION**

**(**

## **UNIT**

=

/

*links,*

**[I]**

/

**8,**

**[DEFECT]**

**/VALUE = \_F (FUNCTION**

**= F,**

/

**[function]**

/

**[fonction\_C]**

**NOM\_PARA**

**= *lnom,***

**[l\_Kn]**

**I PRECISION**

=

/

***prec,***

**[R]**

/

**1.0D-3, [DEFECT]**

***I CRITERION =***  
***/“RELATIVE”,***  
***[DEFECT]***  
***/***  
***“ABSOLUTE”,***

***VALE\_PARA =***  
***will lpara,***  
***[l\_R]***

***/VALE\_REFE = refe,***  
***[R]***

***/***  
***VALE\_REFE\_C =***  
***compl,***  
***[C]***

*VALE\_ABS* =/"YES",  
/

"NOT",  
[DEFECT]  
*REFERENCE* =  
/"ANALYTICAL",

/"SOURCE\_EXTERNE",

/  
"NON\_REGRESSION",

/  
"AUTRE\_ASTER",  
*VERSION* =..., [TXM]

),

/  
*ATTRIBUTE*

=\_F (  
*FUNCTION*  
= F,

/  
[function]

/  
[fonction\_C]

**PARA**  
=  
**reality,**  
**[R]**

**I**  
**PREC\_PARA**  
=  
/  
**prec,**  
**[R]**  
/  
**1.0D-3, [DEFECT]**

**I CRIT\_PARA**  
=/"RELATIVE", [DEFECT]  
/  
"ABSOLUTE",

**ATTR =**  
/"NOM\_PARA",



/

**“NOM\_RESU”,**

/

**“PROL\_DROITE”,**

/

**“PROL\_GAUCHE”,**

/

**“Interpol”,**

/

**“PROL\_GAUCHE\_FONC”,**

/

**“PROL\_DROITE\_FONC”,**

/

**“INTERPOL\_FONC”,**

/

**“NOM\_PARA\_FONC”,**

**ATTR\_REFE**

**= attr,**

**[KN]**

**REFERENCE =**

**/“ANALYTICAL”,**

**/“SOURCE\_EXTERNE”,**

/

**“NON\_REGRESSION”,**

**VERSION**

**=**

**towards,**

**[KN]**

/

**“AUTRE\_ASTER”,**

),  
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**/TABL\_INTSP=\_F (**

**INTE\_SPEC**

**=**

**F,**

**[tabl\_intsp]**

**/**

**NUME\_ORDRE\_I**

**=**

**I,**

**[I]**

***NUME\_ORDRE\_J***

***=***

***J,***

***[I]***

***/NOEUD\_I =***

***nd\_i,***

***[node]***

***NOEUD\_J =***

***nd\_j,***

***[node]***

***NOM\_CMP\_I =***

***ncmp\_i,***

***[KN]***

***NOM\_CMP\_J =***

***ncmp\_j,***

***[KN]***

***NUME\_VITE\_FLUI = n\_vit,***

***[I]***

***VALE\_PARA = real,***

***[R]***

***VALE\_REFE\_C = compl,***

[C]

**I**  
**PRECISION**  
=  
/  
**prec,**  
[R]  
/  
**1.0D-3, [DEFECT]**

**I CRITERION =/“RELATIVE”,**  
**[DEFECT]**  
/  
**“ABSOLUTE”,**  
**REFERENCE =**  
**/“ANALYTICAL”,**

**/“SOURCE\_EXTERNE”,**  
/  
**“NON\_REGRESSION”,**

**VERSION**

=

**towards,**  
**[KN]**

/

**“AUTRE\_ASTER”,**

),

**TEST\_NOOK =/“NOT”,**  
**[DEFECT]**

/

**“YES”,**

)

***The functions are either with actual values [function], or with complex values [fonction\_C].***

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**3 Operands**

**3.1 Operand**

**UNIT**

**UNIT = links**

**Number of the logical unit on which one writes the result of test (OK or NOOK), except case private individuals links = 8.**

**3.2 Word**

**key**

**VALUE**

**VALUE**

**=**

**Key word factor to test a value of a function or a tablecloth.**

**3.2.1 Operand**

**FUNCTION**

**FUNCTION = F**

**Name of the function (with a parameter) or tablecloth (with two parameters) on which is carried out the operation.**

**NB: One cannot test functions of more than two parameters.**

**3.2.2 Operand**

**NOM\_PARA**

**NOM\_PARA =  $lnom$**

**In the case of a function, this word key is not treated.**

*In the case of a tablecloth, the user will give 2 names of parameter: the first defining it parameter of the tablecloth, the second defining the parameter of the function which one wants to test (see order **DEFI\_NAPPE** [U4.31.03]).*

### **3.2.3 Operands**

#### **PRECISION/CRITERION**

**PRECISION** = *prec*

*In the case of a tablecloth, one seeks the function defined by the value of the parameter in one interval defined by the absolute or relative position:*

*“inst ± prec” (cf **CRITERION**).*

*By defect  $prec = 1.0D-3$*

**CRITERION** =

.

*“RELATIVE”: the interval of research is: [inst (1-prec), inst (1+prec)]*

.

*“ABSOLUTE”: the interval of research is: [inst-prec, inst+prec]*

### **3.2.4 Operand**

#### **VALE\_PARA**

**VALE\_PARA** = *will lpara*

*In the case of a function, the user gives the value of the parameter for which the value of function is tested.*

*In the case of a tablecloth, the user gives the 2 values corresponding to the names of both parameters (that of the tablecloth and that of the function).*

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**Procedure **TEST\_FONCTION****



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**3.2.5 Operand**

**VALE\_REFE/VALE\_REFE\_C/VALE\_ABS**

**/VALE\_REFE = refe**

**Value of reference for the functions or the tablecloths to actual values.**

**/**

**VALE\_REFE\_C = compl**

**Value of reference for the functions or the tablecloths to complex values.**

**If VALE\_ABS=' OUI', one tests the absolute value of the function.**

**3.2.6 Operands**

**REFERENCE/VERSION**

**REFERENCE = Key word defining the nature of the reference solution.**

**“ANALYTICAL”:** the reference solution results from an analytical calculation

**“SOURCE\_EXTERNE”:** the reference solution results either from experimental results, or of an average of the results obtained by other computer codes.

**“NON\_REGRESSION”:** the reference solution is that obtained with a version of Code\_Aster and the same modeling of the test.

**“AUTRE\_ASTER”:** the reference solution is that obtained with a version of Code\_Aster but on another modeling of the test.

**If the REFERENCE of the solution is “NON\_REGRESSION”, it is then necessary to indicate the VERSION of**

**Code\_Aster which made it possible to obtain this solution.**

**3.3 Word**

**key**

**ATTRIBUTE**

## ***/ATTRIBUTE***

=

***Key word factor to test an attribute of a function or a tablecloth.***

### ***3.3.1 Operand***

#### ***FUNCTION***

***FUNCTION = F***

***Name of the function or the tablecloth on which the operation is carried out.***

### ***3.3.2 Operand***

#### ***PARA***

***PARA = real***

***In the case of a function, this word key is not necessary.***

***In the case of a tablecloth, the user gives the value of the parameter to recover the function so to test the attribute.***

### ***3.3.3 Operands***

#### ***PREC\_PARA/CRIT\_PARA***

***PREC\_PARA = prec***

***One seeks the function defined by the value of the parameter in an interval defined by the position absolute or relative:***

***“inst ± prec” (cf CRITERION [§3.2.3]).***

***By defect prec = 1.0D-3.***

***CRIT\_PARA =***

***“RELATIVE”: the interval of research is: [inst (1-prec), inst (1+prec)]***

***“ABSOLUTE”: the interval of research is: [inst-prec, inst+prec]***

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### **3.3.4 Operand**

**ATTR**

**ATTR =**

**Name of the attribute to be tested. For the significance of the attributes to refer to *DEFI\_FONCTION* [U4.31.02] or with *DEFI\_NAPPE* [U4.31.03].**

### **3.3.5 Operand**

**ATTR\_REFE**

**ATTR\_REFE = attr**

**Attribute of reference. For the significance of the attributes to refer to *DEFI\_FONCTION* [U4.31.02] or with *DEFI\_NAPPE* [U4.31.03].**

### **3.3.6 Operands**

**REFERENCE/VERSION**

**cf [§3.2.6].**

## **3.4 Word**

**key**

**TABL\_INTSP**

**/TABL\_INTSP**

**=**

**Key word factor to test a value of a concept counts of *tabl\_intsp* type produced by example by *LIRE\_INTE\_SPEC* [U4.36.01], *DEFI\_INTE\_SPEC* [U4.36.02], *CALC\_INTE\_SPEC***

**[U4.36.03], PROJ\_SPEC\_BASE [U4.63.14], DYNA\_SPEC\_MODAL [U4.53.23],  
REST\_SPEC\_PHYS  
[U4.63.22], DYNA\_ALEA\_MODAL [U4.52.22].**

### **3.4.1 Operand** **INTE\_SPEC**

**INTE\_SPEC = F**

**Name of the table of interspectres which contains at least a matrix interspectrale. If table contains several matrices interspectrales (cf [§3.4.2]), key word NUME\_VITE\_FLUI allows to select one of these matrices.**

### **3.4.2 Operand** **NUME\_VITE\_FLUI**

**NUME\_VITE\_FLUI = nvite**

**For the matrices interspectrales coming from a calculation where order CALC\_FLUI\_STRU [U4.66.02] is used, it is necessary to indicate the number corresponding at the speed of the fluid which allowed to define the matrix interspectrale which one wants to test.**

### **3.4.3 Operands** **NUME\_ORDRE\_I/NUME\_ORDRE\_J**

**NUME\_ORDRE\_I = I,  
NUME\_ORDRE\_J = J,**

**Indices of the sequence numbers I and J allowing to define a term of the matrix interspectrale when the lines and columns of this matrix are not named.  
These matrices result from operators PROJ\_SPEC\_BASE [U4.63.14], DYNA\_SPEC\_MODAL [U4.53.24], LIRE\_INTE\_SPEC [U4.36.01], DEFI\_INTE\_SPEC [U4.36.02], CALC\_INTE\_SPEC [U4.36.03], DYNA\_ALEA\_MODAL [U4.52.22].**

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**3.4.4 Operands**

**NOEUD\_I/NOEUD\_J/NOM\_CMP\_I/NOM\_CMP\_J**

**NOEUD\_I = nd\_i,**

**NOEUD\_J = nd\_j,**

**NOM\_CMP\_I = ncmp\_i,**

**NOM\_CMP\_J = ncmp\_j,**

*When the lines and columns of the matrix interspectrale are named, these operands correspond then to the names of the nodes and associated components allowing to define one term of this matrix.*

*These matrices result from operator REST\_SPEC\_PHYS [U4.63.22].*

*These operands are excluded with the definite preceding operands in the paragraph [§3.4.3].*

**3.4.5 Operand**

**VALE\_PARA**

**VALE\_PARA = real**

*Value of the parameter for which the value of the function contained in the table is tested.*

**3.4.6 Operand**

**VALE\_REFE\_C**

**VALE\_REFE\_C = compl**

*Value of reference (complex number: real part, imaginary part or module, phase).*

**3.4.7 Operands**

**PRECISION/CRITERION**

**PRECISION = prec**

*Definition of the interval of research: absolute or relative position:*

*“inst ± prec” (cf CRITERION).*

**By defect  $prec = 1.0D-3$ .**

**CRITERION =**

**“RELATIVE”**: the interval of research is: [*inst (1-prec), inst (1+prec)*]

**“ABSOLUTE”**: the interval of research is: [*inst-prec, inst+prec*]

### **3.4.8 Operands**

**REFERENCE/VERSION**

*cf* [**§3.2.6**].

### **3.5 Operand**

**TEST\_NOOK**

**TEST\_NOOK =**

*This option, to use with precaution, makes it possible to simulate that the attributes of a function (in particular to limit its field of definition) will be well interpreted.*

**Example:**

*On a function with **PROL\_GAUCHE** = “EXCLUDED”, if one tests the function with a value of parameter lower than the value of the lower limit of the interval of definition of the function, one should obtain an error.*

*With **TEST\_NOOK** = “YES”, **TEST\_FONCTION** returns result “OK”.*

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**4 Examples**

**4.1**

**Checking of a tablecloth**

```
df1  
= DEFI_FONCTION  
(NOM_PARA = "INST", NOM_RESU = "DEPL",  
VALE  
=  
(0.,0.,1.,1.,2.,2.,3.,3.,4.,4.  
) )
```

```
df2  
= DEFI_FONCTION  
(NOM_PARA = "INST", NOM_RESU = "DEPL",
```

```
VALE = (3. , 3. , 4. , 4. , 5. , 5. )
```

```
)  
dn1  
= DEFI_NAPPE  
(NOM_PARA = "AMOR", NOM_RESU = "DEPL",  
VALE  
=  
(0.01,  
0.02),  
FUNCTION  
=  
(  
df1,  
df2  
))
```

**TEST\_FONCTION**

(

*# one checks attribute "NOM\_PARA" of the function df1 in the tablecloth dn1***ATTRIBUTE = (\_F (FUNCTION =**  
**dn1****, PARA = 0.01, # 0.01 reached df1****ATTR****=****"NOM\_PARA\_FONC",****ATTR\_REFE****=****"INST"****),***# one checks attribute "NOM\_PARA" of the tablecloth dn1***\_F (FUNCTION =**  
**dn1****, ATTR = "NOM\_PARA",****ATTR\_REFE****=****"AMOR"****)),***# one checks a value of the tablecloth dn1 (in practice on the function df1)***VALUE =****\_F (**  
**FUNCTION =**  
**dn1,****NOM\_PARA = ("AMOR", "INST"****),****VALE\_PARA****=****(****0.01,****1.****),****VALE\_REFE****=****1.****)**



)

## 4.2

### *Checking of a function*

```
li1=DEFI_LIST_REEL (DEBUT=0.,
INTERVALLE=_F (JUSQU_A=2*pi,
PAS=2*pi/20),
)
```

```
f1=FORMULE (NOM_PARA=' INST',
VALE=' sin (INST)
+
cos (INST) ',
)
```

```
fonc=CALC_FONC_INTERP (FONCTION=f1,
LIST_PARA=li1,
NOM_RESU=' DEPL',
INTERPOL=' LIN',
)
```

```
TEST_FONCTION (
# one tests an attribute of the function
ATTRIBUT=_F (
FONCTION=fonc,
ATTR=' INTERPOL',
ATTR_REFE=' FLAX
LIN'),
# one tests a value of the function
VALEUR=_F
(
FONCTION=fonc,
VALE_PARA=pi,
VALE_REFE=sin (pi) +cos (pi),
), )
```

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***Titrate:***

***Procedure TEST\_TABLE***

***Date:***

***22/02/06***

***Author (S):***

***COURTEOUS Mr., J. Key PELLET***

***:***

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***Organization (S): EDF-R & D /AMA***

***Instruction manual***

***U4.9- booklet: Impression/Test***

***Document: U4.92.03***

***Procedure TEST\_TABLE***

***1 Goal***

*To test a “cell” (or a whole column) of a concept of the type counts.*

*Imprime OK if the value found in the cell is identical to the value bench-mark datum, NOOK if not.*

*This order is used primarily by the cases tests to validate the not-regression of results.*

*Instruction manual*

*U4.9- booklet: Impression/Test HT-62/06/004/A*

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*Code\_Aster* ®

*Version*

*8.2*

*Titrate:*

*Procedure TEST\_TABLE*

*Date:*

*22/02/06*

*Author (S):*

*COURTEOUS Mr., J. Key PELLET*

*:*

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*2 Syntax*

*TEST\_TABLE*

*(*

*COUNT*

*=*

*matable,*

*[tabl\_\*]*

*UNIT*

*=*

*/*

*links,*

**[I]**

/

**8,**

**SENSIBILITE= (**

**... to see [U4.50.02]),**

**% 1. Selection of the column to be tested:**

**NOM\_PARA**

**=**

**para,**

**[KN]**

**/% 1.1 Selection of the line containing the cell to be tested:**

**FILTER = (\_F (**

**NOM\_PARA**

**=**

**para**

**,**

**[KN]**

**/**

**CRIT\_COMP**

**=**

**/"EQ"**

**,**

**[defect]**

**/"**

**,**

**/"LT"**

**,**

**/"WP"**

**,**

**/"IT"**

**,**

**/“GE”**

,

**/VALE\_I**

=

**ival**

,

**[I]**

/

**VALE\_K**

=

**kval**

,

**[KN]**

//

**VALE**

=

**rval,**

**[R]**

/  
**VALE\_C**

=  
**cval,**  
**[C]**

/  
**PRECISION**

=  
/  
**prec,**  
**[R8]**

/  
**1.0D-3**  
,  
**[DEFECT]**

```
/
CRITERION =
/
“RELATIVE”,
[DEFECT]
/
“ABSOLUTE”
,
```

```
/
CRIT_COMP
=/“MAXIMUM”,
/“ABS_MAXI”
,
/“MINI”
,
/“ABS_MINI”
,
/“VACUUM”
,
/“NON_VIDE”
,
),),
```

*/% 1.2 to test the whole of a column:*

```
TYPE_TEST =/“SOMM_ABS”,
/
“SOMM”
,
/
“MAX”
,
/
“MIN”
,
```

**% 2. Value of reference:**

/

**VALE\_I**

=

**ival**

,

**[I]**

/

/

**VALE**

=

**rval**

,

**[R]**

/

**VALE\_C**

=

**cval**

,

**[C]**

**VALE\_ABS =/"YES",**

/

**"NOT",**

**[DEFECT]**

**/ PRECISION**

=

/

**prec**

,

**[R]**



/

**1.0D-3,**  
**[DEFECT]**

/

**CRITERION**

=

/

**“RELATIVE”**

,

**[DEFECT]**

/

**“ABSOLUTE”**

,

**REFERENCE =/“ANALYTICAL”,**

/

**“NON\_REGRESSION”**

,

**VERSION**

=

**towards,**

**[KN]**

/

**“SOURCE\_EXTERNE”**

,

/

**“AUTRE\_ASTER”**

,

**INFORMATION**

=

/

**1**

,  
**[DEFECT]**

/  
**2**

,

)

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Procedure *TEST\_TABLE*

Date:

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### **3 Operands**

#### **3.1 Operand**

**COUNT**

*One gives the name of the table which one wants to test.*

#### **3.2 Operand**

**UNIT**

**UNIT =**

*/links,*

*/*

*8,*

*Number of the logical unit on which the result of test (OK or NOOK) will be written, except case private individuals links = 8.*

#### **3.3 Operand**

**SENSITIVITY**

**SENSITIVITY = *par\_sensi***

*Name of the significant parameter associated the value which one wants to test (see [U4.50.02]).*

#### **3.4 Operand**

**NOM\_PARA**

*One gives the name of the parameter identifying the column to be tested.*

### 3.5

*To test a cell; key word **FILTERS***

*This key word factor (répétable at will) is used to select the line containing the cell to be tested. The use of this key word is described in order **IMPR\_TABLE** [U4.91.03]. The only difference by report/ratio with **IMPR\_TABLE** is that the comparison criterions (**CRIT\_COMP**) of inequality are not available.*

*Note:*

*It is often necessary to repeat this key word to select a single line, this is why order **TEST\_TABLE** makes it possible to test only one value at the same time. If one wants to test 3 values in a table, 3 times should be called the order.*

### 3.6

*To test a whole column*

***/TYPE\_TEST = "SOMM\_ABS"***

*The sum of the absolute values of all the column of the table.*

***/TYPE\_TEST = "SOMM"***

*The sum of the values of all the column of the table.*

***/TYPE\_TEST = "MAX"***

*The maximum of the values of all the column of the table.*

***/TYPE\_TEST = "MIN"***

*Minimum of the values of all the column of the table.*

### 3.7

*Definition of the value of reference*

#### 3.7.1 Operands

***VALE/VALE\_I/VALE\_C***

*According to the type of the cell to be tested (real, whole or complex) one will indicate behind key words **VALE**, **VALE\_I** or **VALE\_C** the value of reference which must be found in the selected cell.*

*If VALE\_ABS=' OUI', one tests the absolute value.*

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### *3.7.2 Operands*

#### *CRITERION/PRECISION*

*These 2 key words make it possible to indicate the tolerance which one accepts for the value tested when it is of type real or complex.*

*Examples:*

*VALE= 3.3, “RELATIVE” CRITERE=, PRECISION = 1.D-5,*

*It will be checked that the value found in the cell tested is worth 3.3 with 1.D-5 near in relative error.*

*VALE= 3.3, “ABSOLUTE” CRITERE=, PRECISION = 2.D-3,*

*It will be checked that the value found in the cell tested is worth 3.3 with 2.D-3 near in absolute error.*

### *3.7.3 Operand*

#### *REFERENCE*

*REFERENCE =*

*/“ANALYTICAL”:*

*the provided value of reference is “analytical”*

**/“NON\_REGRESSION”:**

*the provided value of reference was obtained at the time of a precedent*

*calculation by Code\_Aster*

*VERSION = towards worms is the number of the version of Aster which made it possible to obtain*

*value of reference*

**/“SOURCE\_EXTERNE”:**

*the provided value of reference comes from a different program*

*that Aster (or of a bibliographical reference)*

**/“AUTRE\_ASTER”:**

*the provided value of reference is that obtained by another*

*“way” Aster (another order, option of calculation,...)*

### **3.8 Operand**

#### **INFORMATION**

**INFORMATION = inf**

*Print additional information in the file “message” if inf=2. Do not print anything if inf=1.*

### **4 Examples**

**1) To test the table maxFchoc:**

**TEST\_TABLE**

**(TABLE =**

*maxFchoc*

**, NOM\_PARA = “MAXIMUM”,**

**FILTER**

**=**

**(**  
*\_F (NOM\_PARA = “FUNCTION”, VALE\_K = “effochoc”),*

*\_F (NOM\_PARA*

**=**

**“INST”,**

**VALE**

**=**

3.76E-1),)

REFERENCE

=

“ANALYTICAL”,

VALE

=

6,2983E2

,)

2) To test the value of derived from the table G compared to the significant parameter YOUNG:

TEST\_TABLE

(TABLE =

G

, SENSIBILITE= YOUNG,

NOM\_PARA = “G”, VALE = 1.76E+1),)

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Date:

12/01/05

Author (S):

Key **COURTEOUS Mr.**

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Organization (S): EDF-R & D /AMA

***Instruction manual***  
***U4.9- booklet: Impression of the results and tests***  
***Document: U4.92.04***

## ***Procedure TEST\_FICHER***

### ***1 Goal***

***This macro-order makes it possible to test nonthe regression of files produced by the orders Aster, mainly IMPR\_RESU, but one could use it on any file.***

***The interest of this macro-order is that one can round the real numbers to tolerate one certain variability of the values.***

***One uses the module Python md5 which provides a “signature” of the round file (called md5sum).***

***Turn over OK if the file is identical, to the round-offs of the real numbers close, with the file which served as reference,  
NOOK if not.***

***This order is used primarily by the cases tests to validate the not-regression of results.***

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**Procedure TEST\_FICHER**

**Date:**

**12/01/05**

**Author (S):**

**Key COURTEOUS Mr.**

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**2 Syntax**

**TEST\_FICHER (**

**UNIT**

**= /**

**links,**

**[I]**

**/ 8,**

**FILE =**

**fich,**

**[KN]**

**VALE\_K**

**=**

**kval**

,  
[K32]

**NB\_CHIFFRE**

=  
/  
**nbch**

,  
[I]  
/  
6,  
[DEFECT]

**EPSILON**

=  
/  
**epsi**  
,  
[R]  
/  
**1.E-14**

,  
[DEFECT]

**EXPR\_IGNORE**

=  
**regexp,**  
[l\_Kn]

**REFERENCE**

=  
/  
"ANALYTICAL"

,  
[KN]  
/

**“NON\_REGRESSION”**

**VERSION = towards,**

**“SOURCE\_EXTERNE”**

**“AUTRE\_ASTER”**

**INFORMATION**

**[DEFECT]**

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**Procedure TEST\_FICHER**

**Date:**  
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### **3 General information**

*This procedure makes it possible to test nonthe regression of files produced by the Aster orders, mainly IMPR\_RESU, but one could use it on any file.*

*The interest of this macro-order is that one can round the real numbers to tolerate one certain variability of the values. One chooses:*

- to preserve nbch significant figures,*
- to regard as null the values lower than epsi,*
- to be unaware of certain lines of the file according to regular expressions'.*

*One uses the module Python md5 which provides a “signature” of the round file (called md5sum). So any other variation compared to a file of reference a such modification of a text (title, name of components...) or a whole classification (which will not be round) will involve one change of the signature of the file compared to the value of reference.*

#### **Notice 1:**

*The file must be closed so that the value is reliable (with for example DEFI\_FICHER, ACTION = “TO RELEASE”).*

#### **Notice 2:**

*Even if one can use the order on the binary files, that does not have interest, because it y will not have possible round-off, and thus the least variation will be reflected on the md5sum.*

*The method md5file can be called out of Code\_Aster to obtain the value of the md5sum of one file after round-offs:*

*iret, sum = md5file (fich=' nom\_fichier', nbch=6, epsi=1.e-14, info=2)*

### **4 Operands**

#### **4.1 Operand UNIT**

**UNIT = links**

**Logical number of unit on which the result of test (OK or NOOK) will be written, except case private individuals, links = 8 (file result).**

#### **4.2 Operand**

**FILE**

**FILE = fich,**

**One provides the name of the file here to be analyzed with his access path into relative compared to repertory of execution or in absolute. Examples**

**: “fort.37” or**

**“./REPE\_OUT/resultats.pos”.**

#### **4.3 Operand**

**VALE\_K**

**VALE\_K = kval**

**One provides here the value of the md5sum obtained on the file of reference (produced during an execution**

**the preceding one), provided in the form of a chain of 32 characters by the method hexdigest () of modulate md5.**

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#### **4.4 Operand NB\_CHIFFRE**

***NB\_CHIFFRE = nbch***

***It is about the number of significant figures preserved at the time of rounded real numbers.  
More precisely, this number defines the format in which realities will be provided to the module md5.  
Examples: 1.123456789E+01 rounded with***

***nbch=6, one obtains 11.2346 (format %13.6g)***

***nbch=4, one obtains 11.23  
(format %11.4g)***

#### **4.5 Operand EPSILON**

***EPSILON = epsi***

***All the numbers lower than this value are taken as null.***

#### **4.6 Operand EXPR\_IGNORE**

***EXPR\_IGNORE = regexp***

***The lines of the file satisfying the regular expressions given behind this key word will be  
been unaware of in the calculation of the md5sum.***

***Example: \****

***EXPR\_IGNORE = (“DATE= [0-9] {2}/[0-9] {2}/[0-9] {4}”,  
“^VERSION”)***

***Here lines containing DATE = jj/mm/aaaa where J, m, A are figures or starting with  
VERSION are ignored.***

#### **4.7 Definition of the value of reference**

**REFERENCE =**

**/“ANALYTICAL”:**

*the provided value of reference is “analytical”*

**/“NON\_REGRESSION”:**

*the provided value of reference was obtained at the time of a precedent calculation by Code\_Aster*

**VERSION =**

*towards*

*worms is the number of the version of Aster which made it possible to obtain value of reference (ex: “7.3.4”)*

**/“SOURCE\_EXTERNE”:**

*the provided value of reference comes from a different program that Aster (or of a bibliographical reference)*

**/“AUTRE\_ASTER”:**

*the provided value of reference is that obtained by another way Aster (another order, option of calculation,...)*

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**Key COURTEOUS Mr.**

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## **4.8 Operand INFORMATION**

**INFORMATION = inf**

*Specify the detail of the information printed in the file message.  
If inf=1, one has the following summary:*

**File: ./REPE\_OUT/post\_resu.pos**  
**A number of lines: 6371**  
**Format of the real ones: %13.6g**  
**Epsilon: 1e-14**  
**md5sum: c9a6b5c983c903473b0dc9f744f854dd**  
**REFERENCE: c9a6b5c983c903473b0dc9f744f854dd**

*If inf=2, one has for each line the values selected to calculate the md5sum (for a chain characters: the chain itself, for an entirety: entirety itself, for a reality: the value round), example:*

...  
**LINE 4178 VALUE SELECTED 0.269134**  
**LINE 4179 VALUE SELECTED 0.071175**  
**LINE 4179 VALUE SELECTED 0**  
**LINE 4179 VALUE SELECTED 0.0535577**  
**LINE 4180 VALUE SELECTED -5.7844E-05**  
**LINE 4181 VALUE SELECTED -4.28594E-05**  
**LINE 4182 VALUE SELECTED -3.61488E-05**  
**LINE 4183 VALUE SELECTED 2**  
**LINE 4183 VALUE SELECTED 2**

...  
**LINE 4663 VALUE SELECTED \$EndView**  
...

*This makes it possible to make the “diff” between the values selected of two files to see which values were modified.*

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***Version***  
***8.2***

***Titrate:***

***Macro order MACR\_ASCOUF\_MAIL***

***Date:***

***31/01/06***

***Author (S):***

***E. GALENNE, Key Mr. BONNAMY***

***:***

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***Organization (S): EDF-R & D /AMA, AUSY***

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***Booklet U4.CF: ASCOUF***

***Document: U4.CF.10***

***Macro order MACR\_ASCOUF\_MAIL***

***1 Goal***

***To generate the grid of a healthy elbow or comprising a crack or one or more under thicknesses.***

***The lengths must be given in millimetres and the angles in degrees.***

***The concept produced by this macro order is of grid type, containing the topological entities***

*allowing to apply boundary conditions and loadings. The produced grid can be used only or associated macro order MACR\_ASCOUF\_CALC.*

*To use MACR\_ASCOUF\_MAIL, it is necessary to be able to reach to GIBI on the same machine of execution of Code\_Aster (either all locally, or on the central machine Aster).*

*MACR\_ASCOUF\_MAIL calls upon order MODI\_MAILLAGE to transform the grid of plate in grid of tube or elbow, the grid of the plate being produced by the procedures of grid parameterized automatics ASCOUF.*

*Product a concept of the grid type.*

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*Count*

*matters*

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*Macro order MACR\_ASCOUF\_MAIL*

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## 2 Syntax

**netted [grid] = MACR\_ASCOUF\_MAIL**

(  
**EXEC\_MALLAGE**  
**=\_F (SOFTWARE =/"GIBI2000", [DEFECT]**  
**/**  
**"GIBI98"**

,



**UNITE\_DATG =/**

**unit\_d, [I]**

/

70

,  
**[DEFECT]**

**UNITE\_MGIB =/**

**unit\_s, [I]**

/

19

,  
**[DEFECT]**

**NIVE\_GIBI**

=

/

3

,  
**[I]**

/ 4

,

/ 5

,

/ 6

,

/ 7

,

/ 8

,

/ 9

,

/

10

,

**[DEFECT]**

/ 11

,

)

**TYPE\_ELEM**

=

/

**“CU20”**

,

**[DEFECT]**

/

**“CUB8”**

,

**BEND**

=\_F

(

**ANGLE**

=

,

**[R]**

***R\_CINTR =***

***Rc***

,

***[R]***

***L\_TUBE\_P1***

=

***l\_tube\_p1***

,

***[R]***

***L\_TUBE\_P2***

=

/

***l\_tube\_p2,***

***[R]***

/

***0.,***

***[DEFECT]***

***NB\_ELEM\_EPAIS***

=

/

***nbel,***  
***[I]***  
***/***  
***3,***  
***[DEFECT]***

***SYME =/"QUARTER", [TXM]***  
***/***  
***"HALF"***  
***,***  
***[TXM]***  
***/***  
***"WHOLE"***  
***,***  
***[DEFECT]***

***TRANSFORM =/"TUBE"***  
***, [TXM]***  
***/***  
***"ELBOW",***  
***[DEFECT]***

***# So TRANSFORMED = "ELBOW"***

***DEXT***  
***=***  
***Of***  
***,***

**[R]**

**THICK**

=

**E**

,

**[R]**

**SUR\_EPAIS**

=

/

**surep,**

**[R]**

/

**0.,**

**[DEFECT]**

**BOL\_P2**

=

/

**“ASP\_MPP”**

,

**[TXM]**

/

**“TANK”**

,

/

**“Steam Generator”**

,  
**# Finsi**

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**# So TRANSFORMED = "TUBE"**

**TRAN\_EPAIS =/**

**"NOT",**

**[DEFECT]**

**/**

**"YES",**

**[TXM]**

**#**

**If TRAN\_EPAIS = "YES"**



***DEXT\_T1 =***

***De\_t1***

**,**

**[R]**

***EPAIS\_T1***

**=**

***e\_t1***

**,**

**[R]**

***EPAIS\_T2***

**=**

***e\_t2***

**,**

**[R]**

***ANGL\_TETA1=***

***teta1***

**,**

**[R]**

*ANGL\_TETA2=*  
*teta2*  
,  
*[R]*

*EPAIS\_TI*  
=  
*e\_ti*  
,  
*[R]*

/  
*ABSC\_CURV\_TRAN*  
=*ltran*  
, *[R]*  
/  
*POSI\_ANGU\_TRAN*  
=*phi*  
,  
*[R]*

*# Finsi*

*#*  
*If TRAN\_EPAIS = "NOT"*

***DEXT***

=

***Of***

,

***[R]***

***THICK***

=

***E***

,

***[R]***

***SUR\_EPAIS***

=

/

***surep,***

***[R]***

/

***0.,***

***[DEFECT]***

**BOL\_P2**

=

/

**“ASP\_MPP”**

,

**[TXM]**

/

**“TANK”**

,

/

**“Steam Generator”**

,

**# Finsi**

**# Finsi**

)

**/SOUS\_EPAIS\_COUDE =\_F (STANDARD =/“ELLI”,**

**AXE\_CIRC = 2a,**

**[R]**

/

**“AXIS”,**

***AXE\_LONGI***

=

***2b***

,

***[R]***

***DEPTH = C, [R]***

/

***POSI\_CURV\_LONGI = sl***

***, [R]***

/

***POSI\_ANGUL***

=

***beta,***

***[R]***

/  
*POSI\_CURV\_CIRC*  
= *Sc*  
, [*R*]  
/  
*AZIMUTH*  
=  
*phi*  
, [*R*]

*SOUS\_EPAIS* =  
/“*INTERN*”,  
[*TXM*]

/“*EXTERNAL*”,

*NB\_ELEM\_LONGI*  
=  
*nl*  
,  
[*I*]

***NB\_ELEM\_CIRC***

=  
***nc***,  
***[I]***

***PRINT***

=  
/  
***“NOT”***,  
***[TXM]***

/  
***“YES”***,  
***[DEFECT]***

***NB\_ELEM\_RADI***

=  
/  
***NR***,  
***[I]***

/ 3

,  
**[DEFECT]**

)  
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**/SOUS\_EPAIS\_MULTI =\_F (STANDARD =/"ELLI",**



***AXE\_CIRC = 2a, [R]***  
**/**  
**“AXIS”,**

***AXE\_LONGI***  
**=**  
***2b***  
**,**  
***[R]***

***DEPTH =***  
***C***  
**,**  
***[R]***

*/POSI\_CURV\_LONGI = sl,*  
*[R]*  
*/*  
*POSI\_ANGUL*  
*=*  
*beta,*  
*[R]*

*/*  
*POSI\_CURV\_CIRC*  
*= Sc*  
*, [R]*  
*/*  
*AZIMUTH*  
*=*  
*phi*  
*, [R]*

*SOUS\_EPAIS*  
*=/"INTERN", [TXM]*  
*/*  
*"EXTERNAL",*

***NB\_ELEM\_LONGI***

***= nl***

***, [I]***

***NB\_ELEM\_CIRC = nc***

***, [I]***

***PRINT***

***=***

***/***

***“NOT”,***

***[TXM]***

***/***

***“YES”,***

***[DEFECT]***

)  
/  
**FISS\_COUDE**  
**=\_F**  
(  
**DEPTH =**  
**has**  
,  
**[R]**

**AXIS =/**  
**“YES”,**  
/  
**“NOT”,**  
**[DEFECT]**

**# If AXIS = “NOT”**

**LENGTH**  
**=**  
**2c**  
,  
**[R]**  
**# Finsi**

/  
**ABSC\_CURV**

=

*sf*  
,  
[R]  
/  
**POSI\_ANGUL**

=

*beta*  
,  
[R]

**AZIMUTH**

=

/  
*phi*  
,  
[R]  
/  
**90.**

,

[DEFECT]

**ORIEN**

=

/

***xsi***

,

***[R]***

/

***+45.***

,

/

***-45.***

,

/

***90.***

,

***/ 0. ,***

***FISSURE =***

/

***“DEB\_INT”,***

***[TXM]***

/

***“DEB\_EXT”,***

***NB\_TRANCHE =  
NT***

,  
***[I]***

***NB\_SECTEUR =  
NS***

,  
***[I]***

***NB\_COURONNE***

=  
***nc***

,  
***[I]***

***RAYON\_TORE = rc0***

,  
***[R]***

**COEF\_MULT\_RC2**

=  
/  
**rc2**  
,  
**[R]**  
/  
**1.**  
,  
**[DEFECT]**

**COEF\_MULT\_RC3**

= **rc3**  
,  
**[R]**

**ANGL\_OUVERTURE =/**

**eps**  
, **[R]**  
/  
**0.5**  
,  
**[DEFECT]**



)  
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**=\_F IMPRESSION (FILE =**

**nom\_fichier**

**,**

**[TXM]**

**UNIT**

**=**

**unit**

**,**

**[I]**

**/FORMAT**

=

/

**“ASTER”,  
[DEFECT]**

/

**FORMAT**

=

/

**“IDEAS”,**

**VERSION =/**

**4**

,

**[I]**

**/ 5**

,

**[DEFECT]**

/

**FORMAT**

=  
"CASTEM"

,

**NIVE\_GIBI**

=

/

3

,

[I]

/

10

,

[DEFECT]

)

**INFORMATION = /1**

,

[DEFECT]

/2 ,

)

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**3**

**Geometrical definition of the elbow**

**ep**

**Of**

**Rc**

**Rm**

**l\_tube\_p2**

**l\_tube\_p1**

**Y**

**X**

**Z**

**Appear 3-a: Description of the various geometrical parameters of the elbow**

**suction face**

**l\_tube\_p2**

**bend**

**Rc**

**under-surface**

**Y**

**right side**

**l\_tube\_p1**

**X**

**left side**

## Z

*Appear 3-b: Sight 3D of the elbow and its ends*  
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### *4 Operands*

#### *4.1*

*Key word factor EXEC\_MAILLAGE*

##### *4.1.1 Operand*

*SOFTWARE*

*SOFTWARE =/"GIBI2000", [DEFECT]*

*/*  
*"GIBI98"*

*,  
Version of software GIBI carried out for the realization of the grid of the structure.*

*UNITE\_DATG =*

*unit\_d*

*Logical number of unit where data GIBI making it possible are written to generate the grid of plate. The default value is 70.*

**UNITE\_MGIB =**  
**unit\_s**

***Logical number of unit where the grid of plate to format GIBI is written. This grid is generated by GIBI. The default value is 19.***

**NIVE\_GIBI**

**=**  
**/**

**3,**  
**[I]**

**/ 4,**

**/ 5,**

**/ 6,**

**/ 7,**

**/ 8,**

/ 9,  
 /  
 10,  
 [DEFECT]  
 /  
 11,

*Level of the software GIBI in which the grid is generated.*

#### 4.2 Operand TYPE\_ELEM

*Allows to choose the type of element which will constitute the grid.*

TYPE\_ELEM

=  
 /  
 "CU20"  
 ,  
 [DEFECT]  
 /  
 "CUB8"  
 ,  
 [TXM]

#### 4.3 Key word factor BENDS

##### 4.3.1 Operand ANGLE

ANGLE =

*Value of the angle of the elbow in degrees. If one wishes to model only one tube without bending it (in using the option "TUBES" TRANSFORMED operand), the length of this one in its part "elbow" will be  $Rc$  where  $Rc$  is the ray of bending (see operand R\_CINTR). It is thus necessary to choose and  $Rc$  in such a way that the part "elbow" has the wished length, for example:  $=40^\circ$ ,  $Rc=100mm$   $Rc= (40 /180) 100$  Meters the values of authorized lie between 20 and 90 degrees.*

**P2 end**  
**P1 end**  
**part "bends"**  
**L\_TUBE\_P1**  
**Rc**  
**L\_TUBE\_P2**  
**tube**

**Appear 4.3.1-a: longitudinal distances from the structure**  
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**4.3.2 Operand**  
**R\_CINTR**

**R\_CINTR =**  
**Rc**

**Value of the ray of bending of the elbow. The ray of bending must be such as:  $Rc > De/2$ .**

**4.3.3 Operand**  
**L\_TUBE\_P1**

**L\_TUBE\_P1**  
**=**  
**l\_tube\_p1**

**Value length of the P1 end at the end of which the loadings will be applied.**



*length of this end must be higher than the length of damping of the wave of inflection*

**3 R3**

*propagating since the part bends and being worth L*

*m*

*amor =*

*. If this dimension is not*

**2**

**E**

*reached for the end a message of alarm not blocking is transmitted.*

#### **4.3.4 Operand**

**L\_TUBE\_P2**

**L\_TUBE\_P2**

**=**

**l\_tube\_p2**

*Value length of the P2 end at the end of which the conditions will be applied to limits. The length of this end must be higher than the length of damping of the wave of*

**3 R3**

*inflection being propagated since the part bends and being worth L*

*m*

*amor =*

*. If this dimension is not*

**2**

**E**

*not reached for the end a message of alarm not blocking is transmitted (except in the event of presence of a bowl).*

#### **4.3.5 Operand**

**SUR\_EPAIS**

**SUR\_EPAIS**

**=**

**surep**

*Value of the extra thickness presents in internal skin at the under-surface of the elbow. It is distributed thus on*

*the elbow:*

*extra thickness*

*extra thickness*

**9 \*\* Rc/10**

**surep**

**surep**

***X-coordinate***

***curvilinear***

***0***

***azimuth***

***0***

***90° 120°***

***180°***

***240° 270°***

***0 \*Rc/10***

***\*Rc***

***side***

***under-surface***

***side***

***(bases***

***(top***

***left***

***right***

***bend)***

***bend)***

***suction face***

***top***

***bend***

***left***

***right***

***under-surface***

***azimuth = 0°***

***base elbow***

***Appear 4.3.5-a: Extra thickness***

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**Caution:**

*This option is not valid for the elbows or tubes comprising one or more under-thickness.*

**4.3.6 Operand**

**BOL\_P2**

**BOL\_P2**

*Allows to prolong the cylindrical end length  $l_{tube\_p2}$  by a bowl [bib1] on which one apply the boundary conditions. The possibilities are:*

**“TANK”**

*bowl of the pipe type of entry of tank,*

**“ASP\_MPP”** *bowl of the pipe type of primary aspiration of pump,*

**“Steam Generator”**

*bowl of the pipe type of Steam Generator.*

**Caution:**

*This option is not valid for the elbows or tubes with under-thicknesses.*

*The bowl of the type pipe Steam Generator has a conical end where the condition of the connection type*

*3D-beam is not used but is not replaced by a blocking of the section by conditions of type beam (cf [U4.CF.20]).*

**4.3.7 Operand**

**NB\_ELEM\_EPAIS**

**NB\_ELEM\_EPAIS**

**= nbel**

*Allows to give the number of layers of elements present in the thickness of the elbow and of its ends.*

**Caution:**

*This option is not valid for the elbows or tubes with crack (key word factor **FISS\_COUDE**) or with a under-thickness (key word factor **SOUS\_EPAIS\_COUDE**). The number*

*elements in the thickness of the elbow part is then fixed at three (except the zone of the defect which present a refinement specific) and to for the zones ends.*

#### **4.3.8 Operand**

##### **SYME**

**SYME =**

**/“QUARTER”,**

**/**

**“HALF”**

**,**

**/**

**“WHOLE”**

**,**

**[DEFECT]**

*Allows to net all the structure or only one quarter or a half-structure and to thus treat elbows presenting of symmetries. The geometry represented is then the following one:*

**.**

*for SYME=' DEMI': the part of structure going of the median section of the elbow (forming it transverse symmetry plane) at the end of the P1 end,*

**.**

*for SYME=' QUART': the representation of the quarter of structure is made on the same support but for a value of angle [, +] starting from the azimuth position of the center of defect. The tubular structure is then not closed and presents a symmetry plane longitudinal represented by two free edges.*

*Example for the quarter of structure: if the defect is in azimuth 90° (located left side) then it sector of the quarter of structure modelled is located between left side and right side while passing by the under-surface.*

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*Here an illustration of the representation on the structure developed on a plate:*

*defect*

*P2 end*

*Part bends*

*P1 end*

**Appear 4.3.8-a: Representation of half and quarter of structure**

**Caution:**

*This option is valid only for the elbows or tubes comprising a defect.*

*The use of this operand requires four essential conditions:*

- 1) One and only one defect are modelled.*
- 2) This one is placed on the median section of the elbow.*
- 3) If it is about a crack, this one must be directed circonférentiellement. Moreover the elbow does not have to comprise zone of transition from thickness.*
- 4) The lengths of each end must be given equal.*

*Calculations with the grid thus produced could not be carried out with the macro order of calculation MACR\_ASCOUF\_CALC insofar as the P2 end does not exist: in a general way the loadings of basic the effect type related to the internal pressure, moment and effort in P2 cannot not to be applied. One will refer to the paragraphs [§5.3] and [§5.4] for details on conditions of symmetry to apply.*

#### **4.3.9 Operand TRANSFORM**

##### **TRANSFORM**

*Allows to choose the type of transformation applied to the grid resulting from the procedure gibi carried out by the macro-order (see order MODI\_MAILLAGE).*

*TRANSFORM =/“TUBE”, transformation into tube,  
/“ELBOW”, transformation into elbow.*

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#### **4.3.10 Operand TRAN\_EPAIS**

**TRAN\_EPAIS =/**

**“YES”,**

**/**

**“NOT”,**

**[DEFECT]**

***Optional key word indicating the presence or not transition from thickness.***

***The transitions from thickness relate to only the RIGHT tubes. The internal ray remains constant and only the external ray varies. These transitions can be with one or two slopes. For these two types of transition, a defect must be present. The defect is either a circumferential crack, or a under-thickness which can emerge in external skin or internal skin. The defect is always perpendicular to the longitudinal axis of the right pipe. The crack or under-thickness can be axisymmetric. The site of the defect must be imposed so that it is located between the interface: P1 end/zone length R and the beginning of the transition from thickness. In all it C grid, the number of elements in the thickness remains identical.***

***The transition from thickness should not be entirely included/understood in the block of incrustation of fissure, including/understanding the block fissures and the zones of déraffinement to be connected to the grid regulated plate. In the event of transition to two slopes, it can include the first but in no case the totality of the transition.***

***In order to have lines of the grid confused with the beginning, end (and possibly it break of slope) of the transition, the zone length R and the P2 end are dissociated in C several parts to which homotheties are applied. In the fissured case, if transition from thickness begins in the block from incrustation, this one is not modified (except if transition begins outside the block fissures) and the beginning of the transition from thickness is not in it not positioned case in an exact and rectilinear way.***

***The longitudinal size of the elements in the zone length R can vary in manner enough C important following homotheties. It is in this case advised to modify the value of and of to recompute the value of R so that the length R remains unchanged while modifying it C C longitudinal cutting of this zone. It is thus possible to change the longitudinal size of elements of the plate which decreases when increases. The limits of the transition from thickness have then more chance to coincide or to approach the initial position of the nodes grid.***

***Rc  
(ltran) or (. Rc)  
2  
1  
P2 end***

*e\_t2*  
*e\_ti*  
*P1 end*  
*e\_t1*

***Appear 4.3.10-a: Cut thickness of the tube with transition from thickness to two slopes***

### ***4.3.11 Operand DEXT***

***DEXT =***  
***Of***

***Obligatory key word if there is no transition from thickness. Value of the external diameter of the elbow and right ends.***

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### ***4.3.12 THICK operand***

***THICK =***  
***E***

***Obligatory key word if there is no transition from thickness. Value thickness of the elbow and of ends.***

***Note:***



*The beaches of use for this parameter are different according to the type of defect considered:*

-  
*pricking with a single under-thickness: the  $Rm/e$  report/ratio must lie between 5 and 50, where  $Rm$  indicates the average radius;*

-  
*pricking fissured or with under-thicknesses multiple: the  $Rm/e$  report/ratio must be included/understood between 5 and 21.*

*In this last case, it is possible to generate a grid for reports/ratios going up to 50. An alarm is however emitted to announce that the quality of the grid obtained is not guarantee (too stretched meshes, overflow of L `memory capacity...).*

#### **4.3.13 Operand DEXT\_T1**

**DEXT\_T1 =**  
**De\_t1**

*Obligatory operand if there is a transition from thickness. Value of the external diameter of the elbow before the transition from thickness. It must respect 112 mm De\_t1 880 mm if the transition of thickness is to a slope and 77 mm De\_t1 355 mm if the transition from thickness is to two slopes.*

#### **4.3.14 Operand EPAIS\_T1**

**EPAIS\_T1 =**  
**e\_t1**

*Obligatory operand if there is a transition from thickness. Value thickness of the elbow before transition from thickness. It must respect 12 mm e\_t1 80 mm if the transition from thickness is with a slope and 7 mm e\_t1 35 mm if the transition from thickness is with two slopes.*

#### **4.3.15 Operand EPAIS\_T2**

**EPAIS\_T2 =**  
**e\_t2**

*Obligatory operand if there is a transition from thickness. Value thickness of the elbow after transition from thickness. It must respect 20 mm e\_t2 110 mm if the transition from thickness is to a slope and 15 mm e\_t2 40 mm if the transition from thickness is with two slopes.*

#### **4.3.16 Operand ANGL\_TETA1**

**ANGL\_TETA1 =**  
**teta1**

***Obligatory operand if there is a transition from thickness. Value of the angle of inclination of transition from thickness (first slope if there are two of them). It must respect 0° teta1 30°.***

#### ***4.3.17 Operand ANGL\_TETA2***

***ANGL\_TETA2 =  
teta2***

***Operand optional, indicating if it is present a transition from thickness at two slopes. Value of the angle of inclination of the second slope of the transition from thickness. It must respect 0° teta2 45°.***

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#### ***4.3.18 Operand EPAIS\_TI***

***EPAIS\_TI =  
e\_ti***

***Obligatory operand if there is a transition from thickness to two slopes. Value thickness of bend intermediate during the break of slope. It must respect 15 mm e\_ti 40 mm and e\_t1 e\_ti e\_t2.***

#### ***4.3.19 Operand ABSC\_CURV\_TRAN***

***/  
ABSC\_CURV\_TRAN***

**= ltran**

***Obligatory operand if there is a transition from thickness and if key word POSI\_ANGU\_TRAN is absent. Value of the longitudinal position of the beginning of the transition from thickness given by the curvilinear X-coordinate along the axis of the elbow on the external skin of this one, counted positively starting from the interface with the P1 end.***

***If the defect is a circumferential crack located at a curvilinear distance sf of the interface with the end P1, ltran must respect:  $0 \leq sf \leq R$ .***

**C**

***If the defect is a under-thickness whose center is located at a distance sf interface with the end P1 and whose width (AXE\_LONGI) is worth 2b, ltran must respect:  $0 \leq sf+b \leq R$ .***

**R.**

**C**

#### **4.3.20 Operand POSI\_ANGU\_TRAN**

**/**

**POSI\_ANGU\_TRAN**

**= phi**

***Obligatory operand if there is a transition from thickness and if operand ABSC\_CURV\_TRAN is absent. Value of the longitudinal position of the beginning of the transition from thickness given by angular position, counted positively starting from the interface with the P1 end. The X-coordinate curvilinear along the axis of the elbow on the external skin of this one ltran then = R. is worth.***

**C**

***If the defect is a circumferential crack located at a curvilinear distance sf of the interface with the P1 end, must respect:  $0 \leq sf \leq R$ .***

**C**

**C**

***If the defect is a under-thickness whose center is located at a distance sf interface with the P1 end and whose width (AXE\_LONGI) is worth 2b, must respect:  $0 \leq sf+b \leq R$ .***

**C**

**C**

#### **4.4**

**Key word factor SOUS\_EPAIS\_COUDE or SOUS\_EPAIS\_MULTI**

***These two key words factor make it possible to model an elbow or a tube comprising only one pennies thickness (key word SOUS\_EPAIS\_COUDE) thanks to a procedure of grid equipped with déraffinement***

***automatic, or to model one or more under-thicknesses (key word SOUS\_EPAIS\_MULTI)***

*by a procedure of uniformly regulated grid. One repeats key word SOUS\_EPAIS\_MULTI for each under-thickness to be defined.*

#### **4.4.1 Operand TYPE**

**TYPE**

*Allows to define the type of under-thickness to be modelled:*

*“ELLI”: under thickness of the elliptic type defined by its axes circumferential and longitudinal.*

*“AXIS”: under axisymmetric thickness defined by its longitudinal axis.*

#### **4.4.2 Operand AXE\_CIRC**

**AXE\_CIRC = 2a**

*Length of the circumferential axis under-thickness measured in curvilinear X-coordinate in skin external on the elbow, even if the under-thickness is located in internal skin. Is used only if TYPE = “ELLI”.*

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#### **4.4.3 Operand AXE\_LONGI**

**AXE\_LONGI = 2b**

*Length of the longitudinal axis under-thickness measured in curvilinear X-coordinate in skin external on the elbow, even if the under-thickness is located in internal skin.*

#### **4.4.4 Operand**

**DEPTH**

**DEPTH =**

**C**

*Value maximum depth measured in the center under-thickness.*

#### **4.4.5 Operand**

**POSI\_CURV\_LONGI**

**/POSI\_CURV\_LONGI =**

**sl**

*Value of the longitudinal position of the center under-thickness given by the curvilinear X-coordinate along the axis of the elbow on the external skin of this one, counted positively from the interface with the end length  $l_{tube\_p1}$ . This value must lie between 0 and R.*

**C**

#### **4.4.6 Operand**

**POSI\_ANGUL**

**/**

**POSI\_ANGUL =**

**beta**

*Value of the longitudinal position of the center under-thickness given by the angle in degrees formed by the section containing this one and the section with the interface with the end length  $l_{tube\_p1}$ . This value must lie between 0 and.*

#### **4.4.7 Operand**

**POSI\_CURV\_CIRC**

**/POSI\_CURV\_CIRC =**

**Sc**

*Value of the circumferential position of the center under-thickness given by the X-coordinate curvilinear on the external skin of this one, counted positively starting from the suction face. This value must lie between 0 and  $O_f$ . If under-thickness is of the axisymmetric type, the center is by convention positioned in under-surface ( $De/2$ ) and must be indicated like tel.*

#### **4.4.8 Operand**

**AZIMUTH**

**/**  
**AZIMUTH**  
**=**  
**phi**

*Value of the circumferential position of the center under-thickness counted positively in degrees starting from the suction face to the under-surface while passing by the left side. This value must to lie between 0 and 360 degrees. If under-thickness is of the axisymmetric type, the center is by convention positioned in under-surface (180 degrees) and must be well informed like tel.*

#### **4.4.9 Operand**

**SOUS\_EPAIS**

**SOUS\_EPAIS**

*Allows to define the position under-thickness on the skin of the elbow:*

*“INTERN” under-thickness in skin interns elbow,  
“EXTERNAL” under-thickness in external skin of the elbow.*

#### **4.4.10 Operand NB\_ELEM\_LONGI**

**NB\_ELEM\_LONGI**  
**= nl**

*Allows to define the number of elements present on the longitudinal axis under-thickness.*

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**Note:**

**1) The stage of treatment of the macro-order which transforms successively the grid of plate initial in elbow with for effect to compress the meshes in zone longitudinally under-surface and to dilate them in zone suction face. In the event of defect positioned in these zones, it**

**a number of elements defined on the longitudinal axis (which is used to create the grid of plate initial) will be able to see itself slightly reduced or increased. Thus for a under-thickness axisymmetric, the number of elements present longitudinally can vary from two units on an elbow with 90°. Generally, one will advise with the user to discretize sufficient axes defect. The elliptic profile under-thickness will be only better.**

**1) The case of a defect located at horse between elbow and end can cause a representation under-thickness which is not perfectly symmetrical in the longitudinal direction. This is had with the same phenomenon as previously added to the fact that the part the under-thickness present in the end does not undergo geometrical transformation. There still, one can to advise with the user to refine the longitudinal axis to correct this light dissymmetry.**

#### **4.4.11 Operand NB\_ELEM\_CIRC**

**NB\_ELEM\_CIRC =**  
**nc**

**Allows to define the number of elements present on the circumferential axis under-thickness.**

**Note:**

**ATTENTION with coherence enters the circumferential number of elements, the number of elements longitudinal and geometry under-thickness. In particular, when this one is circumferential, the circumferential number of elements must be about 20.**

#### **4.4.12 Operand IMPRESSED**

**PRINT**  
**=**  
**/**  
**“YES”,**  
**[DEFECT]**

*The under-thickness is dug: points belonging to the defining half-ellipsoid under-thickness undergo a geometrical transformation proportional in the thickness.*

/

**“NOT”**,

*The under-thickness is not dug: the geometrical transformation of the points defining it is not activated. The grid does not comprise a under-thickness.*

#### **4.4.13 Operand NB\_ELEM\_RADI**

**NB\_ELEM\_RADI**  
**= NR**

*Allows to radially define the number of elements present (in the direction thickness of bend) at the place of the under-thickened zone. By defect, this value is three as for current part of the elbow.*

**Caution:**

*This option N` is valid that for key word SOUS\_EPAIS\_COUDE calling upon the procedure of grid with déraffinement of an elbow with only one under-thickness.*

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**4.5**

**Key word factor FISS\_COUDE**



*Three cases of figure are possible to distinguish the short cracks and the long cracks. distinction is made according to the ap/cp report/ratio (ap being the depth and CP the half-length of the crack on the plate before transformation into tube or elbow):*

*the cracks are short elliptic if  $ap/cp > 0.2$ ,*

*the cracks are long with the rectilinear bottom and the round ends if  $0.1 < ap/cp < 0.2$  or if the orientation is longitudinal,*

*the cracks are long with the rectilinear bottom if  $ap/cp < 0.1$  and if the orientation is circumferential (it is the case in particular for the axisymmetric cracks).*

#### **4.5.1 Operand DEPTH**

**DEPTH = has**

*Half length of the small axis of the crack measured on the elbow in internal or external skin following the skin on which the crack is.*

#### **4.5.2 Operand LENGTH**

**LENGTH =  $2c$**

*Length of the large axis of the crack measured on the elbow in internal or external skin according to skin on which the crack is. This length is obligatory if the crack is not axisymmetric. It is on the other hand ignored if it is provided and that the crack is axisymmetric.*

#### **4.5.3 Operand AXIS**

**AXIS =/  
"YES",  
/  
"NOT",  
[DEFECT]**

*Optional key word indicating if the crack is axisymmetric or not.*

#### **4.5.4 Operand ABSC\_CURV**

***/ABSC\_CURV = sf***

***Value of the position of the center of the crack given by the curvilinear X-coordinate along the axis of bend on the internal or external skin (according to the position of the crack), positively counted with to leave the interface with the end length l\_tube\_p1. This value must lie between 0 and  $[Rc + (Rm + e/2) \cos(\phi)]$  where 1 is worth if the defect is in external skin and 1 if not.***

#### ***4.5.5 Operand***

***POSI\_ANGUL***

***/  
POSI\_ANGUL =  
beta***

***Value of the longitudinal position of the center of the crack given by the angle in degrees formed by the section containing this one and the section with the interface with the end length l\_tube\_p1. This value must lie between 0 and.***

#### ***4.5.6 Operand***

***AZIMUTH***

***AZIMUTH  
=  
phi***

***Value of the circumferential position of the center of the crack counted positively in degrees with to leave the suction face to the under-surface while passing by the left side. The position defined by defect is located on the left side (azimuth equal to 90 degrees). The azimuth must lie between 0° and 180°.***

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#### ***4.5.7 Operand*** ***ORIEN***

***ORIEN =***  
***xsi***

***Value of the angle in degrees formed by the large axis of the crack and the generator of the elbow thus giving the orientation of the defect.***

***Caution:***

***Only three types of orientation are possible:***

- ***longitudinal crack (xsi = 0 degree),***
- ***circumferential crack (xsi = + 90 degrees),***
- ***tilted crack (xsi = +45 or -45 degrees), only for the short cracks.***

***A longitudinal crack cannot encroach on one of the two right ends, or both right ends at the same time. On the other hand, the block fissures can it. In other words, the crack must inevitably to be in the elbow, the block crack can overflow on the right ends.***

#### ***4.5.8 Operand*** ***FISSURE***

***FISSURE***

***Allows to define the position of the crack on the skin of the elbow:***

***“DEB\_INT” fissures emerging in internal skin of the elbow,***  
***“DEB\_EXT” fissures emerging in external skin of the elbow.***

#### ***4.5.9 Operand*** ***NB\_TRANCHE***

***NB\_TRANCHE = NT***

***For the short cracks, numbers sections along the bottom of crack on a quarter of ellipse.***

*The total number of sections is then this data multiplied by two (see [Figure 4.5.9-a]). This value must be a power of 2 and must be worth 8 at least.*

*For the long cracks with round ends, NT is the total number of sections, included/understood between 20 and 186 on the totality of the bottom of crack, with 8 sections for each round end and between 4 and 170 sections on the rectilinear part.*

*For the long cracks at rectilinear bottom only, the number of sections must be included/understood between 8 and 40.*

*In the case of the circumferential cracks, the following table provides an estimate of the number of sections reasonable for the rectilinear part of the long cracks according to the  $2c$  ratio/ $2R_m$  (length of the crack over width of the plate) for two levels of refinement. For long cracks with round ends, 16 sections thus should be added.*

*C/Rm >*

*0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18*

*0.2 0.22 0.24 0.26 0.28 0.32 0.34 0.36*

*C/Rm < 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2 0.22 0.24 0.26 0.28 0.32 0.34 0.36*

*1*

*NT*

*at the end of 8 10 12 14 16 18*

*20*

*22*

*24*

*26*

*28*

*30*

*32*

*34 36 38 40*

*40*

*NT*

*large 4 4 6.6 8 8 10*

*10*

*12*

*12*

*14*

*14*

*16*

*16 18*

*18 20*

*20*

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***In the case of the longitudinal cracks or of the cracks having a report/ratio has/C such as 0.1 A/C < 0.2, the number of sections can vary between 20 and 186. included. A report/ratio is needed of stretching of the meshes from approximately 10 (large side/small side), a report/ratio of stretching about 20 being acceptable.***

***crowns***

***rc0\*rc1***

***rc0\*rc2***

***rc0\*rc3***

***rc0***

***sections***

***sectors***

***Appear 4.5.9-a: Parameters of the basic grid radiating of crack***

***4.5.10 Operand NB\_SECTEUR***

***NB\_SECTEUR = NS***

***A number of sectors on 90 degrees in a crown of the torus modelling the bottom of crack. numbers total sectors on a crown is then this data multiplied by four (see [Figure 4.5.9-a]).***

***For the long cracks, this value must be worth 2, 3 or 4. For the other types of crack this value should not exceed 8.***

#### **4.5.11 Operand NB\_COURONNE**

**NB\_COURONNE = nc**

*A number of crowns of the grid radiating around the bottom of crack, including the crown formed power station of prisms (see [Figure 4.5.9-a]).*

*For the long cracks, this value must be worth 3 or 4.*

#### **4.5.12 Operand RAYON\_TORE**

**RAYON\_TORE = rc0**

*Allows to define the value of the ray of the torus of the zone in imposed grid of radiant type around the bottom of crack (see [Figure 4.5.9-a]). Are with the depth of the crack and E the thickness of the pipe, by defect, the ray is worth:*

*rc0*

*rc =*

*ref. has where rc ref. = 2 mm*

*superior*

*is*

*sections*

*of*

*numbers*

*if*

*16,*

*with*

*equal*

*or*

*0*

*,  
0 2*

*0*

*E*

= 5

.

1 mm

if not.

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#### **4.5.13 Operand COEF\_MULT\_RC2**

**COEF\_MULT\_RC2**

= rc2

*Value of the multiplying coefficient of rc0 allowing to define the thickness of the first crown déraffinement sections (see [Figure 4.5.9-a]). By defect this coefficient is worth 1.*

#### **4.5.14 Operand COEF\_MULT\_RC3**

**COEF\_MULT\_RC3**

= rc3

*Value of the multiplying coefficient of rc0 allowing to define the thickness of the second crown déraffinement sections (see [Figure 4.5.9-a]). By defect, this coefficient is worth 1 if the number of sections is lower than 16 and 1.4 if not.*

#### **4.5.15 Operand ANGL\_OUVERTURE**

**ANGL\_OUVERTURE**

= *eps*

*Value in degrees of the half angle of opening of the crack. By defect, eps is worth 0.5.*

#### **4.6 Key word**

**factor**

**IMPRESSION**

##### **4.6.1 Operand**

**FILE**

**FILE = nom\_fichier**

*Name given to the print file. By defect, the print file is the file of the type grid Aster (.mast). It is thus important to put this type of file in the profile of study if one uses the default options of the key word IMPRESSION.*

##### **4.6.2 Operand**

**UNIT**

**UNIT = unit**

*Logical number of unit associated the print file.*

##### **4.6.3 Operand**

**FORMAT**

**FORMAT**

*Allows to specify the format of impression of the grid. By defect the format is "ASTER".*

##### **4.6.4 Operand**

**VERSION**

**VERSION**

*If and only if the operand FORMAT is worth "IDEAS", this operand makes it possible to specify the version*

*Ideas software. By defect VERSION is worth 5. Only versions 4 and 5 are supported.*

##### **4.6.5 Operand**

**NIVE\_GIBI**

**NIVE\_GIBI**



***If and only if the operand `FORMAT` is worth “`CASTEM`”, this operand makes it possible to specify the level***

***software `GIBI` in which the grid will be printed. By defect `VERSION` is worth 10. Only them levels 3 and 10 are supported.***

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## **4.7 Operand INFORMATION**

*INFORMATION*

=

*Indicate the level of impression of the results of the operator,*

1:  
*no impression,*

2:  
*impression of information relating to the grid.*

*The impressions are made in the file "MESSAGE".*

## **5 Topological grid and groups**

### **5.1 Grid of plate**

*Grid of plate 3D produced by the procedure of grid GIBI before geometrical transformation out of tube or elbow is defined as follows:*

### **Plate generated by procedure GIBI**

*Rm*

: average radius,

*alpha*

: angle of the elbow in radians,

*E*:

thickness,

*Rc*

: ray of bending,

*L\_TUBE\_P1*

: length of the P1 end,

*L\_TUBE\_P2*

: length of the P2 end.

The reference mark of the grid plate is at the base of the part bends (interface between the zone bends and

the end P1), the plate occupies the following fields: X [ $Rm-e/2$ ,  $Rm+e/2$ ], Y [ $- *Rm$ ,  $*Rm$ ], Z [ $- L\_TUBE\_P1$ ,  $Alpha*Rc + L\_TUBE\_P2$ ].

Macro order *MACR\_ASCOUF\_MAIL* generates the following grids according to the geometry wished (healthy elbow, elbow with crack, elbow with under-thicknesses):

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**5.2**

**Regulated healthy elbow**

The grid thus carried out comprises the following geometrical groups (the fields are given in the reference mark grid plates):

**P4SGV**  
**P3SGV**  
*SGV top Steam Generator*  
**BOU3**  
**BOU1**  
**P2SGV**  
**P1SGV**  
**P3SC**  
*SC top bends*  
**P4SC**  
**P1SC**  
**P2SC**  
**MED2 MED3**  
**MED4**  
**MED5**  
**MED6**  
**MED1**  
**P3BC**  
**P4BC**  
*BC bases elbow*  
**P2BC**  
**P1BC**  
**POVBC PEDBC PGABC**  
**PIDBC**  
**PDRBC**  
**P4BT**  
**P3BT**  
*BT bases tube*  
**P1BT POVBT PEDBT PGABT**  
**PIDBT**  
**PDRBT**  
**P2BT**

***Geometrical groups of the healthy elbow regulated before transformation into elbow***

- .  
*MED6: group nodes nearest made up of the node located in external skin on the right side median section of the part bends ( $X = Rm+e/2$ ,  $Y = *Rm$ ,  $Z = *Rc/2$ ),*
- .  
*MED5: group nodes more made up of the node located in external skin on the under-surface close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = *Rm/2$ ,  $Z = *Rc/2$ ),*
- .  
*MED4: group nodes more made up of the node located in external skin on the left side*

close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = 0$ ,  $Z = *Rc/2$ ),

MED3: group nodes more made up of the node located in external skin on the suction face close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = - *Rm/2$ ,  $Z = *Rc/2$ ),

MED2: group nodes more made up of the node located in external skin close to the section median of the part bends ( $X = Rm+e/2$ ,  $Y = -4 ** Rm/5$ ,  $Z = *Rc/2$ ),

MED1 (=MED6 on the elbow): group nodes made up of the node located in external skin on right side more close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = - *Rm$ ,  $Z = *Rc/2$ ).

**Groups of points useful for the boundary conditions of the beam type:**

BOU1: group nodes made up of the node located in external skin on the left side at top of the P2 end or the bowl ( $X = Rm-e/2$ ,  $Y = 0$ ,  $Z = *Rc + l\_tube\_p2 + length\ bowl$ ),

BOU3: group nodes made up of the node located in external skin on the right side at the top P2 end or bowl ( $X = Rm-e/2$ ,  $Y = +*Rm$ ,  $Z = *Rc + l\_tube\_p2 + length\ bowl$ ),

P1: node located at the center section EXTUBE,

P2: node located at the center section CLGV.

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### **Groups of points defining the generators of the elbow:**

.  
*LEFT: group nodes constituting the whole of the nodes located in external skin on left side of the elbow and the ends ( $X = Rm+e/2$ ,  $Y = 0$ ),*

.  
*RIGHT: group nodes constituting the whole of the nodes located in external skin on the side right of the elbow and the ends ( $X = Rm+e/2$ ,  $Y = - *Rm$ ),*

.  
*INTRA: group nodes constituting the whole of the nodes located in external skin on the under-surface elbow and ends ( $X = Rm+e/2$ ,  $Y = +*Rm/2$ ),*

.  
*EXTRA: group nodes constituting the whole of the nodes located in external skin on the suction face of the elbow and the ends ( $X = Rm+e/2$ ,  $Y = - *Rm/2$ ).*

### **Group linear meshes:**

.  
*BORDTU: contour interns section at the end of the P1 end ( $Z = - l\_tube\_p1$ ).*

### **Group surface meshes:**

.  
*PEAUEXT: external skin of the elbow and the ends ( $X = Rm+e/2$ ),*

.  
*PEAUINT: skin interns elbow and ends ( $X = Rm-e/2$ ),*

.  
*EXTUBE: section at the end of the P1 end ( $Z = - l\_tube\_p1$ ),*

.  
*CLGV: section at the end of the P2 end ( $Z = *Rc+ l\_tube\_p2$ ).*

### **Very Important:**

*The elements of skin described above have an external outgoing normal in external skin and one outgoing normal interns in internal skin.*

### **Group voluminal meshes:**

.  
*BEND: group voluminal meshes constituting the elbow, the P1 end and the P2 end representing the part of the stainless structure made up,*

.  
*PACOUDE: group voluminal meshes constituting elbow ( $0 Z *Rc$ ),*

*EMBOUTTU: group voluminal meshes constituting the P1 end (- l\_tube\_p1 Z 0),*

.

*EMBOUTGV: group voluminal meshes constituting the end P2 (\*Rc Z \*Rc + l\_tube\_p2),*

.

*MA: group meshes containing the whole of the voluminal and surface meshes defined, thus that discrete meshes.*

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## 5.3

### ***Bend with under-thicknesses***

#### ***Bend with under-thicknesses (ELBOW)***

*With the exit of the execution of the procedure, the grid will give a report on the following topological entities in order to facilitate visualization, the application of the loadings, the assignment of the boundary conditions and mechanical analysis:*

.

#### ***BEND***

*: together voluminal elements of the grid bends and ends,*

.

#### ***CLGV***

*: elements of membrane located at the end of the P2 end,*

.

**EXTUBE**

: elements of membrane located at the end of the P1 end,

.

**PEAUINT**

: elements of membrane located in internal skin of the structure,

.

**PEAUEXT**: elements of membrane located in external skin of the structure,

.

**BOU1**

: node located at the end of the P2 end in external skin and left side,

.

**BOU3**

: node diametrically opposed to BOU1 on the section of the tube, located at the end P2 end in external skin and right side,

.

**P1**

: node located at the center of section EXTUBE,

.

**P2**

: node located at the center of section CLGV,

.

**BORDTU**: contour interns section at the end of the P1 end ( $Z = 0$ ).

Points BOU1 and BOU3 are located left side and right side for an azimuth of the defect  $=90^\circ$ , they “turn” if this one is different. Eight groups of nodes formed by the ligaments in the thickness taken all the 45 degrees (or closest to these positions) on a section are prefixed in the following way:

*FDRO* (right side)

*EXDR*

*INDR*

*Y*

*EXTR*

*X*

*INTR*

*Z*

(suction face)

(under-surface)

*EXGA* (between suction face and

*INGA* (between under-surface and  
left side)

left side)

*FGAU* (left side)



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.  
**EXGAMI, FGAUMI, INGAMI, INTRMI, INDRMI, FDROMI, EXDRMI, EXTRMI:** groups of nodes formed by the ligaments in the thickness all 45 degrees on the median section of the elbow (or nearest).  
.

.  
**EXGATU, FGAUTU, INGATU, INTRTU, INDRTU, FDROTU, EXDRTU, EXTRTU:** groups of nodes formed by the ligaments in the thickness all the 45 degrees on the section interfaces between the end tubes and the elbow.  
.

.  
**EXGAGV, FGAUGV, INGAGV, INTRGV, INDRGV, FDROGV, EXDRGV, EXTRGV:** groups of nodes formed by the ligaments in the thickness all the 45 degrees on the section interfaces between the end Steam Generator and the elbow.  
.

.  
**EXGAx, FGAUx, INGAx, INTRx, INDRx, FDROx, EXDRx, EXTRx:** groups of formed nodes by the ligaments in the thickness all 45 degrees on the section corresponding to the thickness minimal the N°x under-thickness.  
.

*For the nonaxisymmetric under-thicknesses:*

.  
**CIRx\_y:** group nodes representing the circumferential ligament n°y under-thickness n°x. The ligaments are sorted according to Y's growing on the grid plates.  
.

.  
**LONx\_z:** group nodes representing the longitudinal ligament n°z under-thickness n°x.

*The ligaments are sorted according to Z growing on the grid plates.*

*.  
PCIRCx: together nodes the  $N^{\circ}x$  under-thickness located on the circumferential axis and at right of this one on all the thickness,*

*.  
PLONGx: together nodes the  $N^{\circ}x$  under-thickness located on the longitudinal axis and at the right of this one on all the thickness,*

*.  
PCENTx: together nodes the  $N^{\circ}x$  under-thickness located at the center of the ellipse and the right of this one on all the thickness (intersection of the groups PLONGx and PCIRCx),*

***Important:***

*For each ligament, the nodes are ordered external skin with the internal skin.*

*Center*

*Circumferential*

*CIR1\_1*

*.....*

*CIR1\_9*

*Longitudinal axis*

*LON1\_5*

*.....*

*ligaments*

*LON1\_1*

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### 5.3.1 Case of the half-structure

The following entities present but are associated places different from the whole structure:

.

#### **CLGV**

: elements of membrane located in median section forming the symmetry plane transverse of the elbow,

.

#### **BOU1**

: node located on the median section in external skin on the left side for one azimuth of the defect of  $90^\circ$ ,

.

#### **BOU3**

: node diametrically opposed to BOU1 on the median section, located in skin external on the right side,

.

#### **P2**

: node located at the center section CLGV.

Ligaments **EXGAGV**, **FGAUGV**, **INGAGV**, **INTRGV**, **INDRGV**, **FDROGV**, **EXDRGV**, **EXTRGV** do not exist.

Boundary conditions for a half-structure in order to block displacements of rigid body and to simulate the conditions of symmetry are as follows (is the angle of the elbow and the azimuth of the defect):

.

Blocking of normal displacement to the median section (CLGV):

$DZ = 0$  for a tube,

$DNOR = 0$  for an elbow.

.

A point on the aforementioned section blocked in the plan of this one:

$DX = DY = 0$  for a tube,

$DY = 0$  and  $\cos(\alpha) DX - \sin(\alpha) DZ = 0$  for an elbow.

.

The point opposed symmetrically (located at azimuth  $1$ ) to the precedent in the section, blocked in tangent displacement with the aforementioned section:

$\sin(\alpha) DX + \cos(\alpha) DY = 0$  for a tube,

$\sin(\alpha) \cos(\beta) DX + \cos(\alpha) DY - \sin(\alpha) \sin(\beta) DZ = 0$  for an elbow.

**Note:**

One can also for the half-structure plan to preserve the principle of the connection 3D-beam (used with whole modeling in the MACR\_ASCOUF\_CALC) with a node in the middle of median section (in fact P2).

### 5.3.2 Case of the quarter of structure

The modifications are similar to the preceding paragraph. Moreover, two edges forming the plan of symmetry longitudinal of the elbow are available:

**BORD1**

: elements of membrane located left side for an azimuth of defect =90°,

**BORD2**

: elements of membrane located right side for an azimuth of defect =90°.

Boundary conditions for a quarter of structure in order to block displacements of rigid body and to simulate the conditions of symmetry are as follows (is the angle of the elbow and the azimuth of defect):

**Blocking of normal displacement to the median section (CLGV):**

$DZ = 0$  for a tube,

$DNOR = 0$  for an elbow.

**Blocking of the longitudinal symmetry plane of the tubular structure:**

$DNOR = 0$  on BORD1 and BORD2.

**Blocking of displacement perpendicular to the longitudinal symmetry plane of one of the points (BOU3 to avoid taking the point located in the zone of the defect which is BOU1) located at the intersection of the two plans previously quoted:**

$\cos(\alpha) DX + \sin(\alpha) DY = 0$  for a tube,

$\cos(\alpha) \cos(\beta) DX + \sin(\alpha) DY - \cos(\alpha) \sin(\beta) DZ = 0$  for an elbow.

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## 5.4

***Bend with crack***

***The grid thus carried out comprises the following geometrical groups (the fields are given in the reference mark grid plates):***

***Z  
SGV top Steam Generator or bowl  
BOU1  
BOU3  
LGV  
SC top bends  
ksiref  
block fissures  
MED1 MED2 MED3  
MED4  
MED5  
MED6  
Alpha\*Rc  
BC bases elbow  
Sf  
octagone  
MIL1 MIL2 MIL3  
MIL4  
MIL5  
MIL6  
Y1  
Z1  
X***

**Y****BT bases tube****LT****EXT1 EXT2 EXT3****EXT4****EXT5****EXT6****2Rm**

*The following points are located for an azimuth of the defect =90°, they “turn” if this one is different:*

.

*EXT6: group nodes made up of the node located in external skin on the right side at the base of the end tubes ( $X = Rm+e/2$ ,  $Y = *Rm$ ,  $Z = -l\_tube\_p1$ ),*

.

*EXT5: group nodes made up of the node located in external skin on the under-surface at the base of the end tubes ( $X = Rm+e/2$ ,  $Y = *Rm/2$ ,  $Z = -l\_tube\_p1$ ),*

.

*EXT4: group nodes made up of the node located in external skin on the left side at the base end tubes ( $X = Rm+e/2$ ,  $Y = 0$ ,  $Z = -l\_tube\_p1$ ),*

.

*EXT3: group nodes made up of the node located in external skin on the suction face at the base of the end tubes ( $X = Rm+e/2$ ,  $Y = - *Rm/2$ ,  $Z = -l\_tube\_p1$ ),*

.

*EXT2: group nodes made up of the node located in external skin at the base of the end tubes ( $X = Rm+e/2$ ,  $Y = -4 ** Rm/5$ ,  $Z = -l\_tube\_p1$ ),*

.

*EXT1 (= EXT6 on the elbow): group nodes made up of the node located in external skin on right side at the base of the end tubes ( $X = Rm+e/2$ ,  $Y = - *Rm$ ,  $Z = -l\_tube\_p1$ ),*

.

*MIL6: group nodes made up of the node located in external skin on the right side at the interface end tubes and bends ( $X = Rm+e/2$ ,  $Y = *Rm$ ,  $Z = 0$ ),*

.

*MIL5: group nodes made up of the node located in external skin on the under-surface at the interface end tubes and bends ( $X = Rm+e/2$ ,  $Y = *Rm/2$ ,  $Z = 0$ ),*

.

*MIL4: group nodes made up of the node located in external skin on the side at the interface end tube and bends ( $X = Rm+e/2$ ,  $Y = 0$ ,  $Z = 0$ ),*

.

*MIL3: group nodes made up of the node located in external skin on the suction face at the interface end tubes and bends ( $X = Rm+e/2$ ,  $Y = - *Rm/2$ ,  $Z = 0$ ),*

.  
**MIL2: group nodes made up of the node located in external skin at the interface end tubes and bend ( $X = Rm+e/2$ ,  $Y = -4 ** Rm/5$ ,  $Z = 0$ ),**  
.

**MIL1 (= MIL6 on the elbow): group nodes made up of the node located in external skin on right side with the interface end tubes and bends ( $X = Rm+e/2$ ,  $Y = - *Rm$ ,  $Z = 0$ ),**

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.  
**MED6: group nodes nearest made up of the node located in external skin on the right side median section of the part bends ( $X = Rm+e/2$ ,  $Y = *Rm$ ,  $Z = *Rc/2$ ),**  
.

**MED5: group nodes more made up of the node located in external skin on the under-surface close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = *Rm/2$ ,  $Z = *Rc/2$ ),**  
.

**MED4: group nodes more made up of the node located in external skin on the left side close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = 0$ ,  $Z = *Rc/2$ ),**  
.

**MED3: group nodes more made up of the node located in external skin on the suction face close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = - *Rm/2$ ,  $Z = *Rc/2$ ),**  
.

**MED2: group nodes more made up of the node located in external skin close to the section median of the part bends ( $X = Rm+e/2$ ,  $Y = -4 ** Rm/5$ ,  $Z = *Rc/2$ ),**  
.

**MED1 (=MED6 on the elbow): group nodes made up of the node located in external skin on right side more close to the median section of the part bends ( $X = Rm+e/2$ ,  $Y = - *Rm$ ,  $Z =$**

*\*Rc/2),*

*BORDTU: contour interns section at the end of the end tubes ( $Z = -l\_tube\_p1$ ).*

*Groups of points useful for the boundary conditions of the beam type:*

*BOU1: group nodes made up of the node located in external skin on the left side at top of the P2 end or the bowl ( $X = Rm-e/2, Y = 0, Z = *Rc + l\_tube\_p2 + \text{length bowl}$ ),*

*BOU3: group nodes made up of the node located in external skin on the right side at the top P2 end or bowl ( $X = Rm-e/2, Y = +*Rm, Z = *Rc + l\_tube\_p2 + \text{length bowl}$ ),*

*P1: node located at the center of section EXTUBE,*

*P2: node located at the center of section CLGV.*

*Group surface meshes:*

*PEAUEXT: group meshes containing the whole of the surface meshes constituting the skin external of the elbow and the ends ( $X = Rm+e/2$ ),*

*PEAUINT: group meshes containing the whole of the surface meshes constituting the skin intern of the elbow and the ends ( $X = Rm-e/2$ ),*

*FACE1: group meshes containing the upper lip of the crack ( $Z1=0-$  plan) of which the orientation of the normal is positive towards  $Z1$  positive,*

*FACE2: group meshes containing the lower lip of the crack ( $Z1=0+$  plan) of which the orientation of the normal is positive towards  $Z1$  negative,*

*EXTUBE: group surface meshes constituting the end of the end tubes ( $Z = -l\_tube\_p1$ ).*

*Very Important:*

*The elements of skin described above have an external outgoing normal in external skin and one outgoing normal interns in internal skin.*

*Group voluminal meshes for the short cracks:*

*BLOCFISS: group meshes constituting the block fissures symmetrized,*



.  
**QUARBLOC:** group meshes constituting the quarter of initial block ( $Y1 > 0$  and  $Z1 < 0$ ),

.  
**BLOCOCTO:** group meshes constituting the block fissures symmetrized and the octagone of incrustation,

.  
**TORE1:** half torus ( $Z1 = 0^-$ ) containing the bottom of crack and part of FACE1,

.  
**TORE2:** half torus ( $Z1 = 0^+$ ) containing the bottom of crack and part of FACE2 (complement of TORE1),

.  
**BEND:** group meshes constituting the whole of the voluminal and surface meshes definite on the grid,

.  
**BOWL:** group meshes constituting the grid of end of the bowl type.

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*Group voluminal meshes for the long cracks (a/c 0.2):*

.  
**BLOCFISS:** group meshes constituting the block fissures symmetrized,

.  
**BLOFISS1:** group meshes constituting the half-block fissures symmetrized ( $Z = 0$ ),

.  
**BLOFISS2:** group meshes constituting the half-block fissures symmetrized ( $Z = 0$ ),

***TORE1: half torus ( $Z1=0^-$ ) containing the bottom of crack and part of FACE1,***

.

***TORE2: half torus ( $Z1=0^+$ ) containing the bottom of crack and part of FACE2 (complement of TORE1),***

.

***BEND: group meshes constituting the whole of the voluminal meshes definite on the grid,***

.

***BOWL: group meshes constituting the grid of end of the bowl type.***

***Group nodes:***

.

***FONDFISS: group nodes constituting the bottom of crack describes in the order of Y1 negative in Y1 positive,***

.

***CLGV: group nodes constituting the end of the P2 end ( $Z = *Rc + l\_tube\_p2$ ),***

.

***P\_AXE\_1: group nodes constituting the small axis of the crack ( $Z1 = 0$ ) ordered in the direction melts of crack - > emerging face,***

.

***P\_AXE\_2: group nodes constituting the small axis of the crack ( $Z1 = 0^+$ ) ordered in feel bottom of crack - > emerging face,***

.

***G\_AXE\_1: group nodes constituting the large axis of the crack ( $Z1 = 0$ ) ordered in feel  $Y<0$  with  $Y>0$  for a circumferential crack and in the  $Z<0$  direction in  $Z>0$  for the others orientations of crack,***

.

***G\_AXE\_2: group nodes constituting the large axis of the crack ( $Z1 = 0^+$ ) ordered in feel  $Y<0$  with  $Y>0$  for a circumferential crack and in the  $Z<0$  direction in  $Z>0$  for the others orientations of crack,***

.

***NOLIG1: group nodes made up of the whole of the points of P\_AXE\_1 and ligament located in the prolongation of this one in the thickness.***

.

***NOLIG2: group nodes made up of the whole of the points of P\_AXE\_2 and ligament located in the prolongation of this one in the thickness.***

#### ***5.4.1 Case of the half-structure***

***The following entities present but are associated places different from the whole structure:***

.

***CLGV***

***: elements of membrane located in median section forming the symmetry plane***

*transverse of the elbow. In the case of a circumferential crack, one will be able y to deduce the lip (entity FACE2) thanks to operator DEFI\_GROUP (DIFFE),*

*BOU1*

*: node located on the median section in external skin on the left side for one azimuth of the defect of 90° (this point also coincides with point MED4),*

*BOU3*

*: node diametrically opposed to BOU1 on the median section, located in skin external on the right side (this point also coincides with point MED6),*

*P2*

*: node located at the center section CLGV.*

*Entities FACE1, TORE1, BLOFISS1, P\_AXE\_1, G\_AXE\_1, NOLIG1, BOWL do not exist.*

*Boundary conditions for a half-structure in order to block displacements of rigid body and to simulate the conditions of symmetry are as follows (is the angle of the elbow and the azimuth of the defect):*

*Blocking of normal displacement to the median section (CLGV from which one will have withdrawn lip of defect LEVRE2):*

*DZ = 0 for a tube,*

*DNOR =0 for an elbow.*

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•  
*A point on the aforementioned section blocked in the plan of this one:*

*$DX = DY = 0$  for a tube,*

*$DY = 0$  and  $\cos(\theta) DX - \sin(\theta) DZ = 0$  for an elbow.*

•  
*The point opposed symmetrically (located at azimuth  $\theta$ ) to the precedent in the section, blocked in tangent displacement with the aforementioned section:*

*$\sin(\theta) DX + \cos(\theta) DY = 0$  for a tube,*

*$\sin(\theta) \cos(\theta) DX + \cos(\theta) DY - \sin(\theta) \sin(\theta) DZ = 0$  for an elbow.*

*Note:*

*One can also for the half-structure plan to preserve the principle of the connection 3D-beam (used with whole modeling in the MACR\_ASCOUF\_CALC) with a node in the middle of median section (in fact P2).*

#### *5.4.2 Case of the quarter of structure*

*The modifications are similar to the preceding paragraph. Moreover, two edges forming the plan of symmetry longitudinal of the elbow are available:*

•  
***BORD1***

*: elements of membrane located left side for an azimuth of defect  $=90^\circ$ ,*

•  
***BORD2***

*: elements of membrane located right side for an azimuth of defect  $=90^\circ$ .*

*Boundary conditions for a quarter of structure in order to block displacements of rigid body and to simulate the conditions of symmetry are as follows (is the angle of the elbow and the azimuth of defect):*

•  
***Blocking of normal displacement to the median section (CLGV from which one will have withdrawn lip of defect LEVRE2):***

*$DZ = 0$  for a tube,*

*$DNOR = 0$  for an elbow.*

•  
***Blocking of the longitudinal symmetry plane of the tubular structure:***

*$DNOR = 0$  on BORD1 and BORD2.*

•  
***Blocking of displacement perpendicular to the longitudinal symmetry plane of one of the points (BOU3 to avoid taking the point located in the zone of the defect which is BOU1) located at the intersection of the two plans previously quoted:***

***$\cos(\alpha) DX + \sin(\alpha) DY = 0$  for a tube,***

***$\cos(\alpha) \cos(\beta) DX + \sin(\alpha) DY - \cos(\alpha) \sin(\beta) DZ = 0$  for an elbow.***

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Author (S):

**E. GALENNE**, Key Mr. **BONNAMY**

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## **6 Examples**

*The following table gives some examples of use of **MACR\_ASCOUF\_MAIL**.*

**Type of defect**

**Structure**

**Grid**

**Bend with short crack**

**longitudinal**

**(ascou15a)**

**Bend with long crack**

**circumferential**

**(ascou19a)**

**Tube with transition**

**of thickness and under-thickness**

**axisymmetric**

**(ascou06a)**

**Bend with under-thickness**

**elliptic internal**

**(ascou03a)**

**Table: Examples of use of macro order *MACR\_ASCOUF\_MAIL***

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***In addition to the examples described here one will be able to consult the command files (fichier. comm) of case tests. The latter are in the repertories:***

- 1. /aster/v6/STA6/astest***
- 2. /aster/v6/NEW6/astest***

***and the names ascou\* carry.***

***6.1***

***Bend with short crack***

***MA1 = MACR\_ASCOUF\_MAIL (***

***EXEC\_MALLAGE=\_F (SOFTWARE = "GIBI2000"),***

***COUDE=\_F (ANGLE = 40. ,***

***R\_CINTR = 654. ,***

***DEXT = 912.4,***

***THICK = 62.5,***

***L\_TUBE\_P1 = 1700. ,***

***L\_TUBE\_P2 = 1700.),***

***FISS\_COUDE=\_F (DEPTH = 10. ,***

**LENGTH = 20. ,**  
**POSI\_ANGUL = 20. ,**  
**AZIMUTH = 90. ,**  
**ORIEN = 0. ,**  
**FISSURE = "DEB\_EXT",**  
**AXIS = "NOT",**  
**NB\_TRANCHE = 8,**  
**NB\_SECTEUR = 3,**  
**NB\_COURONNE = 2)**  
**)**

## **6.2**

***Bend with elliptic under-thickness***

**MA2 = MACR\_ASCOUF\_MAIL (**

**EXEC\_MALLAGE=\_F (SOFTWARE = "GIBI2000"),**

**COUDE=\_F (ANGLE = 40. ,**

**R\_CINTR = 1354. ,**

**DEXT = 912.4,**

**THICK = 62.5,**

**L\_TUBE\_P1 = 1700. ,**

**L\_TUBE\_P2 = 1700.),**

**SOUS\_EPAIS\_COUDE=\_F (STANDARD = "ELLI",**

**DEPTH = 20. ,**

**AXE\_LONGI = 50. ,**

**AXE\_CIRC = 100. ,**

**POSI\_ANGUL = 20. ,**

**AZIMUTH = 0. ,**

**SOUS\_EPAIS = "INTERN",**

**NB\_ELEM\_LONGI = 4,**

**NB\_ELEM\_CIRC = 8)**

**)**

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**6.3**

**Bend with under-ép. elliptic and under-ép. axisymmetric**

**MA3 = MACR\_ASCOUF\_MAIL (**

**EXEC\_MALLAGE=\_F (SOFTWARE = "GIBI2000"),**

**COUDE=\_F (ANGLE = 90. ,**

**R\_CINTR = 1354. ,**

**DEXT = 912.4,**

**THICK = 62.5,**

**L\_TUBE\_P1 = 1700. ,**

**L\_TUBE\_P2 = 1700. ),**

**SOUS\_EPAIS\_MULTI= (**

**\_F (STANDARD = "ELLI",**

**DEPTH = 20. ,**

**AXE\_LONGI = 50. ,**

**AXE\_CIRC = 100. ,**

**POSI\_ANGUL = 45. ,**

**AZIMUTH = 90. ,**

**SOUS\_EPAIS = "INTERN",**

**NB\_ELEM\_LONGI = 4,**

**NB\_ELEM\_CIRC = 8),**

**\_F (STANDARD = "AXIS",**

**DEPTH = 10. ,**

**AXE\_LONGI = 10. ,**

**POSI\_ANGUL = 45. ,**

**AZIMUTH = 180. ,**

**SOUS\_EPAIS = "EXTERNAL",**

**NB\_ELEM\_LONGI = 4,**

**NB\_ELEM\_CIRC = 20,**

```
PRINT = "YES"))  
=_F IMPRESSION (FILE = "MAIL.IDEAS"  
FORMAT = "IDEAS"  
UNIT = 38)  
)
```

## **6.4**

***Tube with short crack and transition from thickness***

```
MA4 = MACR_ASCOUF_MAIL (EXEC_MALLAGE=_F (SOFTWARE = "GIBI2000"),
```

```
COUDE=_F (ANGLE = 60. ,
```

```
R_CINTR = 654. ,
```

```
L_TUBE_P1 = 1700. ,
```

```
L_TUBE_P2 = 1700. ,
```

```
TRANSFORM = "TUBE",
```

```
TRAN_EPAIS = "YES",
```

```
DEXT_T1 = 250. ,
```

```
EPAIS_T1 = 15. ,
```

```
EPAIS_TI = 25. ,
```

```
EPAIS_T2 = 40. ,
```

```
ANGL_TETA1 = 5. ,
```

```
ANGL_TETA2 = 15. ,
```

```
ABSC_CURV_TRAN = 300.),
```

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**FISS\_COUDE=\_F (DEPTH = 4. ,  
LENGTH = 20. ,  
POSI\_ANGUL = 15. ,  
AZIMUTH = 90. ,  
ORIEN = 90. ,  
FISSURE = "DEB\_EXT",  
NB\_TRANCHE = 8,  
NB\_SECTEUR = 2,  
NB\_COURONNE = 3,  
RAYON\_TORE = 0.5),  
IMPRESSION=\_F (UNIT = 37  
FORMAT = "CASTEM")  
)**

**6.5**

***Tube with axisymmetric crack and transition from thickness***

**MA5 = MACR\_ASCOUF\_MAIL (**

**EXEC\_MAILLAGE=\_F (LOGICIEL=' GIBI98'),**

**COUDE=\_F (TRAN\_EPAIS=' OUI',  
EPAIS\_T1=60.0,  
EPAIS\_T2=90.0,  
L\_TUBE\_P2=900.0,  
TRANSFORMEE=' TUBE',  
L\_TUBE\_P1=1010.0,  
DEXT\_T1=660.0,  
ABSC\_CURV\_TRAN=183.541,  
ANGL\_TETA1=30.0,  
R\_CINTR=340.0,  
ANGLE=90.0,)**

**FISS\_COUDE=\_F (NB\_COURONNE=3,  
ABSC\_CURV=150.0,  
PROFONDEUR=7.5,  
NB\_TRANCHE=40,  
LONGUEUR=0.,  
AXIS=' OUI',  
AZIMUT=0.0,  
NB\_SECTEUR=2,  
FISSURE=' DEB\_EXT',  
RAYON\_TORE=1.8,  
ORIEN=90.0,)**

**IMPRESSION=\_F (FORMAT=' IDEAS'),**

)

## **7 Bibliography**

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[3]

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**Author (S):**

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**Organization (S): EDF-R & D /TESE**

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Document: U4.MK.10***

***Operator DEFI\_FONC\_ELEC***

## ***1 Goal***

***To define a function of time intervening in the calculation of the forces of Laplace.***

***These forces are exerted on a principal driver (being based on an Aster grid) acting with one or several secondary drivers (not being based necessarily on grids Aster); these drivers are traversed by intensities of current of short-circuit. The expression of the force of Laplace of the product of a function of time due itself is composed to the products of the intensities of current and a function of space due to the relative position of the drivers.***

***Product a structure of data of the function type.***

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## **2 Syntax**

***F [function] = DEFI\_FONC\_ELEC***

(

***FREQ =***

/

***Fr,***

***[R]***

/

***50.,***

***[DEFECT]***

***SIGNAL***

=

/

***“COMPLETE”, [DEFECT]***

/

***“CONTINUOUS”,***

***/COURT = (\_F (***

***INTE\_CC\_1***

=

***II,***

***[R]***

***TAU\_CC\_1***

=

***1, [R]***

***/PHI\_CC\_1 = 1, [R]***

/

***INTC\_CC\_1***

=

***ICI,***

***[R]***

***INTE\_CC\_2***

=

***I2,***

***[R]***

***TAU\_CC\_2***

=

***2, [R]***

***/PHI\_CC\_2 = 2, [R]***

/

***INTC\_CC\_2***

=

***IC2,***

***[R]***

***INST\_CC\_INIT***

= ***Ti,***

***[R]***



***INST\_CC\_FIN = tf,***  
***[R]***  
***),),***

***/***  
***COUR\_PRIN = (\_F (***

***INTE\_CC\_1***  
***=***  
***1,***  
***[R]***

***TAU\_CC\_1***  
***=***  
***1, [R]***

***/PHI\_CC\_1 = 1, [R]***

***/***

***INTC\_CC\_1***

***=***

***ICI,***

***[R]***

***INTE\_RENC\_1***

***=***

***IIR,***

***[R]***

***TAU\_RENC\_1 =***

***IR, [R]***

***PHI\_RENC\_1 = 1R, [R]***

***INST\_CC\_INIT = Ti,  
[R]***

***INST\_CC\_FIN = tf,  
[R]***

***INST\_RENC\_INIT = /shooting, [R]  
/  
0.,  
[DEFECT]***

***INST\_RENC\_FIN***

**=/tfR, [R]**  
**/**  
**0.,**  
**[DEFECT]**  
**),),**

**COUR\_SECO = (\_F (**

**INTE\_CC\_2**  
**=**  
**I2,**  
**[R]**

**TAU\_CC\_2**  
**=**  
**2, [R]**

***/PHI\_CC\_2 = 2, [R]***

***/***

***INTC\_CC\_2***

***=***

***IC2,***

***[R]***

***INTE\_RENC\_2***

***=***

***I2R,***

***[R]***

***TAU\_RENC\_2 =***

***2R, [R]***

***PHI\_RENC\_2 = 2R, [R]***

***DIST =/D,  
[R]  
/  
1.,  
[DEFECT]  
),),***

***INFORMATION  
=  
/  
1,  
[DEFECT]***

***/ 2,***

***)  
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Author (S):***

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### **3 Operands**

**The treated data can be divided into two groups:**

**.**  
**those relating to only one secondary driver, generally in a position unspecified compared to the principal driver but with several intervals of time. These intervals of time can be continuous between them (case of the same current with characteristics different from one interval to another) or discontinuous (case of one or more resets at various levels of intensity key word factor COURT),**

**.**  
**those concerning one or more possibly parallel secondary drivers and/or infinite with an interval of time corresponding to the short-circuit and possibly one second interval of time corresponding to a reset (key words factors COUR\_PRIN and COUR\_SECO).**

**One can notice that:**

**.**  
**in the second group of data, the characteristics of the currents crossing them secondary drivers are separately treated those of the currents crossing it principal driver (with key word COUR\_SECO which one can repeat several times),**

**.**  
**all the cases treated by the second group of data can be treated by the first group. However in the case of current crossing several secondary drivers, it is then necessary to repeat as many operator DEFI\_FONC\_ELEC with the key word COURT time as there is secondary drivers (and the same for AFFE\_CHAR\_MECA and CALC\_VECT\_ELEM).**

### **3.1 Operand FREQ**

**FREQ =/50. ,**  
**/**  
**Fr,**

*Frequency of the current in Hertz (50.0 per defect).*

### **3.2 Operand SIGNAL**

**SIGNAL**  
**=**

*Specify the mode of calculation of the electric function of time:*

*/“COMPLETE”*

*all the terms of the electric function are taken into account,*

*/“CONTINUOUS”*

*one does not take into account the periodic terms of the function  
electric.*

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### **3.3 Word**

**key**

**COURT**

**/COURT = (\_F (**



***INTE\_CC\_1 = I1***

***effective intensity of the current of short-circuit,***

***crossing the principal driver (in Amps),***

***TAU\_CC\_1 = 1***

***time-constant of the current of short-circuit,***

***crossing the principal driver (in seconds),***

***/***

***PHI\_CC\_1 = 1***

***dephasing (in degrees) of the principal current***

*(current of short-circuit),*

*/INTC\_CC\_1 = I<sub>C1</sub> intensity of first peak of the principal current*

*(in Amps), amounts giving a dephasing,*

*INTE\_CC\_2 = I<sub>2</sub>  
effective intensity of the current of short-circuit,*

*crossing the secondary driver (in Amps),*

*TAU\_CC\_2 = 2  
time-constant of the current of short-circuit,*

*crossing the secondary driver (in seconds),*

*/*  
***PHI\_CC\_2 = 2***  
*dephasing (in degrees) of the secondary current*

*(current of short-circuit),*

***/INTC\_CC\_2 = IC2 intensity of first peak of the secondary current***

*(in Amps), amounts giving a dephasing,*

***INST\_CC\_INIT = Ti***  
*initial moment of an interval of current, by defect,*

*equal  
with  
the moment  
final  
of  
the interval  
precedent*

*(them  
intervallles  
are  
then  
continuous),*

*INST\_CC\_FIN = tf  
final moment of an interval of current*

*),  
)*

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### **3.4 Word**

*key*

***COUR\_PRIN***

/  
***COUR\_PRIN = ( \_F (***

***INTE\_CC\_1 = II***  
*effective intensity of the current of short-circuit,*

*beam*  
*the principal driver (in Amps),*

***TAU\_CC\_1 = I***  
*time-constant of the current of short-circuit,*  
*beam*  
*the principal driver (in seconds),*

/  
***PHI\_CC\_1 = I***  
*dephasing (in degrees) of the principal current*  
*(running*  
*of*  
*short-circuit),*

***/INTC\_CC\_1 = ICI***

***intensity of first peak of the principal current***

***(in***

***Amps),***

***returns***

***with***

***to give***

***one***

***dephasing,***

***INTE\_RENC\_1 = IIR***

***effective intensity of the current of reset,***

***beam***

***the principal driver (in Amps),***

***TAU\_RENC\_1 = IR***

***time-constant of the current of short-circuit,***

***beam***

***the secondary driver (in seconds),***

***PHI\_RENC\_1***

***=***

***IR dephasing (in degrees) of the principal current of***

***reset,***

***INST\_CC\_INIT = Ti***

*initial moment of the current of short-circuit,*

*INST\_CC\_FIN = tf*

*final moment of the current of short-circuit,*

*INST\_RENC\_INIT*

*=*

*/shooting, initial moment of the current of reset,*

*/*

*0.,*

*INST\_RENC\_FIN =/tfR urgent final of the current of reset,*

*/*

*0.,*

*), ),*

***Note:***

***By defect, shooting and tfR are null and there is no current of reset.***

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***3.5 Word***

***key***

***COUR\_SECO***

***/***

***COUR\_SECO = (\_F (***

***INTE\_CC\_2 = I2***

***effective intensity of the current of short-circuit,  
beam***

***the secondary driver (in Amps),***

***TAU\_CC\_2 = 2***

***time-constant of the current of short-circuit,  
beam***

***the secondary driver (in seconds),***

***/***

***PHI\_CC\_2 = 2***



*dephasing (in degrees) of the secondary current  
(running  
of  
short-circuit),*

*/INTC\_CC\_2 = IC2 intensity of first peak of the secondary current  
(in  
Amps),  
returns  
with  
to give  
one  
dephasing,*

*INTE\_RENC\_2 = I2R  
effective intensity of the current of reset,  
beam*

*secondary driver (in Amps),*

*TAU\_RENC\_2 = 2R  
time-constant of the current of reset,  
beam*

*secondary driver (in seconds),*

*PHI\_RENC\_2  
=*

***2R dephasing (in degrees) of the secondary current of reset,***

***DIST =/D,***

***distance (in meters) from an infinite secondary driver***

***/ 1.,***

***and parallel with the principal driver.***

***Note:***

***Not credit in the other cases and taken with 1. per defect to neutralize its action in the calculation of the force of LAPLACE.***

***), ),***

### ***3.6 Operand INFORMATION***

***INFORMATION***

***=***

***Specify the options of impression on the file MESSAGE.***

***1 = not of impression (default option),***

***2 = impression of the parameters plus the list of the first 10 values in the ascending order parameter.***

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## **4** **Expression of the calculated function**

### **4.1** **Data of the first group**

*In the case of given first group, with NR occurrences of the key word factor COURT correspondent with NR intervals of time, arguments entered to K ième occurrence of the key word factor are affected index (K) that is to say:*

(K)

(K)

(K)

(K)

(K)

(K)

(K)

(K)

I

,

,

, I

,

,

, T

, T

I

1  
1  
2  
2  
2  
1  
F  
.

**4.1.1 Signal complete**

The expression of the calculated function is:

$$\begin{aligned}
 & ( \\
 & F T) \\
 & -7 \\
 & (K) \\
 & (K) \\
 & = . \\
 & 4 10 \\
 & * I \\
 & * I \\
 & 1 \\
 & 2 \\
 & (K) \\
 & T - tr \\
 & - \\
 & (K) \\
 & K \\
 & * \\
 & \cos 2 * Fr * \\
 & (T - T \\
 & K \\
 & I \\
 & K \\
 & R \\
 & ) ( )
 \end{aligned}$$

(  
+  $I$   
)  
( )  
( )  
-  $E$   
\*  $\cos I$

( $K$ )

$T - tr$

-  
( $K$ )  
 $K$

\*  
 $\cos 2 * Fr *$

( $T - T$

$K$

$2$

$K$

$R$

)( )

(

+  $2$

)

( )

( )

-  $E$

\*  $\cos 2$

## 4.1.2 Signal continuous

(  
 $F T$ )

-7

( $K$ )

( $K$ )

= .

4 10

\*  $I$

\*  $I$

1

2

(

1

1

$K$ )

- ( $T - T$

$R$

)

+

1

(

$K$ )

( $K$ )

$K$

$K$

\*

1

2

.cos (

-

2

1

)

( )

( )

(K)

(K)

+ E

\* cos

\* cos

1

2

2

(K)

(K)

for T [T

, T

I

F

J

,

K

=

,

1

NR.

(K)

( )

1

( )

with T

defined by: T

= T1

R

R



*I*  
*(K)*  
*(K -) I*  
*(K)*  
*(K -)*  
*T*

=  
*T*  
*if T*

=  
*T*  
*1,*

*K*  
=  
*2,*  
*NR*

*R*  
*R*  
*I*  
*F*  
*T (K)*  
*(K)*  
*(K)*  
*(K -) I*  
*R*

= *Ti*

*if Ti*

> *T F*

, *K*

=  
*2, NR*

(  
*F T)*  
*(K)*  
*(K -) I*

(K -) 1  
(K)  
= 0  
if  
Ti  
> T F  
, and T [T F  
, Ti] K = 2, NR  
(NR)  
or  
if  
T > T F

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Titrate:

Operator *DEFI\_FONC\_ELEC*

Date:

09/02/05

Author (S):

**B. RIOU** Key

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**4.2**

***Data of the second group***

***In the case of given of the second group, with an occurrence of key word *COUR\_PRIN* (one running principal) and NR occurrences of the key word factor *COUR\_SECO* (NR current secondary), them***

***arguments entered to the kth occurrence of *COUR\_SECO* are assigned to the index (K) that is to say:***

(K)

(K)

(K)

(K)

I

,

,

, D

(K)

(K)

(K)

2

2

2

and possibly I

, T

2R

2R

, 2

R

.

#### 4.2.1 Case

or

T belongs to the first interval of current

#### 4.2.1.1 Signal

complete

The expression of the calculated function becomes then: if T [T, T

I

F]

T - T

-

I

(

F T) = . -

4 10 7 \* I \* cos

l

l

(2 \* Fr \* (T - T

I) + I

) - *E*  
\* *cos*

*I*

(  
*T - T*  
*K*)  
*I*

*I*

-

*K*

\*

2

*cos 2 Fr*

(

\*

\* *T - T*

*K*

2

*K*

*I*)

( )

+

-

*K*

(

2 )

( )

( )

( )

*E*

\*

*cos*

2

*K =,*

*1 NR D*

**4.2.1.2 Signal  
continuous**

(  
*F T) =. -*  
*4 10 7 \* 11*

*1*

*1*

*(K)*

*I*

*- T - T*

+

*1*

*2*

(

*I*

*K)*

*(K)*

*K*

\*

*cos*

*1*

*2*

*K*

-

+

$K$   
 $(2$   
 $1$   
 $)$   
 $($   
 $)$   
 $($   
 $($   
 $($   
 $E$   
 $* \cos * \cos$   
 $1$   
 $2$   
  
 $2$   
 $K =,$   
 $1 NR D$

*if T [T, T*  
*ir*  
*Fr] with T*  
 $0 > T$   
*ir*  
*F*

**4.2.2 Case where**

*T belongs to the second interval of current (reset)*

**4.2.2.1 Signal complete**

$T - T$   
*ir*

-

(  
 $F T) = 4 * -$   
 $10 7 * I$   
*cos*  
 $1R$   
  
 $1R$   
 $(2 * Fr * (T - shooting) + 1R)$   
 $- E$   
 $*$   
*cos l*  
 $R$

$T - T$

*ir*

-  
 $K$   
 $2 * Fr * (T - T$   
 $K$   
 $2$

$R$   
 $K$   
*ir)*  
 $()$   
 $()$   
 $+ 2$   
 $R$

)  
 $()$   
 $()$   
 $- E$   
 $* cos 2$   
 $R$

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### **4.2.2.2 Signal** **continuous**

(

*F T) =. -*

*4 10 7 \* IIR*

*1*

*1*

*(K)*

*I*

*- T - shooting*

*+*

*1*

*2R*



(K)

(K)

K

\*

cos

1R

2R

K

-

+

2

1

1

2

K

(

R

R

)

(

)

( )

( )

( )

E

\* cos

\* cos

R

R

2

K =,

1 NR

D

$F(T) = 0$  if  $T \leq T_{ir}$   
 $F$   
 $ir$   
 or if  $T > \max(T_{Fr}, T_{ir})$   
 $F$   
 $Fr$

## 5 Examples of function of current

### 5.1 With data of the two groups

Definition of functions of currents using as well the data of the first group as of the second group.

Case of two-phase short-circuit during 0.5 second with reset from 1.5 to 2 seconds of intensity 20 kA, null and time-constant phase 0.2 second before reset and of intensity 15 kA after reset.

Data of the first group:

$f1$   
 $=$   
 $DEFI\_FONC\_ELEC$   
 $($

$COURT$   
 $= (_F (INTE\_CC\_1$   
 $=$   
 $20.E3,$   
 $TAU\_CC\_1$   
 $=$

$0.2,$   
 $PHI\_CC\_1$   
 $=$

0.,

*INTE\_CC\_2*

=

*20.E3,*

*TAU\_CC\_2*

=

*0.2,*

*PHI\_CC\_2*

=

*180.,*

*INST\_CC\_INIT*

=

*0.,*

*INST\_CC\_FIN*

=

*0.5,*

),

*\_F (INTE\_CC\_1*

=

*15.E3,*

*TAU\_CC\_1*

=

*0.2,*

*PHI\_CC\_1*

=

*0.,*

*INTE\_CC\_2*

=

*15.E3,*

*TAU\_CC\_2*

=

0.2,  
*PHI\_CC\_2*  
=  
180.,  
*INST\_CC\_INIT*  
=

1.5,  
*INST\_CC\_FIN*  
=

2.0,  
,),

)

.

*Data of the second group:*

*f2*  
=  
*DEFI\_FONC\_ELEC*  
(

*COUR\_PRIN*  
= (*\_F* (  
*INTE\_CC\_1*  
=  
20.E3,  
*TAU\_CC\_1*  
=

0.2,  
*PHI\_CC\_1*  
=

0.,  
*INTE\_RENC\_1*

=  
15.E3,  
TAU\_RENC\_1 =

0.2,  
PHI\_RENC\_1 =

0.,  
INST\_CC\_INIT  
=

0.  
,  
INST\_CC\_FIN  
=

0.5,  
INST\_RENC\_INIT  
=

1.5,  
INST\_RENC\_FIN  
=

2.0,  
,),

COUR\_SECO = (\_F (INTE\_CC\_2  
=

20.E3,  
TAU\_CC\_2  
=

0.2,  
PHI\_CC\_2  
=  
180. , INTE\_RENC\_2  
=

15.E3,  
TAU\_RENC\_2 =

0.2,

*PHI\_RENC\_2 =  
180.,  
,),*

)  
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***5.2***

***With only of the data of the first group***

*Definition of functions of currents **strictly** using the data of the first group.*

*Case of two-phase short-circuit during 1 second, null phase, time-constant 0.2 second and stages of intensity of 20 kA during 0.5 second, 15 kA between 0.5 second and 0.7 second, of 10 kA between 0.7 second and 1 second.*

*f1*

*=*

*DEFI\_FONC\_ELEC*

*(*

*COURT*  
= (*\_F (INTE\_CC\_1*  
=  
*20.E3,*  
*TAU\_CC\_1*  
=

*0.2,*  
*PHI\_CC\_1*  
=

*0.,*  
*INTE\_CC\_2*  
=

*20.E3,*  
*TAU\_CC\_2*  
=

*0.2,*  
*PHI\_CC\_2*  
=

*180.,*  
*INST\_CC\_INIT*  
=

*0.*  
*,*  
*INST\_CC\_FIN*  
=

*0.5,*

*),*  
  
*\_F (INTE\_CC\_1*  
=  
*15.E3,*  
*TAU\_CC\_1*

=

0.2,  
*PHI\_CC\_1*

=

0.,  
*INTE\_CC\_2*

=

15.E3,  
*TAU\_CC\_2*

=

0.2,  
*PHI\_CC\_2*

=

180.,  
*INST\_CC\_FIN*

=

0.7,

),

*\_F (INTE\_CC\_1*

=

10.E3,  
*TAU\_CC\_1*

=

0.2,  
*PHI\_CC\_1*

=

0.,  
*INTE\_CC\_2*

=

10.E3,



*TAU\_CC\_2*

=

*0.2,*

*PHI\_CC\_2*

=

*180.,*

*INST\_CC\_FIN*

=

*1.0,*

*),),*

)

### **5.3**

#### ***With preferentially of the data of the second group***

*Definition of functions of current **preferentially** using the data of the second group.*

*To express the interaction of two drivers with the studied phase, the use of data of first group would result in defining two functions F1 and F2 (by two calls to *DEFI\_FONC\_ELEC*) and two loads *ch1* and *ch2*.*

*The data of the second group make it possible to be limited to only one function.*

*Case of three-phase short-circuit during 1 second of intensity 20 kA, phase 45 degrees, constant of time 0.2 second with phases parallel and infinite apart 2 meters.*

*f1*

=

*DEFI\_FONC\_ELEC*

(

***COUR\_PRIN***

= (***\_F*** (

***INTE\_CC\_1***

=

**20.E3,**  
**TAU\_CC\_1**  
=  
**0.2,**  
**PHI\_CC\_1**  
=  
**45.,**  
**INST\_CC\_INIT**  
=  
**0.**  
,  
**INST\_CC\_FIN**  
=

**1.,**  
,),  
  
**COUR\_SECO**  
= (**\_F (**  
**INTE\_CC\_2**  
=

**20.E3, TAU\_CC\_2**  
=  
**0.2,**  
**PHI\_CC\_2**  
=  
**165.,**  
**DIST**  
=  
**2.,**

,),  
  
**\_F (**  
**INTE\_CC\_2**  
=

**20.E3,**  
**TAU\_CC\_2**  
**=**

**0.2,**  
**PHI\_CC\_2**  
**=**

**-**  
**75.,**  
**DIST**  
**=**

**-**  
**2.,**  
**),),**

)

*One will find examples of **DEFI\_FONC\_ELEC** in case-tests **SDNL101A** and **YYYY103A**.*

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***Operator DEFI\_THER\_JOULE***

***Date:***  
***03/02/05***  
***Author (S):***  
***B. RIOU Key***  
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***Organization (S): EDF-R & D /TESE***

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***Document: U4.MK.20***

***Operator DEFI\_THER\_JOULE***

***1 Goal***

***To calculate the temporal evolution of the temperature due to the Joule effect of a current of short-circuit in a conducting cable.***

***A traditional scenario of short-circuit is supposed: at the moment of the short-circuit, the driver (crossed by a charging current) is in thermal balance in a medium at a temperature known ; after the elimination of the short-circuit, it is crossed by no current until reset.***

*The law of evolution is described with [§4].*

*One gives the moments of definition of the function, the characteristics of the electrical current traversing the conducting cable (effective intensity, moments of appearance and disappearance of the currents), them temperatures initial and ambient and thermo-electric sizes of the driver (heat specific voluminal, convection coefficient and resistivity).*

*The produced functions are then used to define a field in the nodes of functions, by the order AFFE\_CHAM\_NO [U4.44.11], then a result of the evol\_ther type, by order CREA\_RESU [U4.44.12], finally a thermal load, by order AFFE\_CHAR\_MECA [U4.44.01].*

*Product a concept of the function type.*

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*2 Syntax*

*F1 [function] = DEFI\_THER\_JOULE*

*(  
LIST\_INST*

=

*list\_instant,*  
*[listr8]*

*INST\_CC\_INIT =*

*/ 0.,*  
*[DEFECT]*  
*/*  
*inst\_cc\_init,*

*[R]*

*INST\_CC\_FIN =*

*/*  
*1.D10,*  
*[DEFECT]*  
*/*  
*inst\_cc\_fin,*  
*[R]*

*INST\_RENC\_INIT =/*

*1.D10,*  
*[DEFECT]*  
*/*  
*inst\_renc\_init,*  
*[R]*

***INST\_RENC\_FIN***

=

/

***1.D10,  
[DEFECT]***

/

***inst\_renc\_fin,  
[R]***

***TEMP\_EXT\_POSE***

=

/

***15.,  
[DEFECT]***

/

***temp\_ext\_pose,  
[R]***

***TEMP\_EXT***

= /

***15.,  
[DEFECT]***

/

***temp\_ext,  
[R]***

***TEMP\_RESI\_REF***

=

/

***20.,  
[DEFECT]***

/

***tref,  
[R]***

***PARA\_COND\_ID = (\_F (***

***INTE\_CC =/0. ,***

***[DEFECT]***

***/***

***inte\_cc,***

***[R]***

***INTE\_RENC =/0. ,***

***[DEFECT]***

***/***

***inte-renc, [R]***



***With =***  
***/***  
***1.,***  
***[DEFECT]***

***/has,***

***[R]***

***SECTION =/***  
***“CIRCLE”,***  
***[DEFECT]***

**RESI\_RO =/0. ,**  
**[DEFECT]**  
/  
**ro,**

**[R]**

**RESI\_R1 =/0. ,**  
**[DEFECT]**  
/  
**r1,**

**[R]**

**RHO\_CP =/1. ,**  
**[DEFECT]**  
/  
**CP,**

**[R]**

**COEF\_H**  
=  
/  
40.,  
**[DEFECT]**  
/  
**coef\_h, [R]**

**TEMP\_INIT =/15. ,**

**[DEFECT]**  
/  
**temp\_init, [R]**  
,),

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**Titrate:**

## ***Operator DEF1\_THER\_JOULE***

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***03/02/05***

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### ***3 Operands***

#### ***3.1 Operand***

***LIST\_INST***

***LIST\_INST = list\_instant***

***Concept of the listr8 type giving the list of the moments when the function is calculated.***

#### ***3.2 Operand***

***INST\_CC\_INIT***

***INST\_CC\_INIT =***

***/ 0.,***

***/***

***inst\_cc\_init,***

***Moment of appearance of the current of short-circuit. It does not belong inevitably to the preceding list.***

#### ***3.3 Operand***

***INST\_CC\_FIN***

***INST\_CC\_FIN =***

***/***

***1.D10,***

***/***

***inst\_cc\_fin,***

*Moment of elimination of the current of short-circuit. The very great default value is useful when it current of short-circuit does not disparait throughout analysis.*

### **3.4 Operand INST\_RENC\_INIT**

*INST\_RENC\_INIT =/1.D10,  
/  
inst\_renc\_init,*

*Moment of appearance of the current of reset. The very great default value is useful when it does not have there current of reset throughout analysis.*

### **3.5 Operand INST\_RENC\_FIN**

*INST\_RENC\_FIN =/1.D10,  
/  
inst\_renc\_fin,*

*Moment of disappearance of the current of reset.*

### **3.6 Operand TEMP\_EXT\_POSE**

*TEMP\_EXT\_POSE =/15. ,  
/  
temp\_ext\_pose,*

*Temperature of the cable during the installation.*

### **3.7 Operand TEMP\_EXT**

*TEMP\_EXT =  
/ 15.,  
/  
temp\_ext,*

*Temperature of the ambient air at the time of the analysis.*

*If TEMP\_INIT is not defined, it is also the initial temperature of the driver (cf [§3.9.5]).*

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### **3.8 Operand**

**TEMP\_RESI\_REF**

*TEMP\_RESI\_REF = /20. ,*

*/*

*tref,*

*Temperature of reference for the resistivity. The value of the resistivity at the temperature T is:*

*$\rho(T) = \rho_0 [1 + K (T - T_{ref})]$  éq*

**3.8-1**

*Coefficients  $\rho_0$  and K are further defined [§3.9.3].*

### **3.9 Word**

*key*

**PARA\_COND\_1D**

*PARA\_COND\_1D =*

*Under this key word factor, one defines the parameters specific to a driver.*

*There is at least an occurrence of the key word factor PARA\_COND\_1D:*

.

*if there is only one of them, the function F defines the temperature of **only one** driver,*

1

.

*if there is NR of it, the function F defines the temperature of the node common to NR drivers.*

1

*This temperature is taken equal to the average temperature of the NR drivers adjacent.*

*The temperature defined by each occurrence of PARA\_COND\_1D is equal, at the moment T:*

.

*if  $T < INST\_CC\_INIT$ , with TEMP\_EXT\_POSE*

.

*if  $T \geq INST\_CC\_INIT$ :*

*- with TEMP\_INIT, or with TEMP\_EXT if TEMP\_INIT is not defined, as long as none intensity of current did not traverse the driver,*

-

*at a calculated temperature (phases of heating separated by phases from cooling), starting from the appearance of the first current.*

### ***3.9.1 Operands defining the intensities of currents***

*INTE\_CC =/0. ,*

/

*inte\_cc,*

*Effective intensity of the current of short-circuit (in amps).*

*INTE\_RENC =/0. ,*

/

*inte\_renc,*

*Effective intensity of the current of reset (in amps).*

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### ***3.9.2 Operands describing the shape of the driver***

*With*

=

/ 1.,

/

*has,*

*Surface of the cross section of driver.*

*SECTION = "CIRCLE"*

*The cross-section is a full circle.*

### ***3.9.3 Operands defining the resistivity of the driver***

*RESI\_RO =/0. ,*



/ro,

*Value of coefficient 0 of the formula [éq 3.8 - 1].*

*RESI\_R1 =/0. ,*

/  
*r1,*

*Value of the coefficient K of the formula [éq 3.8 - 1].*

### ***3.9.4 Operand defining the thermal characteristics***

*RHO\_CP =/1. ,*

/  
*CP,*

*Voluminal specific heat of the driver.*

*COEF\_H =/40. ,*

/  
*coef\_h,*

*Convection coefficient enters the wall of the driver and the surrounding air.*

### **3.9.5 Operand**

#### **TEMP\_INIT**

*TEMP\_INIT = /15. ,  
/  
temp\_init,*

*Initial temperature of the driver, at the moment when the short-circuit appears.*

*It is the temperature of the driver crossed by a charging current, in thermal balance in a medium of known temperature (TEMP\_EXT).*

*If TEMP\_INIT is not defined, the temperature of the driver, at the time of the short-circuit, is taken with TEMP\_EXT, which returns to the case of a dead conductor, before short-circuit.*

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**4**

***Expression of the change of the temperature with time***

*From the law of evolution of the resistivity with the temperature:*

$= 0 [1 + K (- \text{réf})]$

*and while indicating by:*

*A: the surface of the section of the driver, presumedly circular full,*

*p: the perimeter of the section ( $p = 2 A$ ),*

*Cv: voluminal specific heat of metal,*

*H: the thermal convection coefficient with outside,*

*ext.: the ambient temperature,*

*I<sub>eff</sub>: effective intensity of the current of short-circuit,*

*the temperature of the driver is defined by a function of time T:*

.

*with the heating, when it is traversed by the current of short-circuit:*

*B*

*B*

*- C (T Ti)*

*has +*

*C*

*2D*

*(T Ti)*

*= 2 -*

*-*

*E*

*+*

*2 -*

*E*

*- .*

*I*

*1*

*B - 2c*

*I being the temperature at the moment Ti and:*

*2*

*I*

*O have*

=

*(1-K réf*

)

2

*EFF;*

2

*Cv*

*With*

2 2

*I*

*B*

= *K O EFF;*

2

*Cv A*

*H p*

*C*

=

*D*

;

= *C*

*AC*

*ext.*

*v*

.

*with cooling, as from the moment T FCC of end of short-circuit:*

- *C (T T*

- *FCC)*

- *C (T T FCC)*

= *FCC E*

-

+ *ext.*

[1. - *E*

]

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**Example: heating of a cable per Joule effect**

*Extract of the command file of case-test HSNL100A*

*l\_inst0 = DEFI\_LIST\_REEL (BEGINNING = -0.1,  
INTERVAL*

*=  
(\_F (JUSQU\_A*

*=  
0.,*

*= 1 NUMBERS),),  
INTERVAL*

*=  
(\_F (JUSQU\_A*

*=  
40.,  
NUMBERS = 8),),*

)

*F01 = DEFI\_THER\_JOULE =*  
(  
*LIST\_INST*  
=  
*l\_inst0,*  
*INST\_CC\_INIT*  
=  
*0.D0,*  
*INST\_CC\_FIN*  
=  
*10.D0,*  
*INST\_RENC\_INIT*  
=  
*20.D0,*  
*INST\_RENC\_FIN*  
=  
*30.D0,*  
*TEMP\_EXT\_POSE*  
=  
*12.D0,*  
*TEMP\_EXT*  
=  
*1.D0,*  
*TEMP\_RESI\_REF*  
=  
*2.D0,*  
  
#  
*PARA\_COND\_1D*  
=  
(*\_F* (  
*INTE\_CC =*  
*3.1415927D0,*  
*INTE\_RENC*  
=  
*3.1415927D0,*  
*With*  
=  
*3.1415927D0,*  
*RESI\_R0 =*  
*4.D0,*  
*RESI\_R1 =*

0.5D0,  
RHO\_CP  
=  
1.D0,  
COEF\_H  
=  
0.5D0,  
TEMP\_INIT  
=  
1.D0,

),

\_F (  
INTE\_CC =  
3.1415927D0,  
INTE\_RENC  
=  
3.1415927D0,  
With  
=  
3.1415927D0,  
RESI\_R0 =  
4.D0,  
RESI\_R1 =  
0.5D0,  
RHO\_CP  
=  
1.D0,  
COEF\_H  
=  
0.5D0,  
TEMP\_INIT



=  
*1.D0*,  
)  
  
#  
  
*F02 = DEFI\_THER\_JOULE =*  
(

*LIST\_INST*  
=  
*l\_inst0*,  
*TEMP\_EXT*  
=  
*33.D0*,  
*PARA\_COND\_1D*  
=  
(*\_F* (  
*TEMP\_INIT*  
=  
*10.D0*  
),  
  
*\_F* (  
*TEMP\_INIT*  
=  
*20.D0*  
),),

)

The functions *F01* and *F02* are defined on the interval  $[- 0.1, 40]$  (*l\_inst0*).

The *F01* function is equal to:

.

if  $T = 0.1$ : 12 (*TEMP\_EXT\_POSE*)

.

if  $T > 0$  (*INST\_CC\_INIT*): it is the average of two identical functions, because the key word factor *PARA\_COND\_1D* appears twice, with the same arguments, under *DEFI\_THER\_JOULE*.

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---

**Code\_Aster** ®

*Version*

7.4

*Titrate:*

*Operator DEFI\_THER\_JOULE*

*Date:*

03/02/05

*Author (S):*

**B. RIOU** Key

:

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*This function is the temperature of a cable which:*

.

*warm up by the effect of a current of short-circuit starting from temperature *TEMP\_INIT* of 3.14A (*INTE\_CC*) of moment 0 (*INST\_CC\_INIT*) at moment 10. (*INST\_CC\_FIN*),*

.

*cools moment 10. at moment 20. ,*

.

*warm up by the effect of a current of reset of 3.14A (*INTE\_RENC*) of the moment*

20. (*INST\_RENC\_INIT*) at moment 30. (*INST\_RENC\_FIN*),

·  
cools moment 30. at moment 40.

The *F02* function, or *INST\_CC\_INIT = 0 per defect*, is equal to:

·  
if  $T = -0.1$ : the temperature is 15 (*TEMP\_EXT\_POSE*, **by defect**),

·  
if  $T \geq 0$ , it is the average of the *TEMP\_INIT* defined under the two *PARA\_COND\_1D*,  
i.e. 15. No intensity of current indeed comes to modify these temperatures  
initial.

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**Code\_Aster** ®

*Version*

7.4

*Titrate:*

*Operator DIST\_LIGN\_3D*

*Date:*

09/02/05

*Author (S):*

**B. RIOU** Key

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*Organization (S): EDF-R & D /TESE*

***Instruction manual  
Booklet U4.MK: MEKELEC  
Document: U4.MK.30***

***Operator DIST\_LIGN\_3D***

### ***1 Goal***

***To calculate, during a transient, the minimal distance between two telegraphic structures or one structure and a fixed point.***

***The result of calculation is a distance according to time. Each line of telegraphic elements being defined by a list of groups of meshes not necessarily contiguous.***

***Product a structure of data of the function type.***

***Instruction manual***

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***Code\_Aster*** ®

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***:***

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## 2 Syntax

*F (function) = DIST\_LIGN\_3D*

(  
*MODEL*  
=  
*model, [model]*

*RESULT*  
=  
*result,*  
/  
*[evol\_noli]*

/  
*[dyna\_trans]*

/

*[evol\_elas]*

*/TOUT\_ORDRE = "YES",*

*[DEFECT]*

/

*NUME\_ORDRE =*

*l\_ordre,*

*[l\_I]*

/

*INST*

*=*

*l\_inst, [l\_R]*

/

*LIST\_INST*

*=*

*listinst,*

*[listr8]*

/

*LIST\_ORDRE =*

*listordre, [listis]*

*PRECISION*

*=*

/

*prec,*

*[R]*

/

*1.E-3,*

*[DEFECT]*

*CRITERION*

*=*

/

“RELATIVE”, [DEFECT]

/

“ABSOLUTE”,  
[DEFECT]

*GROUP\_MA\_1*

=

*l\_grma1,*  
*[l\_gr\_maille]*

*/GROUP\_MA\_2 = l\_grma2,*  
*[l\_gr\_maille]*

/

*POIN\_FIXE*

=

*(x0,*  
*y0,*  
*z0),*  
*[l\_R]*

*INFORMATION =*

*/ 1*

,

*[DEFECT]*

*/ 2,*

)

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*Date:*  
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***B. RIOU Key***  
*:*  
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### ***3 Operands***

#### ***3.1 Operand*** ***MODEL***

***MODEL = model***

***Name of the concept models on which one defined the calculated evolution.***

#### ***3.2 Operand*** ***RESULT***

***RESULT = result***

***Name of the concept result of a calculated evolution.***

#### ***3.3 Operands*** ***TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE***

***/TOUT\_ORDRE = "YES"***

***The function distance is calculated for any order of the evolution.***

***/NUME\_ORDRE = l\_ordre***

***The function distance is calculated for a succession of sequence numbers of the evolution.***

***/LIST\_ORDRE = listordre***



*The function distance is calculated for a succession of sequence numbers defined in a concept of listis type.*

### **3.4 Operands**

**INST/LIST\_INST**

**/INST = l\_inst**

*The function distance is calculated for a succession of actual values of moments extracted from evolution.*

**/LIST\_INST = listinst**

*The function distance is calculated for a succession of actual values of moments defined by one concept of the listr8 type.*

### **3.5 Operands**

**PRECISION/CRITERE**

**PRECISION = prec**

*Reality defining the precision of extraction of a field in a given moment of the evolution.*

**CRITERION =**  
**/“RELATIVE”,**  
**/**  
**“ABSOLUTE”,**

*Defines the type of criterion of extraction, relative or absolute, of a field at one moment given of evolution.*

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**Titrate:**

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### **3.6 Operand**

**GROUP\_MA\_1**

**GROUP\_MA\_1 = l\_grma1**

**List groups of meshes defining the first line of telegraphic elements in space.**

### **3.7 Operands**

**GROUP\_MA\_2/POIN\_FIXE**

**/GROUP\_MA\_2 = l\_grma2**

**List groups of meshes defining the second line of telegraphic elements in space.**

**/POIN\_FIXE = (x0, y0, z0)**

**List of the three real co-ordinates of the fixed point by report/ratio to which the distance will be calculated**

**during the evolution, meshes of the first line.**

### **3.8 Operand**

**INFORMATION**

**INFORMATION**

**Specify the options of impression on the file RESULT.**

**1**

**Impression of the name of the function, the number of moments of definition of the function, the type interpolation as well as options of prolongation.**

2

*Like 1, plus the list of all the values of the function in the order ascending of time, as well as the list of the elements of each line, given by their relative sequence number of description, where is obtained at every moment, the relative distance between the lines.*

#### *4 Example*

*Minimal distance between two cables.*

*Extract of the command file of the case test SDNL101A.*

```
D1 = DIST_LIGN_3D (  
RESULT  
=  
RESU,  
MODEL  
=  
MO,  
TOUT_ORDRE =  
“YES”,  
GROUP_MA_1 =  
“cc1”,  
GROUP_MA_2 =  
“cc2”,  
)
```

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*Version*

*8.2*

*Titrate:*

*Macro order MACR\_ASPIC\_MAIL*

*Date:*

*31/01/06*

*Author (S):*

*E. GALENNE Key*

*:*  
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**Organization (S): EDF-R & D /AMA**

**Instruction manual  
Booklet U4.PC: ASPIC  
Document: U4.PC.10**

**Macro order MACR\_ASPIC\_MAIL**

**1 Goal**

**To generate the grid of a healthy pricking or with long or short crack.**

**The lengths must be given in millimetres and the angles in degrees.**

**The concept produced by this macro order is of grid type, containing the entities topological allowing to apply boundary conditions and loadings. Grid product can be used only or associated the macro MACR\_ASPIC\_CALC.**

**To use MACR\_ASPIC\_MAIL, it is necessary to be able to reach to GIBI on the same machine of execution that Code\_Aster (either all locally, or on central machine Aster).**

**MACR\_ASPIC\_MAIL calls upon order MODI\_MAILLAGE to transform the grid of the square in grid of pricking.**

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**2 Syntax**

**grid [grid] = MACR\_ASPIC\_MAIL**

**(**

**EXEC\_MAILLAGE**

**=\_F (**

**SOFTWARE**

**=**

**/"GIBI98"**

**,**

**/"GIBI2000"**

**,**

**[DEFECT]**

**UNITE\_DATG =/**

**70,**

**[DEFECT]**

**/**

**unit\_d**

,  
[I]

**UNITE\_MGIB** =/  
19

,  
[DEFECT]

/  
**unit\_s**

,  
[I]

**NIVE\_GIBI**

=

/

10,

[DEFECT]

/

3,4,5,6,7,8,9,11,

[I]

),

**TYPE\_ELEM**

=

/  
"CU20"  
,  
[DEFECT]  
/  
"CUB8"  
,  
[TXM]

**RAFF\_MAIL**  
=  
/  
"LARGE"  
,  
[DEFECT]  
/  
"FINE"  
,  
[TXM]

**PIPE**  
=\_F  
(  
**E\_BASE**  
=  
*thickness*  
,  
[R]

**DEXT\_**  
**BASE=**  
*diameter,*  
[R]

***L\_BASE***

=

***length,***

***[R]***

***L\_CHANF***

=

***length,***

***[R]***

***E\_TUBU***

=

***thickness***

,

***[R]***

***DEXT\_TUBU***

=



*diameter*

,  
[R]

*Z\_MAX*  
=  
*length*

,  
[R]

*TYPE*  
=  
/  
"TYPE\_1"  
,  
[TXM]

/  
"TYPE\_2"  
,

***L\_PENETR***

=

/

***0.***

,

***[DEFECT]***

/

***length***

,

***[R]***

),

***WELDING***

= ***\_F (***

***H\_SOUD***

=

***height***

,

***[R]***

***ANGL\_SOUD***

=

***angle***

,

***[R]***

***JEU\_SOUD***

=

***play***

,

***[R]***

),

***BODY***

=\_F

(

***E\_CORP***

=

***thickness***

,

***[R]***

***DEXT\_CORP***

=

***diameter,***

***[R]***

*X\_MAX*  
=  
*length*,  
*[R]*

),

*FISS\_SOUDURE*  
=*F*  
(*/STANDARD = "LONG"*,

*AXIS=*/  
*"YES"*,  
/  
*"NOT"*,  
*[DEFECT]*  
/  
*TYPE*  
=  
*"SHORT"*  
,

*COEF\_MULT\_RC1*

=

*rc1*

,

*[R]*

*COEF\_MULT\_RC2*

=

*rc2*

,

*[R]*

*COEF\_MULT\_RC3*

=

*rc3*

,

*[R]*

*NB\_SECTEUR =*

*NS*

,

*[I]*

*NB\_COURONNE*

=

*nc*

,

*[I]*

*NB\_TRANCHE =*

*NT*

,

*[I]*

*RAYON\_TORE =*

*rc0*

,

*[R]*

*DEPTH* =

*has*

,

[R]

*LENGTH*

=

$2c$

,

[R]

*AZIMUTH*

=

*theta,*

[R]

*POSITION* =/"RIGHT", [TXM]

/

"INCLINES"

,

*FISSURE* =/"DEB\_INT"  
, [TXM]  
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/

"DEB\_EXT"

,

/

"NON\_DEB"

,

/

"THROUGH"

,

# If CRACK = "NON\_DEB" then

LIGA\_INT =

lig

, [R]

# Finsi



*ANGL\_OUVERTURE* =/eps,  
[R]  
/  
0.,  
[DEFECT]

),

*IMPRESSION*  
= \_F (FILE =  
nom\_fichier  
,  
[TXM]

*UNIT*  
=  
unit,  
[I]

/FORMAT  
=  
"ASTER"  
,  
[DEFECT]

*/FORMAT*  
=  
“*CASTEM*”,

*NIVE\_GIBI*  
=  
/  
*10,*  
*[DEFECT]*

*/3,*  
/  
*FORMAT*  
=  
“*IDEAS*”

*VERSION =/  
5,  
[DEFECT]*

*/ 4,*

*),*

*INFORMATION  
=  
/  
1  
,  
[DEFECT]*

*/ 2*

)  
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**3**  
***Geometrical definition of pricking***

*Zmax*

*LZmax*

*1/2 DEXT\_TUBU*

*E\_TUBU*  
*chamfer*

*L\_CHANF*

*1/2 DEXT\_BASE*

*extra thickness or*  
*under - thickness*  
*E\_BASE*

*L\_BASE*  
*ANGL\_SOUD*

*saddle*  
*H\_SOUD*

*E\_CORP*

*center*

*pipe*  
*1/2 DEXT\_CORPS*

*L\_PENETR*  
*JEU\_SOUD*

*LXmax*  
*O*

*Xmax*  
*Center body*

***Appear 3-a: description of the various parameters (welding of type\_1)***

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There are two types of welding:

PIPE

WELDING

BODY

Type\_1

Type\_2

### **Determination of $X_{max}$ and $Z_{max}$**

In a general way, the maximum dimension of a tube " $D_{max}$ " is defined starting from the length of damping " $L_{dmax}$ ". This length is calculated by the following formula

:

3

$3 R_m$

Max

,  $3 R \times$

$E$ , where  $R$  is the average radius of the tube considered and  $E$  its thickness.

2

$E$

m

m

.  
*Calculation of LXmax (body): one applies the preceding formula with R average radius of the body  
m  
(BODY) and E its thickness.*

.  
*Calculation of LZmax: the ray and the thickness of the pipe are not constant. It is thus necessary  
to successively twice apply the formula of the maximum, with the following data:*

*1) R average radius of pipe (TUBU) and E its thickness;*

*m*

*2) R average radius of the base of the pipe (BASE) and E its thickness.*

*m*

*Then one takes the maximum of the two preceding values.*

*These lengths of damping are counted starting from the edge external of the base of the pipe (according  
to  
X) and with the top of the chamfer (according to Z).*

*One thus obtains finally:*

*X*

*= LX*

*+ 1/2 DEXT\_ BASE*

*max*

*max*

*Z*

*= LZ*

*+ 1/2 DEXT\_ CORP + L\_ BASE + L\_ CHANF*

*max*

*max*

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## ***4 Operands***

***4.1***  
***Key word factor EXEC\_MAILLAGE***

***4.1.1 Operand***  
***SOFTWARE***

***SOFTWARE =/"GIBI98",***

***/***  
***"GIBI2000",***

***Software GIBI carried out for the realization of the grid of the square.***

***UNITE\_DATG***  
***= unit\_d***

***Number of the logical unit where one can print data GIBI generated for the realization grid of the square. By defect, 70.***

***UNITE\_MGIB***  
***= unit\_s***

***Logical number of unit where one can print the grid of the square generated by GIBI. By defect, 19.***

***NIVE\_GIBI***  
***=***

***Level of GIBI used, which is worth 10 per defect.***



## 4.2

**Operand TYPE\_ELEM**

*Allows to choose the type of element which will constitura the grid.*

```

/  

"CU20"  

,  

[DEFECT]  

/  

"CUB8"  

,  

[TXM]

```

## 4.3

**Operand RAFF\_MAIL**

*This operand makes it possible to define the refinement of the grid close to the welding. It is GROSSier by defect, but it can be FINER. [Table 4.3-1] the number of nodes indicates on the saddle and on the interface (see [Figure 5-a]) when one uses operand RAFF\_MAIL in the case of "healthy" grids.*

*A many nodes on the saddle Number nodes on the interface*

**LARGE**

2 3

**END**

3 7

**Table 4.3-1: Topological definition of the welding**

*For the fissured grids, this parameter defines the refinement of the grid around the bottom of crack and*

*determine the default values of the various optional parameters (cf [§4.10] and [§4.11]).*

**Notice 1:**

*In the case of a thermomechanical calculation on a healthy pricking, grid with coarse refinement is not sufficient to make it possible to apply the methods simplified functions of influence which require to be able to collect it correctly heat gradient, it is thus not validated. An analysis of harmfulness of defect on healthy pricking in linear elasticity with ASPIC must be led on a grid of fine refinement which allows a faithful representation of the field of temperature and of constraints during the transient.*

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**Notice 2:**

*In the case of a linear elastic design on a fissured pricking (short crack), the **presence** of a fissured block very refined around the crack led, whatever the refinement grid of the pipes on both sides of the welding, with a faithful representation rate of refund of energy  $G$  during the transient. Grids of ASPIC with fine or coarse refinement are thus validated. From a practical point of view and in order to limit the computing times, one can be satisfied with a grid with refinement coarse.*

*For the justification of the two remarks above, the reader will be able to consult the reference: "Tool-trade ASPIC Validations of the grids for the calculation of the thermal transients. ", **author:** S. MUSI, **ref.:** Note SEPTEN E-N-T-MS/00-01108-A of the 25/1/2001.*

**4.4**

**Key word factor PIPE**

*All the coasts of the grid must be given in Meters.*

**4.4.1 Operand**

**E\_BASE**

E\_BASE

=

*thickness*

*Value thickness of the pipe in the zone of connection with the body.*

#### **4.4.2 Operand**

##### **DEXT\_BASE**

*DEXT\_BASES = diameter*

*Value of the diameter external of the pipe in the zone of connection with the body.*

#### **4.4.3 Operand**

##### **L\_BASE**

*L\_BASE*

=

*length*

*Value length of the base of the pipe counted starting from surface external of the body.*

#### **4.4.4 Operand**

##### **L\_CHANF**

*L\_CHANF = length*

*Value length of the chamfer.*

#### **4.4.5 Operand**

##### **E\_TUBU**

*E\_TUBU*

=

*thickness*

*Value thickness of the pipe to the top of the chamfer.*

#### **4.4.6 Operand**

##### **DEXT\_TUBU**

*DEXT\_TUBU*

=

*diameter*

*Value of the diameter external of the pipe with the top of the chamfer.*

#### **4.4.7 Operand**

##### **Z\_MAX**

*Z\_MAX =*

*length*

*Value of the maximum dimension in Z of the pipe specifying the localization of the torque of effort (see [§3] [Figure 3-a]). This value must correspond to the computed value with a relative precision of one thousandths.*

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#### **4.4.8 Operand**

##### **TYPE**

**TYPE =**

*The position of the welding defines.*

*/“TYPE\_1”*

*the bevel of the welding is located in the body*

*/“TYPE\_2”*

*the bevel of the welding is located in the pipe*

**TYPE\_1 TYPE\_2**

*angl\_soud*

*angl\_soud*

*LXmax*

*LXmax*

#### ***Appear 4.4.8-a: Definition of the position of the welding***

#### ***4.4.9 Operand***

***L\_PENETR***

*L\_PENETR =*

*length*

*Value the length of penetration of the pipe counted starting from the internal skin of the body in the case of a penetrating pricking. By defect, pricking is not penetrating (the length of penetration is null).*

*A length of nonnull penetration is authorized only for the weldings of the type 1.*

*The case of the **tilted cracks emerging in skin interns with a play not no one and a pricking penetrating is prohibited**, because in this case, one cannot net the corner of the penetrating part of the pipe. The user must then choose a null play (operand JEU\_SOUD).*

### ***4.5***

#### ***Key word factor WELDING***

#### ***4.5.1 Operand***

***H\_SOUD***

*H\_SOUD*

*=*

*height*

*Value height of the welding counted starting from surface external of the body for weldings of the type 1 and the pipe for the weldings of the type 2.*

#### ***4.5.2 Operand***

***ANGL\_SOUD***

*ANGL\_SOUD*

*=*

*angle*

*Value of the angle of the welding, in degrees.*

### **4.5.3 Operand**

***JEU\_SOUD***

*JEU\_SOUD =*

*play*

*Value of the space located between the body and the pipe representing the play of the welding.*

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## **4.6**

***Key word factor BODY***

### **4.6.1 Operand**

***E\_CORP***

*E\_CORP*

=

*thickness*

*Value thickness of the body.*

### **4.6.2 Operand**

***DEXT\_CORP***

**DEXT\_CORP**

=

*diameter*

*Value of the diameter external of the body.*

#### **4.6.3 Operand**

**X\_MAX**

X\_MAX =

*length*

*Value of the maximum dimension in X of the body specifying the localization of the torque of effort (see [§3]*

*[Figure 3-a]). This value must correspond to the computed value with a relative precision of one thousandths.*

#### **4.7**

**Key word factor FISS\_SOUDURE**

*Key word specific to fissured prickings.*

##### **4.7.1 Operand**

**TYPE**

TYPE =

*The type of crack defines: long crack or short crack.*

*/"LONG" one considers the case of long but not very deep cracks (1/8 or 1/4 thickness)*

*/"SHORT" one considers the case of cracks of maximum depth equal to the half thickness pricking*

##### **4.7.2 Operand**

**AXIS**

AXIS =

*To be able to treat the case of the axisymmetric cracks ("YES") or not axisymmetric ("NOT") (if parameter fissures **long** exclusively).*

*crowns*  
*rc0\*rc1*  
*rc0\*rc2*  
*rc0\*rc3*  
*rc0*  
*sections*  
*sectors*

### ***Appear 4.7.2-a: Parameters of the basic grid radiating of crack***

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#### ***Caution:***

*If AXIS = "YES" and if the crack is inclined, the depth of the crack will be corrected only if ANGL\_SOUD lies between 8 and 26 degrees, this whatever the type of the welding: TYPE\_1 or TYPE\_2. If the crack is axisymmetric and right the correction of depth is carried out whatever the authorized value of ANGL\_SOUD.*

#### ***4.7.3 Operand***

***COEF\_MULT\_RC1***

*COEF\_MULT\_RC1*

= *rc1*

*Multiplying coefficient of the parameter rc0 allowing to define the thickness of the crown of déraffinement sectors (if parameter fissures **short** exclusively, with two values by defect according to the refinement of the grid).*



**4.7.4 Operand****COEF\_MULT\_RC2**

COEF\_MULT\_RC2

= rc2

*Multiplying coefficient of the parameter rc0 allowing to define the thickness of the first crown déraffinement sections (if parameter fissures **short** exclusively, with two default values according to the refinement of the grid).*

**4.7.5 Operand****COEF\_MULT\_RC3**

COEF\_MULT\_RC3

= rc3

*Multiplying coefficient of the parameter rc0 allowing to define the thickness of the second crown déraffinement sections (if parameter fissures **short** exclusively, with two default values according to the refinement of the grid).*

**4.7.6 Operand****NB\_SECTEUR**

NB\_SECTEUR =

NS

*A number of sectors on 90°, which is worth 2 or 4 in general.*

**4.7.7 Operand****NB\_COURONNE**

NB\_COURONNE = nc

*A many crowns, which are worth 3 or 4 in general.*

**4.7.8 Operand****NB\_TRANCHE**

NB\_TRANCHE =

NT

*A number of sections corresponding to a **quarter of elliptic crack**, which is worth 8 or 16 in general (16 or 32 for the cracks with strong eccentricity).*

*For the long cracks, the minimal value of 8 is imposed.*

#### **4.7.9 Operand RAYON\_TORE**

*RAYON\_TORE =  
rc0*

*Ray of the torus of the zone with imposed grid of type radiating around the bottom of crack.  
For the long cracks, this parameter is calculated automatically.*

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#### **4.7.10 Operand DEPTH**

**DEPTH =**

**has**

***So STANDARD = "LONG" A = depth of the crack if the crack is emerging***

***= half-depth of the crack if the crack is not emerging***

***So STANDARD = "SHORT" A = size of the small half centers elliptic cracks***

***= depth of the crack if the crack is emerging***

***= half-depth if the crack is not emerging***

**Note:**

***In the case of a "SHORT" crack of the type and emerging ("DEB\_INT" or "DEB\_EXT"),  
real depth of the crack in the generated grid is calculated. That thus allows***

*the user to check coherence between its data input and the grid obtained. This information appears in the file MESSAGE, at the end of the messages associated with macro order MACR\_ASPIC\_MAIL:*

*<MACR\_ASPIC\_MAIL> DEPTH OF THE CRACK IN THE GRID: 29.99*

#### ***4.7.11 Operand LENGTH***

***LENGTH =***

***2c***

*So STANDARD = "LONG" length of the crack*

*So STANDARD = "SHORT" size of the large axis of the elliptic cracks*

*For the short cracks (elliptic), a/c must lie between 1 and 0.2.*

*When the crack is axisymmetric (AXIS), it is useless to give a length, and this one is not then not taken into account. This operand is on the other hand obligatory in the case of a crack not axisymmetric.*

#### ***4.7.12 Operand AZIMUTH***

***AZIMUTH***

***=***

***theta***

*Position of the center of the crack, counted positively starting from axis X of the body, in degrees.*

#### ***4.7.13 Operand POSITION***

***POSITION =***

***/"RIGHT"***

*The crack is located at the interface between the pipe and the welding for a welding of type 1 and to the interface enters the body and the welding for a welding of the type 2.*

*/The crack "INCLINES" is located at the interface between the body and the welding for a welding of type 1 and with the interface enters the pipe and the welding for a welding of the type 2.*

***TYPE\_1***

***TYPE\_2***

***INCLINE***

***RIGHT***

***INCLINE***

***RIGHT***

***Appear 4.7.13-a: Definition of the position of a crack according to the type of the welding***

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#### ***4.7.14 Operand FISSURES***

***FISSURE =***

***Give the position of the crack: emerging in internal skin (“DEB\_INT”) or in external skin (“DEB\_EXT”) or not emerging (“NON\_DEB”), or crossing (“THROUGH”).***

#### ***4.7.15 Operand LIGA\_INT***

***LIGA\_INT***

***Defines the length in mm of the interior ligament for a crack not emerging.***

#### ***4.7.16 Operand ANGL\_OUVERTURE***

***ANGL\_OUVERTURE =***

*eps*

*The half angle of opening of the crack in degrees (0 per defect) defines.*

**4.8**

**Key word factor IMPRESSION**

**4.8.1 Operand**

**FILE**

*Name given to the print file. By defect, the print file is the file of the grid type ASTER (standard .mast). It is thus important to put this type of file in the profile of study if one use the default options of the key word IMPRESSION.*

**4.8.2 Operand**

**UNIT**

*Logical number of unit associated the file.*

**4.8.3 Operand**

**FORMAT**

*Specify the format of impression of the grid of pricking. By defect, the format is ASTER.*

**4.8.4 Operand**

**VERSION**

*File IDEAS has a structure different according to the version from the software. This operand is not thus licit that when the operand FORMAT is worth IDEAS. By defect, VERSION is worth 5. Only versions 4 and 5 are supported.*

**4.8.5 Operand**

**NIVE\_GIBI**

*File CASTEM has a structure different according to the level from exit of the Gibi software. This operand is thus licit only when the operand FORMAT is worth CASTEM. By defect, VERSION is worth 10. Only them levels 3 and 10 are supported.*

**4.9 Operand**

**INFORMATION**

## **INFORMATION**

=  
/1

,  
**[DEFECT]**

/2

,  
**[I]**

**Level of information.**

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### **4.10 Default settings for the short cracks**

.

**two values according to the refinement of the grid,**

.

**variable values according to the eccentricity of the crack.**

**$a/c > 0.4999$**

**$a/c > 0.3499$**

**$a/c < 0.3499$**

**grid type**

**large end large end large end**

**NT**  
8 16 8 16 16 32  
**nc**  
3 4 3 4 3 4  
**NS**  
2 4 2 4 2 4  
**ndt (\*)**  
1 2 1 2 2 2  
**nsdt (\*)**  
2 4 2 4 4 4  
**rc0**  
 $a*0.12 a*0.10 a*0.12 a*0.10 a*0.08 a*0.08$   
**rc1**  
1.2 1.0 1.2 1.0 1.2 1.0  
**rc2**  
1.4 1.2 1.4 1.2 1.4 1.2  
**rc3**  
\* 2.2 \* 2.0 2.5 2.0  
**beta (\*)**  
1 1 1 1 1 1  
**alpha (\*)**  
0 0 0.4  
0.4  
0.8  
0.8

**Table 4.10-1: Default settings of the short cracks**

**(\*) Parameters nonaccessible to the user**

#### **4.11 Default settings for the long cracks**

.  
**two values according to the refinement of the grid**

**grid type**  
**large end**  
**nc**  
3 4  
**NS**  
2 4  
**ndt (\*)**  
2 3  
**rc0**  
**has (ndt+1) A (ndt+1)**

*f\_etir\_f (\*)*

*30\*Léquerre/Lpiquage 15\*Léquerre/Lpiquage*

*f\_etir\_p (\*)*

*60\*Léquerre/Lpiquage 30\*Léquerre/Lpiquage*

*Table 4.11-1: Default settings of the long cracks*

*(\*) Parameters nonaccessible to the user*

#### *4.12 Numerical values for the geometrical parameters*

*The values of the geometrical parameters must be included/understood in the following forks:*

*21 mm < epC <*

*60 mm*

*epC*

*E\_CORP,*

*406 mm < DEC < 1500 mm*

*DEC*

*DEXT\_CORP,*

*141 mm < epT1 <*

*70 mm*

*epT1*

*E\_BASE,*

*8 mm < epT2 < 56 mm*

*epT2*

*E\_TUBU,*

*140 mm < DeT1 < 880 mm*



***DeT1***

***DEXT\_BASE,***  
***114 mm < DeT2 < 812.8 mm***

***DeT2***

***DEXT\_TUBU,***  
***41 mm < d1 < 825 mm***

***d1***

***L\_BASE,***  
***22 mm < d2 < 135 mm***

***d2***

***L\_CHANF,***  
***15 mm H***  
***30 mm according to UTO/SIS***  
***H***

***H\_SOUD,***  
***0 mm < play < 20 mm***

***play***

***JEU\_SOUD,***  
***15°***  
***< alpha < 50°***

*alpha*

*ANGL\_SOUD.*

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5

***Topological grid and groups***

*Macro order MACR\_ASPIC\_MAIL generates the grid [Figure 5-a].*

Z

*P\_TUBU*

*extubu*

Y

*peautubu*

*excorp1*  
*excorp2*

*X*

*P1\_CORP*

*peaucorp*  
*P2\_CORP*

***Appear 5-a: Grid obtained***

*One notes:*

*.*  
*peautubu*  
*: interior skin of the pipe,*

*.*  
*peaucorp*  
*: interior skin of the body,*

*.*  
*excorp1*  
*: the extreme section of the body, located at the dimension  $X = -X_{max}$ ,*

*.*  
*excorp2*  
*: the extreme section of the body, located at the dimension  $X = +X_{max}$ ,*

*.*  
*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  $Z = Z_{max}$ ,*

*.*  
*P\_TUBU*  
*: the node located at the center of extubu.*

***Note:***

*The groups of meshes TUBU, CORP and SOUD are present only in the case of pricking healthy. They are replaced by TUBU and SOUDCORP or SOUDTUBU and CORP, according to the type welding and the position of the crack (see the documentation of MACR\_ASPIC\_CALC, [§3.5.1]).*

*For the postprocessings of healthy pricking, the nodes located at the ends of each segment, with various azimuths, whose whole forms an interface between the welding and the body, on the one hand, and between the welding and the pipe, in addition, are created so that one can record the constraints there normals and tangential.*

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*For fissured prickings, one notes also the following objects:*

.

*levrtubu*

*: the lip of the crack, side pipe (surface meshes),*

.

*levrcorp*

*: the lip of the crack, side body (surface meshes),*

.

*fondfiss*

*: bottom of crack (meshs SEG3), in the case of emerging cracks unspecified or not emerging short which has one bottom of fissure,*

.

*fond\_sup*

*: bottom of crack (meshs SEG3) higher (external side skin) in the case long or axisymmetric cracks not emerging which have two funds of crack,*

.

*fond\_inf*

*: bottom of crack (meshs SEG3) lower (side skin interns) in the case of them long or axisymmetric cracks not emerging which have two funds of fissure.*

*Pfondfis, pfondsuf and pfondinf are the groups of meshes POII respectively associated the groups fondfiss, fond\_sup and fond\_inf.*

*The table below presents the groups of meshes suitable for the breaking process:*

***fissure not emerging***

***fissure emerging***

*name of Gibi object*

*description*

*name of Gibi object*

*description*

*vfcos1*

***1/8 fissured block volume***

*vfco1*

***1/4 block volume***

***body higher  $Y>0$  side***

***fissured body on the side***

*$Y>0$*

*vftus1*

***1/8 fissured block volume***

*vftu1*

***1/4 block volume***

***pipe higher side***

***fissured pipe of***

*$Y>0$*

*$Y>0$  side*

*torecos1*

*1/8 of torus pertaining to*

*toreco1*

*1/4 of torus*

*vfcos1*

*belonging to vfco1*

*toretus1*

*1/8 of torus pertaining to*

*toretu1*

*1/4 of torus*

*vftus1*

*belonging to vftu1*

*vfcos2*

***1/8 fissured block volume***

*vfco2*

***1/4 block volume***

***body higher  $Y<0$  side***

***fissured body on the side***

*$Y<0$*

*vftus2*

***1/8 fissured block volume***

*vftu2*  
*1/4 block volume*  
***pipe higher side***  
***fissured pipe of***  
*Y<0*  
*Y<0 side*  
*torecos2*  
*1/8 of torus pertaining to*  
*toreco2*  
*1/4 of torus*  
*vfcos2*  
*belonging to vfco2*  
*toretus2*  
*1/8 of torus pertaining to*  
*toretu2*  
*1/4 of torus*  
*vftus2*  
*belonging to vftu2*  
*vfcoi1 1/8*  
***fissured block volume***

***body lower Y>0 side***  
*vftui1 1/8*  
***fissured block volume***

***pipe lower side***  
*Y>0*  
*torecoi1*  
*1/8 of torus pertaining to*

*vfcoi1*  
*toretui1*  
*1/8 of torus pertaining to*

*vftui1*  
*vfcoi2*  
***1/8 fissured block volume***

***body lower Y<0 side***  
*fvtui2*

*1/8 fissured block volume*

*pipe lower side*

*Y<0*

*torecoi2*

*1/8 of torus pertaining to*

*vfcoi2*

*toretui2*

*1/8 of torus pertaining to*

*vftui2*

***Table 5-1: Location of geometrical entities for the breaking process***

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*The other groups of meshes, not specified here, are used for the geometrical transformation of the square in pricking, (sticking together of surfaces and suppression of the double nodes) and with automatic calculation*

*basic effect, in the macro-orders.*

*For healthy prickings:*

*one notes for the azimuth  $n^\circ x$  (X ranging between 1 and 48 for the refined grids and between 1 and 40 for*



*coarse grids):*

- 
- nedx: node external of the right segment,*
- 
- nidx: interior node of the right segment,*
- 
- neix: node external of the inclined segment,*
- 
- niix*  
*: interior node of the inclined segment,*
- 
- ldx*  
*: line going of nidx with nedx,*
- 
- lix*  
*: line going of niix with neix.*

- nedx*
- saddle*
- neix*
- interface right n°x*
- interface right n°*
- interface inclin*
- interface*
- ée n°x*
- 
- nidx*
- niix*

***Appear 5-b: Names of the groups of nodes to the azimuth n°x of healthy pricking***

*The classification of the azimuths (from 1 to 40 for the coarse grids or from 1 to 48 for the grids ends) is done in the trigonometrical direction around axis Z starting from axis X of the body.*

- Y*
- azimuth n° 1*
- Z*
- X*

***Appear 5-c: Classification of the azimuths for healthy prickings***

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## 6 Example

*In addition to the examples described here one will be able to consult the command files (fichier. comm) of case tests. The latter are in the repertories:*

1. */aster/v7/STA7/astest*
2. */aster/v7/NEW7/astest*

*and the names asplic\* carry.*

**MA=MACR\_ASPIC\_MAIL (**

**EXEC\_MALLAGE=\_F (SOFTWARE = "GIBI2000"),**

**TUBULURE=\_F (E\_BASE = 60.0,**

**DEXT\_BASE = 872.0,**

**L\_BASE = 298.0,**

**L\_CHANF = 102.0,**

**TYPE=' TYPE\_1',**

**E\_TUBU = 27.0,**

**DEXT\_TUBU = 812.8,**

**Z\_MAX = 3398.2),**

**RAFF\_MAIL=' GROS',**

**SOUDURE=\_F (H\_SOUD = 15.0,  
ANGL\_SOUD = 25.0,  
JEU\_SOUD = 10.0),**

**CORPS=\_F (E\_CORP = 60.0,  
DEXT\_CORP = 1500.0,  
X\_MAX = 4177.2),**

**FISS\_SOUDURE=\_F (STANDARD = "LONG",  
DEPTH = 30.0,  
LENGTH = 300.0,  
AZIMUTH = 0.0,  
POSITION = "INCLINES",  
FISSURE = "DEB\_INT"),**

**IMPRESSION=\_F (  
FILE = "FICH\_MA",  
UNIT = 37,  
FORMAT = "CASTEM",  
)  
)**

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*Organization (S): EDF-R & D /AMA*

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***Macro order MACR\_ASPIC\_CALC***

***1 Goal***

*To carry out a preset calculation of healthy or fissured prickings, as well as associated postprocessings. lengths of the grid produced by MACR\_ASPIC\_MAIL are in millimetres, it is necessary to hold account of it in the units of the characteristics material and loading.*

*The principal stages of the macro order are:*

- .  
assignment of the models mechanical and thermal by order AFFE\_MODELE,*
- .  
assignment of materials by order AFFE\_MATERIAU,*
- .  
assignment of the characteristics of the discrete elements by order AFFE\_CARA\_ELEM  
(null rigidities),*
- .  
definition of the boundary conditions of embedding of the beam type with the connection 3D-beam  
by order AFFE\_CHAR\_MECA,*
- .  
definition of the loading mechanical (pressure, basic effect, torque of effort, deformation  
of thermal origin) by order AFFE\_CHAR\_MECA,*
- .  
definition of the thermal loading (temperature of fluid, coefficient of exchange) by  
order AFFE\_CHAR\_THER\_F,*

realization of linear thermal calculation and linear mechanical calculation or not linear by orders *Ther\_Lineaire* and *Stat\_Non\_Line*, then calculation of options by *Calc\_Elem*,

realization of the post treatment by orders *Post\_Releve\_T*, or *Defi\_Fond\_Fiss*, *Calc\_Theta*, *Calc\_G\_Theta* and *Calc\_G\_Local*,

impression of postprocessing by orders *Impr\_Resu* and *Impr\_Table*.

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## 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]

*PIPE =\_F (*

*TYPE =/"TYPE\_1",*  
[TXM]

*/"TYPE\_2",*

),

*GRID = nom\_maillage, [grid]*

*MODEL*

=

*CO*

*("modmec"),*  
[TXM]

*CHAM\_MATER=*

*CO*

*("chmat"), [TXM]*

**CARA\_ELEM**

=

**CO**

(“*carael*”),

[TXM]

**FOND\_FISS1= CO**

(“*fonfiss1*”),

[TXM]

**FOND\_FISS2= CO**

(“*fonfiss2*”),

[TXM]

**CHARGE**

=

**CO**

(“*chmeth*”),

[TXM]

**RESU\_THER**

=

**CO**

(“*resuth*”),

[TXM]

**AFFE\_MATERIAU =\_F (/ALL = “YES”,**

/

**GROUP\_MA**

=

/

**“TUBU”,**

/

**“CORP”,**

/

**“SOUD”,**

/  
“**SOUDTUBU**”,  
/  
“**SOUDCORP**”,

**MATER**  
=  
*material,*  
*[to subdue]*

**TEMP\_REF**  
=  
/  
0.  
,  
**[DEFECT]**  
/  
*tref*  
,  
**[R]**

**RCCM**  
=  
/

**“YES”,**  
**[TXM]**  
**/**  
**“NOT”,**

**),**

**BALANCE =\_F (NOEUD=/"P1\_CORP",**  
**/**  
**“P2\_CORP”,**

**),**

**PRES\_REP =\_F**  
**(**  
**NEAR**  
**=**  
**near,**  
**[R]**

**NODE =/"P1\_CORP",**  
**/**  
**“P2\_CORP”,**

***EFFE\_FOND***

=

/

***“YES”,  
[DEFECT]***

/

***“NOT”,***

***PRES\_LEVRE =/***

***“YES”,***

/

***“NOT”,  
[DEFECT]***

***FONC\_MULT***

=

***fmult1, [function/formula]***

),

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**=\_F EXCHANGE**

**(**

**COEF\_H\_TUBU = htubu**

**, [function/formula]**

**COEF\_H\_CORP = hcorp, [function/formula]**

**TEMP\_EXT**

**=**

**chtex**

**,**

**[function/formula]**

**),**

**TORS\_CORP**

**=\_F**



(  
**NODE**  
=/"P1\_CORP",  
/  
"P2\_CORP",

/  
**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\_INCR***  
=***\_F***  
(***RELATION =/“VMIS\_ISOT\_TRAC”***,

),  
/  
**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**

**TERMINALS**

= **\_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])

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**NEWTON**

= (see the document [U4.51.03])

**RECH\_LINEAIRE**= (see the document [U4.51.03])

**INCREMENT**

= (see the document [U4.51.03])

**PAS\_AZIMUT** =/1, [DEFECT]

/  
**not**  
,  
**[I]**  
  
=**\_F IMPRESSION**  
**(/FORMAT**  
**=/"RESULT", [DEFECT]**  
  
/  
**"ASTER",**  
**[TXM]**  
  
/  
**"CASTEM"**  
  
,  
**[TXM]**  
  
/  
**"IDEAS",**  
**[TXM]**  
  
**# If FORMAT = "IDEAS" or "CASTEM"**

**NOM\_CHAM**  
  
=  
  
/  
**"DEPL"**  
  
,  
**[TXM]**  
  
/  
**"EQUI\_ELNO\_SIGM"**  
  
,  
  
/  
**"TEMP"**  
  
,

**TOUT\_ORDRE = "YES"**  
  
,  
**[TXM]**

***NUME\_ORDRE = lordre***

,  
***[I\_I]***

***INST = linst***

,  
***[I\_R]***  
***# Finsi***

***# If FORMAT = "CASTEM"***

***NIVE\_GIBI***

***= /3,***  
***/10***

,  
***[DEFECT]***

***# If FORMAT = "IDEAS"***

***VERSION =/4,***

***/***  
***5,***  
***[DEFECT]***



),

**TITRATE**

=

**nom\_titre**

**[l\_Kn]**

**INFORMATION =/**

**1**

,

**[DEFECT]**

**/ 2**

,

**[I]**

)

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**3 Operands**

**Z**

**P\_TUBU**

*extubu*

**Y**

*peautubu*

*excorp1*

*excorp2*

**X**

## ***P1\_CORP***

*peaucorp*

## ***P2\_CORP***

***Appear 3-a: Grid 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:***

***These entities are not used in the macro-order of calculation but they appear in detail orders carried out by this macro (file of the mess type).***

***Notice 3-2:***

***The groups of meshes TUBU, CORP and SOUD are present only in the case of healthy pricking. They are replaced by TUBU and SOUDCORP or by SOUDTUBU and CORP, according to the type of welding (1 or 2) and the position of the crack (right or tilted) (see [§3.6.1]).***

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### **3.1 Word**

**key**

**TYPE\_MAILLAGE**

**TYPE\_MAILLAGE =**

**/“SAIN\_GROS”**

**calculation is carried out on a healthy pricking built with the option  
RAFF\_MAIL = “LARGE” in MACR\_ASPIC\_MAIL.**

**/“SAIN\_FIN”**

**calculation is carried out on a healthy pricking built with the option  
RAFF\_MAIL = “FINE” in MACR\_ASPIC\_MAIL.**

**/“FISS\_COUR\_DEB”**

**calculation is carried out on a pricking fissured (mechanical of  
rupture) with an emerging short crack.**

**/“FISS\_COUR\_NONDEB”**

**calculation is carried out on a pricking fissured (mechanical of  
rupture) with a short crack not emerging.**

**/“FISS\_LONG\_DEB”**

**calculation is carried out on a pricking fissured (mechanical of  
rupture) with an emerging long crack.**

**/“FISS\_LONG\_NONDEB”**

**calculation is carried out on a pricking fissured (mechanical of  
rupture) with a long crack not emerging.**

***/"FISS\_AXIS\_DEB"***

***calculation is carried out on a pricking fissured (mechanical of rupture) with an emerging axisymmetric crack.***

***/"FISS\_AXIS\_NONDEB"***

***calculation is carried out on a pricking fissured (mechanical of rupture) with an axisymmetric crack not emerging.***

***This information already given by the user in the macro-order of grid MACR\_ASPIC\_MAIL must be repeated here to determine the type of calculation and postprocessing to be made.***

***The table below recapitulates the configuration of the bottom of crack, and the treatment carried out for each position of crack in the square, in the case of a pricking with crack.***

***One will refer to the reference documents [R7.02.01], [R7.02.03], [R7.02.04], [R7.02.05] and [R7.02.07] for more detail on calculation of the G-room.***

***Cracks***

***Configuration melts of emerging or***

***Type fissures***

***Calculation of G\_Local***

***fissure***

***not***

***a bottom of crack***

***short***

***Legendre-Legendre***

***not closed***

***Cracks***

***a bottom of crack***

***long***

***Legendre-Legendre***

***emerging***

***not closed***

***a bottom of crack***

***axisymmetric***

***Lagrange-Lagrange***

***closed***

***a bottom of crack***

*short*  
*Lagrange-Lagrange*

*closed*  
*Cracks not*  
*two funds of crack*  
*long*  
*Legendre-Legendre*  
*emerging*  
*not closed*  
*two funds of crack*  
*axisymmetric*  
*Lagrange-Lagrange*  
*closed*

*Table 3.1-1: Various configurations of the bottom of crack*

*Notice 3-3:*

*In the case of cracks not emerging long, one nets two funds of crack because the connection at each end is not with a grid.*

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*For healthy prickings, one calculates in postprocessing the constraints according to the modes of opening IF, SII and SIII:*

**IF**

**SII**

**SIII**

**standard welding 1**

**siXX siXY siXZ**

**interface right**

**(cylindrical reference mark)**

**standard welding 1**

**siYY siXY siYZ**

**tilted interface**

**(local reference mark)**

**standard welding 2**

**siYY siXY siYZ**

**interface right**

**(local reference mark)**

**standard welding 2**

**siYY siXY siYZ**

**tilted interface**

**(local reference mark)**

**Table 3.1-2: Constraints according to the modes of opening**

**Notice 3-4:**

**The sign obtained on SIII in the local reference mark is explained by the difference between the reference mark**

**room chosen by the SEPTEN and that of Code\_Aster®.**

**3.2**

**Key word factor PIPE**

**PIPE**

**= /**

**“TYPE\_1”,**

**[DEFECT]**

**/**

**“TYPE\_2”,**

**[TXM]**

**Point out the type of welding defined in MACR\_ASPIC\_MAIL to define the reference marks of examination of postprocessings.**

**3.3 Word**

**key**

## **GRID**

**GRID = grid**

*Here the grid used is specified. This grid results from MACR\_ASPIC\_MAIL.*

### **3.4 Word**

*key*

**MODEL**

**MODEL = CO (“modmec”)**

*This key word makes it possible to possibly name the mechanical model in order to re-use it, by example to make another calculation (not using MACR\_ASPIC\_CALC) or of postprocessing.*

### **3.5 Word**

*key*

**CHAM\_MATER**

**CHAM\_MATER = CO (“chmat”)**

*This key word makes it possible to possibly name the field material corresponding to the model mechanics in order to re-use it, for example to make another calculation (not using MACR\_ASPIC\_CALC) or of postprocessing.*

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### **3.6 Word**



*key*

**CARA\_ELEM**

**CARA\_ELEM = CO (“carael”)**

*This key word makes it possible to possibly name the concept of the cara\_elem type (order AFFE\_CARA\_ELEM) in order to re-use it, for example to make another calculation (not using MACR\_ASPIC\_CALC).*

**3.7 Word**

*key*

**FOND\_FISS1**

**FOND\_FISS1 = CO (“fonfiss1”)**

*This key word makes it possible to possibly name the concept fond\_fiss (order DEF1\_FOND\_FISS) in order to re-use it, for example to make another calculation (not using MACR\_ASPIC\_CALC) or of postprocessing.*

**3.8 Word**

*key*

**FOND\_FISS2**

**FOND\_FISS2 = CO (“fonfiss2”)**

*This key word makes it possible to possibly name the concept fond\_fiss (order DEF1\_FOND\_FISS) in order to re-use it, for example to make another calculation (not using MACR\_ASPIC\_CALC) or of postprocessing. It is used if the crack comprises two melt of crack, (see [§3.1]).*

**3.9 Word**

*key*

**CHARGE**

**CHARGE = CO  
 (“chmeth”)**

*This key word makes it possible to possibly name the mechanical loading due to a calculation preceding thermics (concept: char\_meca, order: AFFE\_CHAR\_MECA), for example for to make another calculation (not using MACR\_ASPIC\_CALC) or of postprocessing.*

**3.10 Word**

*key*

**RESU\_THER**

**RESU\_THER = CO**  
**(“resuth”)**

*This key word makes it possible to possibly name the result of thermal calculation, for example for to make another calculation (not using MACR\_ASPIC\_CALC) or of postprocessing.*

### **3.11 Key word factor AFFE\_MATERIAU**

**AFFE\_MATERIAU**

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

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#### **3.11.1 Operands ALL, GROUP\_MA**

**/**

**ALL**

**=**

**“YES”**

,  
/  
**GROUP\_MA**  
=  
/  
**“TUBU”**  
,  
/  
**“CORP”**  
,  
/  
**“SOUD”**  
,  
/  
**“SOUDTUBU”**  
,  
/  
**“SOUDCORP”**  
,

*These key words make it possible to affect material on all the meshes of the grid (ALL), or on one part of grid (GROUP\_MA).*

*For “healthy” prickings, one can affect:*

**“TUBU”**  
*: the pipe,*

**“CORP”**  
:  
*body,*

**“SOUD”**  
:  
*welding.*

*For prickings with right crack if the welding is of type 1 or with tilted crack if the welding is of type 2, one can affect:*

**“TUBU”**  
*: the pipe,*

**“SOUDCORP”**: *the unit  
welding-body.*

*For prickings with tilted crack if the welding is of type 1 or with right crack if the welding is of type 2, one can affect:*

*“CORP”  
: the body,*

*“SOUDTUBU”: the unit  
welding-pipe.*

*TYPE\_1  
TYPE\_2*

*RIGHT  
INCLINE*

*INCLINE  
RIGHT*

*Appear 3.11.1-a: Definition of the position of a crack according to the type of the welding*

*3.11.2 MATER operand*

*MATER*

*Name of the material which one wants to affect.*

*3.11.3 Operand RCCM*

*RCCM =  
/“YES”,*

*/  
“NOT”,*

*Is used to specify if one wants to make a postprocessing of type POST\_RCCM. Attention if them characteristics material necessary to POST\_RCCM are not defined in an order DEFI\_MATERIAU preceding MACR\_ASPIC\_CALC calculation will stop in FATAL ERROR with*

*moment to carry out POST\_RCCM.*

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### *3.11.4 Operand TEMP\_REF*

*TEMP\_REF*

*Temperature of reference for which there is no thermal deformation (cf orders AFFE\_MATERIAU).*

### *3.12 Key word factor BALANCES*

*BALANCE*

*One defines an embedding of the beam type in the one of two ends (P1\_CORP or P2\_CORP). The 6 degrees of freedom of the discrete point are thus blocked.*

*Note:*

*There is a connection 3D-beam between discrete nodes P1\_CORP, P2\_CORP and P\_TUBU and respectively excorp1, excorp2 and extubu which is the sections ends of the body and pipe.*

#### *3.12.1 Operand NODE*

*NODE =/“P1\_CORP”,*

*/*

**“P2\_CORP”**,

*Node of application of embedding.*

### **3.13 Key word factor PRES\_REP**

**PRES\_REP**

#### **3.13.1 Operands NEAR**

**CLOSE = near**

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

#### **3.13.2 Operands NODE/EFFE\_FOND**

**NOEUD=**

**/“P1\_CORP”**,

**/**

**“P2\_CORP”**,

*Determine the face of application of the basic effect on the body.*

*This operand is obligatory in the event of taking into account of the basic effect.*

**Note:**

*If balance is applied to node P1\_CORP then the basic effect will be applied to the face associated P2\_CORP, and conversely. The macro-order checks that the selected position for balance is different from the position of the basic effect on the body.*

**EFFE\_FOND**

**=**

**/**

**“YES”**,

**[DEFECT]**

**/**

**“NOT”**,

*Indicator of taking into account of the basic effect.*

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***The basic effect is applied to the face associated with node P\_TUBU and the one with the two faces ends***

***body (partner with node P1\_CORP or P2\_CORP). It is calculated in an automatic way in function pressure exerted on the wall internal, according to the formula and applied below with PRES\_REP.***

***R2***

***Tfond = near***

***I***

***\* R2 - R2***

***E***

***I***

***Note:***

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

***3.13.3 Operand PRES\_LEVRE***

***PRES\_LEVRE***

***Allows to activate or not the application of the pressure, evoked with [§3.6.1] of this document, on lips of the crack when this one emerges in internal skin. By defect PRES\_LEVRE is worth "NOT".***

***Attention to be used PRES\_LEVRE = "YES" only for the cracks which emerge in skin intern.***

***3.13.4 Operand FONC\_MULT***

***FONC\_MULT***

***= fmult1***

***Multiplying function of the time of the loading of pressure. By defect:  $f_{mult1} = 1$ .***

### ***3.14 Key word factor EXCHANGE***

#### ***EXCHANGE***

***This key word factor makes it possible to apply conditions of exchange to the internal skin of pricking (cf orders AFPE\_CHAR\_THER\_F) and to carry out a linear thermal calculation (with THER\_LINEAIRE) preliminary to mechanical calculation. For thermics, one uses the solver by defect, the value of the parm\_theta by defect and the temp\_init is calculated starting from a calculation***

***stationary and the temperature of the fluid at the initial moment is worth (TEMP\_EXT).***

#### ***3.14.1 Operands COEF\_H\_TUBU and COEF\_H\_CORP***

***COEF\_H\_TUBU = htubu,***

***COEF\_H\_CORP = hcorp,***

***Value of the coefficient of exchange on the skin interns pipe (PEAUTUBU) and body (PEACORP), given in the form of function.***

#### ***3.14.2 Operand TEMP\_EXT***

***TEMP\_EXT = chtex***

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

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### 3.15 Key word factor *TORS\_CORP*

#### *TORS\_CORP*

*This key word is used to take into account the torque of efforts on the body.*

#### 3.15.1 Operand *NODE*

##### *NODE*

*=/“P1\_CORP”,*

*/*

*“P2\_CORP”,*

*The position of the torque here is indicated. If balance is given for P1\_CORP (key word BALANCES) then the torque will be applied to P2\_CORP. The macro-order checks that the selected position for balance is different from the position of the torque of effort on the body.*

#### 3.15.2 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]**

*The torque of efforts here is informed. The components must be provided in the reference mark of grid.*

### **3.15.3 Operand FONC\_MULT**

**FONC\_MULT**  
= **fmult2**

*Multiplying function of the time of loading TORS\_CORP. By defect: fmult2 = 1.*

### **3.16 Key word factor TORS\_TUBU**

**TORS\_TUBU**

*This key word is used to take into account the torque of effort on the pipe. It is applied at the end pipe on node P\_TUBU.*

#### **3.16.1 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]**

*The torque of efforts here is informed. The components must be provided in the reference mark of grid.*

### **3.16.2 Operand FONC\_MULT**

**FONC\_MULT**  
= **fmult3**

*Multiplying function of the time of loading TORS\_TUBU. By defect: **fmult3 = 1.***

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### **3.17 Key word factor COMP\_INCR**

**RELATION =**

**Type of relation of incremental behavior used to carry out mechanical calculation with STAT\_NON\_LINE:**

**“VMIS\_ISOT\_TRAC” elastoplastic behavior of Von Mises with isotropic work hardening not linear (only behavior supported by the macro one).**

### **3.18 Key word factor COMP\_ELAS**

**RELATION =**

**Type of elastic relation of behavior used to carry out mechanical calculation with STAT\_NON\_LINE.**

**/“ELAS”**  
**Linear elastic behavior.**

**/“ELAS\_VMIS\_TRAC” Nonlinear elastic behavior of Von Mises with work hardening isotropic nonlinear.**

### **3.19 Operand**

**THETA\_3D**

**THETA\_3D**

**For postprocessing in breaking process, this key word defines the rays of the crowns surrounding the bottom of crack and used in the method théta. The choice of the rays allows to check the stability of the method.**

#### **3.19.1 Operand R\_INF**

***R\_INF***

=

***r\_inf***  
**[R8]**

### ***3.19.2 Operand R\_SUP***

***R\_SUP***

=

***r\_sup***  
**[R8]**

### ***3.20 Operand OPTION***

***OPTION***

= /

***“CALC\_G\_MAX”***

,

/  
***“CALC\_G\_MAX\_LOCAL”,***

***This option relates to only the maximization of G (G\_THETA for “CALC\_G\_MAX” and G\_LOCAL for “CALC\_G\_MAX\_LOCAL”) under constraints terminals [R7.02.01]. It is necessary then also to provide the value of the constraints terminals behind the key word factor TERMINALS.***

### ***3.21 Key word factor TERMINALS***

***TERMINALS***

***=\_F***

(

**NUME\_ORDRE**

= *num*

,  
**[I]**

**VALE\_MIN**

= *qmin*

, **[R]**

**VALE\_MAX**

= *qmax*

, **[R]**

)

*This key word factor is obligatory if one uses option “CALC\_G\_MAX” or the option “CALC\_G\_MAX\_LOCAL”. The syntax of this key word is described in the document [U4.82.03], with in private individual an example of maximization of G in the presence of signed and not signed constraints.*

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### **3.22 Operand SOLVEUR**

*One defines the solver retained for mechanical calculation.  
The syntax of this key word is described in the document [U4.50.01].  
One privileges the default options.*

### **3.23 Operand CONVERGENCE**

*The syntax of this key word is described in the document [U4.51.03].*

### **3.24 Operand NEWTON**

*The syntax of this key word is described in the document [U4. 51.03].*

### **3.25 Operand RECH\_LINEAIRE**

*The syntax of this key word is described in the document [U4. 51.03].*

### **3.26 Operand INCREMENT**

*The syntax of this key word is described in the document [U4. 51.03].*

### **3.27 Key word PAS\_AZIMUT**

**PAS\_AZIMUT =**

**/  
1  
,  
[DEFECT]  
/  
not  
,  
[I]**

*This key word makes it possible to limit the examinations in the case of healthy prickings.  
In the case of the refinement of coarse/fine grid: one strips by defect on 40 azimuths/48  
azimuths with the 2 interfaces right-hand side and tilted.*

### **3.28 Operand IMPRESSION**

**=\_F IMPRESSION  
(/FORMAT  
=/"RESULT", [DEFECT]  
/  
"ASTER",  
[TXM]  
/  
"CASTEM"  
,  
[TXM]  
/  
"IDEAS",  
[TXM]  
  
# If FORMAT = "IDEAS" or "CASTEM"**

**NOM\_CHAM  
=  
/  
"DEPL"  
,  
[TXM]  
/  
"EQUI\_ELNO\_SIGM"  
,  
/  
"TEMP"  
,**

**TOUT\_ORDRE = "YES"  
,  
[TXM]**

**NUME\_ORDRE = lordre**



,  
[L\_I]

*INST = linst*

,  
[L\_R]  
# Finsi

# If *FORMAT = "CASTEM"*

*NIVE\_GIBI*  
= /3,  
/10,  
[DEFECT]

# If *FORMAT = "IDEAS"*

*VERSION =/4,*  
/  
5,  
[DEFECT]

)

*Allows to define a format for the impression of the results, “RESULT”, “ASTER”, “CASTEM” or “IDEAS”, (see the user's documentation of order IMPR\_RESU).*

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**Note:**

*In the cases of a fissured or healthy grid, following postprocessings are carried out:*

### **1 fissured Grid**

.

*Impression in the file RESULT of the field of temperature in bottom of crack for each step of calculated time, (if it were calculated and if there is only one bottom of crack, cf [§ 3.1]);*

.

*Impression, at the request of the user, format CASTEM or IDEAS of the grid and of following fields:*

“DEPL”

“EQUI\_ELNO\_SIGM”

“TEMP”

### **2 healthy Grid**

.

*Impression in the file RESULT of the principal stress fields IF, SII, SIII (EQUI\_ELNO\_SIGM) for all the steps of time and all the lines of examination asked by the user;*

.

*Impression in the file RESULT of the field of temperature (if it were calculated) for all steps of time and all lines of examination requested by the user;*

·  
*Impression in the file RESULT of the stress fields  $P_m$  and  $P_m+P_b$  (POST\_RCCM) for all the lines of examination requested by the user;*

·  
*Impression in the file RESULT of the parameters characterizing the distribution of temperature (if it were calculated) in the thickness of the ligament for all the steps of time and all lines of examination requested by user (POST\_RELEVE\_T, OPERATION = "AVERAGE").*

### **3.29 Operand TITRATE**

*Titrate structure of data result [U4.03.01].*

### **3.30 Operand INFORMATION**

*INFORMATION =*

*Indicate the level of impression of the results of the operator:*

- 1: no impression,*
- 2: impression of information relating to the grid.*

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## 4 Examples

*In addition to the examples described here one will be able to consult the command files (fichier. comm) of case tests. The latter are in the repertories:*

1. */aster/v7/STA7/astest*
2. */aster/v7/NEW7/astest*

*and the names aspik\* carry.*

### 4.1

#### *Elastic mechanical calculation*

```

RESU=MACR_ASPIC_CALC (
TYPE_MAILLAGE=' FISS_COUR_DEB',
MAILLAGE=MA,
TUBULURE=_F (TYPE=' TYPE_1'),
AFFE_MATERIAU=_F (ALL = "YES",
RCCM = "NOT",
MATER = STAINLESS),
EQUILIBRE=_F (NODE = "P1_CORP"),
PRES_REP=_F (CLOSE = 1.55E+1,
NODE = "P2_CORP",
FONC_MULT = VARPRESS),
THETA_3D= (_F (
R_INF = 3.09,
R_SUP = 9.27),
_F (
R_INF = 9.27,
R_SUP = 18.54)),
TORS_CORP=_F (NODE = "P2_CORP",
FY = 0.0,
FONC_MULT = VARFOR),

```

**TORS\_TUBU=\_F (FZ = 0.0,  
FONC\_MULT = VARFOR),**

**COMP\_ELAS=\_F (RELATION = "ELAS"),**

**INCREMENT=\_F (LIST\_INST = LIST,  
NUME\_INST\_FIN = 1),**

**IMPRESSION=\_F (FORMAT = "ASTER")  
)**

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**4.2**

***Elastic thermomechanical calculation***

***RESU=MACR\_ASPIC\_CALC (TYPE\_MAILLAGE=' FISS\_AXIS\_DEB',***

***TUBULURE=\_F (TYPE=' TYPE\_1'),***

***MAILLAGE=MA,***

***MODELE=CO ("MOMEC"),***

***CHAM\_MATER=CO ("CHMAT"),***

***CARA\_ELEM=CO ("CARAEL"),***

***FOND\_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\_CORP'),  
PRES\_REP=\_F (PRES=7.45,  
NOEUD=' P2\_CORP',  
EFFE\_FOND=' OUI'),  
ECHANGE=\_F (COEF\_H\_TUBU=COEFHTUB,  
COEF\_H\_CORP=COEFHCOR,  
TEMP\_EXT=VARTEMP),  
TORS\_CORP=\_F (NOEUD=' P2\_CORP',  
FX=-1789.0,  
FY=120.0,  
FZ=480.0,  
MX=-7.3E5,  
MY=7.01E5,  
MZ=3.25E5,  
FONC\_MULT=VARP),  
TORS\_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=LIST),  
IMPRESSION=\_F (FORMAT = "CASTEM",  
NOM\_CHAM = ("DEPL", "EQUI\_ELNO\_SIGM",  
"TEMP"),  
INST = (1.0, 20.0),),)**

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***Structure of data result***

***Date:***

***27/06/03***

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***J. PELLET***

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***Document: U5.01.00***

***Structure of data result***

***1 General information***

***The structure of data result is used to gather fields and parameters***

*scalars associated with these fields.*

*It y currently several types of structure of data result:*

*acou\_harmo base\_modale  
comb\_fourier  
dyna\_harmo  
dyna\_trans\_fourier\_elas  
harm\_gene mode\_acou  
mode\_cycl mode\_flamb  
mode\_gene mult\_elas  
theta\_geom.  
evol\_char  
evol\_elas  
evol\_noli evol\_ther evol\_varc mode\_stat  
mode\_stat\_depl mode\_stat\_acce mode\_stat\_forc mode\_meca  
mode\_meca\_c*

*In a structure of data result, one reaches a field (or a parameter) while specifying a field name (or parameter) and a sequence number.*

*The names of the field and the parameters are preset for a given type. For example, the type evol\_elas uses the field names: “DEPL”, “SIEF\_ELGA\_DEPL”,... and parameters: “INST”, “NUME\_ORDRE”, “STORAGE”,...*

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*The sequence numbers are entireties which make it possible to distinguish several fields from same names.*

*For example in a result of the evol\_ther type, one stores the fields of temperature for several moments of calculation. Each field of temperature (NOM\_CHAM=' TEMP') is identified by one different sequence number.*

*Certain parameters are called “variable access” because they make it possible to identify their number of order. For example in a result of the type evol\_ther, the moment of calculation (NOM\_PARA=' INST') is a variable of access.*

*The various structures of accessible data result are described in this booklet.*

*A whole of orders makes it possible to create, enrich or exploit a structure of data result whatever its type.*

## **2** **General orders of creation/modification**

### **Type of action**

#### **Order**

#### **Reference**

#### **Action**

#### **Creation**

#### **CREA\_RESU**

**[U4.44.12]**

*Create a structure of data from insulated fields*

#### **LIRE\_RESU**

**[U7.02.01]**

*Built a structure of data to be left of a file IDEAS, EnSight or MED*

#### **Calculations**

#### **CALC\_ELEM**

**[U4.81.01]**

*Enriches the structure of data by complementary calculation of elementary fields*

#### **CALC\_NO**

**[U4.81.02]**

*Enriches the structure of data by  
calculation of fields defined in the nodes*

**POST\_ELEM**

*[U4.81.22]*

*Calculate total sizes on  
structure*

*Impression*

**IMPR\_RESU**

*[U4.91.01]*

*Print*

**MODI\_REPERE**

*[U4.74.01]*

*Modification of the reference mark for the fields.  
Cylindrical reference mark or “user”*

*Extraction*

**RECU\_FONCTION**

*[U4.32.03]*

*Extract of the values of the fields or of  
parameters and recovers them in one  
function*

**POST\_RELEVE\_T**

*[U4.81.21]*

*Carry out extractions on spot  
geometrical and calculates various sizes*

**CREA\_CHAMP**

*[U4.72.04]*

*Recover a field by extraction (or  
interpolation between two moments)*

*Test*

**TEST\_RESU**

*[U4.92.01]*

*Test the values of the results*

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*Accessible fields in the Structures of data of the result type*

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*27/06/03*

*Author (S):*

*J. Key **PELLET***

*:*

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*Accessible fields in the Structures  
data of the result type*

*Summary:*

*One gives in this document a very short definition of the fields stored in the structures of data of result type. Many of these fields are obtained by postprocessing (orders CALC\_ELEM and CALC\_NO). There will be a more precise description of much of these fields by consulting documentation*

*order CALC\_ELEM [U4.81.01].*

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*Accessible fields in the Structures of data of the result type*

*Date:*

*27/06/03*

*Author (S):*

**J. Key PELLET**

*:*

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**1**

***Definition of the accessible fields***

**1.1**

***General rules concerning the field names***

*A great number of the fields listed below have form.*

*The 3 “words”, YYYY and ZZZZ of these names very often have the following significance:*

*: nature of the field.*

*Examples:*

*ECIN: kinetic energy*

*EPSI: deformation*

*SIPO: constraints due to efforts of beams*

*RADI: indicator of the losses of radiality*

*YYYY: localization of the field*

*ELGA: field by elements at the points of Gauss,*

*ELNO: field by elements with the nodes (a priori discontinuous from one element to another),*

*ELEM: constant field by element,*

*NOEU: field with the nodes obtained by arithmetic mean of the values of the elements*

*contributing in this node. This field is calculated by operator CALC\_NO. CALC\_NO takes in entry a field of name and manufactures field.*

*ZZZZ: starting from which quantity the field is calculated*

*Examples:*

*RADI\_ELGA\_SIGM: losses of radialities calculated starting from constraints (SIGM),*

*SIEF\_ELGA\_DEPL: state of stress calculated starting from displacements (DEPL).*

## **1.2 Mechanics**

**Reference symbol**

**Significance**

**ACCE**

*Field of acceleration to the nodes*

**ACCE\_ABSOLU**

*Field of absolute acceleration to the nodes (seismic calculation multi-support)*

*Tensor ALPH0\_ELGA\_EPSP of the modified variable alpha0 taken in an initial state in the method ZAC [U4.83.21]*

*Tensor ALPHP\_ELGA\_ALPH0 of the modified variable alpha in method ZAC [U4.83.21] calculated at the points of Gauss (for the adaptation, it is about the value limits alpha, for accommodation, it acts either of the average value, or of lower value, is higher value)*

**BEHAVIOR**

*Relation of selected nonlinear behavior*

*(ex: STAT\_NON\_LINE/COMP\_INCR)*

**CRIT\_ELNO\_RUPT**

*Criteria of rupture in orthotropism. Cf CALC\_ELEM.*

**DCHA\_ELGA\_SIGM**

*Local indicator of discharge [R4.20.01]. This option requires the existence of field of reference symbol SIEF\_ELGA*

**DCHA\_ELNO\_SIGM**

*Local indicator of discharge [R4.20.01]. This option requires the existence of field of reference symbol SIEF\_ELGA*

**DCHA\_NOEU\_SIGM**

*Local indicator of discharge [R4.20.01].*

**DEDE\_ELNO\_DLDE**

*Derived Eulérienne from the field of displacement [R4.03.01]*

**DEDE\_NOEU\_DLDE**

*Derived Eulérienne from the field of displacement [R4.03.01]*

**DEGE\_ELNO\_DEPL**

*Generalized deformation calculated starting from displacements for elements of structures [R3.08.XX]*

**DEGE\_NOEU\_DEPL**

*Generalized deformation calculated starting from displacements*

**DEPL**

*Field of displacement to the nodes*

**DEPL\_ABSOLU**

*Absolute displacement (seismic calculation multi-support)*

**DESI\_ELNO\_DLSI**

*Derived Eulérienne from the constraints*

**DESI\_NOEU\_DLSI**

*Derived Eulérienne from the constraints*

*Instruction manual*

*U5.0- booklet: Structure of data result HT-66/03/002/A*

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**DLDE\_NOEU**

*Lagrangian derivative of displacements [R4.03.01]*

**DLSI\_ELGA\_DEPL**

*Lagrangian derivative of the constraints*

**DLSI\_ELNO\_DLDE**

*Lagrangian derivative of the constraints*

**DLSI\_NOEU\_DLDE**

*Lagrangian derivative of the constraints*

**ECIN\_ELEM\_DEPL**

*Kinetic energy*

**EFGE\_ELNO\_CART**

*Generalized efforts calculated starting from displacements for the elements of structure in the total Cartesian reference mark*

**EFGE\_ELNO\_DEPL**

*Generalized efforts calculated starting from displacements for the elements of structure in the local reference mark*

**EFGE\_NOEU\_CART**

*Efforts generalized starting from displacements for the elements of structure in the total Cartesian reference mark*

**EFGE\_NOEU\_DEPL**

*Efforts generalized starting from displacements for the elements of structure*



*in the local reference mark*

**ENDO\_ELNO\_SIGA**

*Rate of triaxiality and equivalent constraint of damage*

**ENDO\_ELNO\_SINO**

*Rate of triaxiality and equivalent constraint of damage*

**ENDO\_NOEU\_SINO**

*Rate of triaxiality and equivalent constraint of damage*

**ENEL\_ELGA**

*Density of energy elastic*

**ENEL\_ELNO\_ELGA**

*Density of energy elastic*

**ENEL\_NOEU\_ELGA**

*Density of energy elastic*

**EPGR\_ELGA**

*Deformations of creep (Granger model of concrete) [R7.10.01]*

**EPGR\_ELNO**

*Deformations of creep (Granger model of concrete)*

**EPME\_ELGA\_DEPL**

*“Mechanical” deformation (= total deflection - “thermal” deformation)*

*(in small displacements)*

**EPME\_ELNO\_DEPL**

*“Mechanical” deformation (= total deflection - “thermal” deformation)*

*(in small displacements)*

**EPMG\_ELGA\_DEPL**

*“Mechanical” deformation (= total deflection - “thermal” deformation)*

*(in great displacements)*

**EPMG\_ELNO\_DEPL**

*“Mechanical” deformation (= total deflection - “thermal” deformation)*

*(in great displacements)*

**EPOT\_ELEM\_DEPL**

*Elastic deformation energy*

**EPSA\_ELNO**

*Anelastic deformations (nonlinear elasticity)*

**EPSA\_NOEU**

*Anelastic deformations (nonlinear elasticity)*

**EPSG\_ELGA\_DEPL**

*Deformations of Green-Lagrange*

**EPSG\_ELNO\_DEPL**

*Deformations of Green-Lagrange*

**EPSG\_NOEU\_DEPL**

*Deformations of Green-Lagrange*

**EPSI\_ELGA\_DEPL**

*Linearized deformations calculated starting from displacements*

***EPSI\_ELNO\_DEPL***

***Linearized deformations calculated starting from displacements***

***EPSI\_NOEU\_DEPL***

***Linearized deformations calculated starting from displacements***

***EPSP\_ELGA***

***Plastic deformations***

***EPSP\_ELNO***

***Plastic deformations***

***EPSP\_ELNO\_ZAC***

***Plastic deformations (or amplitudes) (method ZAC [U4.83.21])***

***EPSP\_NOEU***

***Plastic deformations***

***EPSP\_NOEU\_ZAC***

***Plastic deformations (or amplitudes) (method ZAC [U4.83.21])***

***EQUI\_ELGA\_EPME***

***“Mechanical” deformations equivalent***

***EQUI\_ELGA\_EPSI***

***Equivalent deformations and principal deformations***

***EQUI\_ELGA\_SIGM***

***Equivalent constraints and principal constraints***

***EQUI\_ELNO\_EPME***

***“Mechanical” deformations equivalent and principal deformations***

***EQUI\_ELNO\_EPSI***

***Equivalent deformations and principal deformations***

***EQUI\_ELNO\_SIGM***

***Equivalent constraints and principal constraints***

***EQUI\_NOEU\_EPME***

***“Mechanical” deformations equivalent and principal deformations***

***EQUI\_NOEU\_EPSI***

***Equivalent deformations and principal deformations***

***EQUI\_NOEU\_SIGM***

***Equivalent constraints and principal constraints***

***ERRE\_ELEM\_NOZ1***

***Estimator of error of ZHU\_ZIENKIEWICZ (linear elasticity 2D) noted ZZ1, with to leave option “SIGM\_NOZ1\_ELGA” [R4.10.01]***

***ERRE\_ELEM\_NOZ2***

***Estimator of error of ZHU\_ZIENKIEWICZ (linear elasticity 2D) noted ZZ2, with to leave option “SIGM\_NOZ2\_ELGA” [R4.10.01]***

***ERRE\_ELGA\_NORE***

***Estimator of error in residue [R4.10.01]***

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**ERRE\_ELNO\_ELGA**

**Estimator of error in residue [R4.10.01]**

**ERRE\_NOEU\_ELGA**

**Estimator of error in residue [R4.10.01]**

**ETOT\_ELEM**

**Density of total energy of deformation. Cf CALC\_ELEM [U4.81.01]**

**ETOT\_ELGA**

**Density of total energy of deformation. Cf CALC\_ELEM [U4.81.01]**

**ETOT\_ELNO\_ELGA**

**Density of total energy of deformation. Cf CALC\_ELEM [U4.81.01]**

**FORC\_NODA**

**Nodal internal forces resulting from the field of deformation**

**LANL\_ELGA**

**Multipliers of Lagrange of the nonlocal problem (STAT\_NON\_LINE/**

**MODELE\_NON\_LOCAL)**

**PMPB\_ELGA\_SIEF**

**Calculation of criteria of the RCC-M G3000 for the elements of beams POU\_D\_E and POU\_D\_T.**

**PMPB\_ELNO\_SIEF**

**Calculation of criteria of the RCC-M G3000 for the elements of beams POU\_D\_E and POU\_D\_T.**

**PMPB\_NOEU\_SIEF**

**Calculation of criteria of the RCC-M G3000 for the elements of beams POU\_D\_E and POU\_D\_T.**

**PRES\_DBEL\_DEPL**

**Acoustic pressure (in decibel) (modelings XXX\_FLUIDE)**

**RADI\_ELGA\_SIGM**

**Indicator of the losses of radially calculated [R4.20.01]. This option requires the existence of the field of reference symbol SIEF\_ELGA**

**RADI\_ELNO\_SIGM**

*Indicator of the losses of radiality calculated [R4.20.01]. This option requires the existence of the field of reference symbol SIEF\_ELGA*

**RADI\_NOEU\_SIGM**

*Indicator of the losses of radiality [R4.20.01].*

**REAC\_NODA**

*Forces of nodal reactions (difference between the nodal forces and it loading applied not follower)*

**SIEF\_ELGA**

*State of constraints (or generalized efforts) into nonlinear*

**SIEF\_ELGA\_DEPL**

*State of constraints (or generalized efforts) calculated from displacements in linear elasticity*

**SIEF\_ELNO**

*Constraints with the nodes. Field obtained by order LIRE\_RESU*

**SIEF\_NOEU**

*Constraints with the nodes by elements. Field obtained by the order LIRE\_RESU and used in order PROJ\_MESU\_MODA*

**SIEF\_ELNO\_ELGA**

*State of constraints (or generalized efforts) to the nodes by elements calculated starting from the points of Gauss*

**SIEF\_NOEU\_ELGA**

*State of stresses (or of generalized efforts)*

**SIGM\_ELNO\_CART**

*Constraints calculated starting from displacements in the total reference mark in linear elasticity*

**SIGM\_ELNO\_COQU**

*State of stress in an element of hull (in a point thickness)*

**SIGM\_ELNO\_DEPL**

*Constraints calculated starting from displacements in linear elasticity*

**SIGM\_ELNO\_SIEF**

*Constraints linearized starting from the generalized efforts*

**SIGM\_ELNO\_TUYO**

*State of stress in a pipe section (in a point thickness and for a given azimuth)*

**SIGM\_ELNO\_VARI**

*State of stress in an element of hull (modeling DKT in not linear)*

**SIGM\_ELNO\_ZAC**

*Constraints (method ZAC [U4.83.21])*

**SIGM\_NOEU\_CART**

*Constraints starting from displacements in the total reference mark in elasticity linear*

***SIGM\_NOEU\_COQU***

*State of stress in an element of hull*

***SIGM\_NOEU\_DEPL***

*Constraints starting from displacements in linear elasticity*

***SIGM\_NOEU\_SIEF***

*Constraints starting from the generalized efforts*

***SIGM\_NOEU\_ZAC***

*Constraints (method ZAC [U4.83.21])*

***SIGM\_NOZ1\_ELGA***

*Constraints with the nodes (linear elasticity 2D); the constraints are obtained by a total smoothing (within the meaning of least squares) of the constraints with points of Gauss [R4.10.01]*

***SIGM\_NOZ2\_ELGA***

*Constraints with the nodes (linear elasticity 2D); the constraints are obtained by a local smoothing with a patch of elements (within the meaning of least squares) of constraints at the points of Gauss [R4.10.01]*

***SIPO\_ELNO\_DEPL***

*Constraints due to each effort of beam obtained from displacements [R3.08.XX]*

***SIPO\_ELNO\_SIEF***

*Constraints due to each effort of beam obtained starting from the efforts generalized*

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**SIPO\_NOEU\_DEPL**

*Constraints due to each effort of beam*

**SIPO\_NOEU\_SIEF**

*Constraints due to each effort of beam obtained starting from the efforts  
generalized*

**SIRE\_ELNO\_DEPL**

*Constraints for the estimator of error in residue used for the calculation of  
option ERRE\_ELGA\_NORE [R4.10.01]*

**SIRE\_NOEU\_DEPL**

*Constraints for the estimator of error in residue used for the calculation of  
option ERRE\_ELGA\_NORE [R4.10.01]*

**VALE\_CONT**

*Information on the state of contact. See AFFE\_CHAR\_MECA/CONTACT.*

**VALE\_NCOU\_MAXI**

*For the visualization of the extreme quantities raised on the “under-points”  
pipe sections. See CALC\_ELEM [U4.81.01].*

**VARI\_ELGA**

*State of the variables intern for the behavior (into nonlinear)*

**VARI\_ELGA\_ZAC**

*Variables intern (method ZAC [U4.83.21])*

**VARI\_ELNO**

*State of the variables intern for the behavior (into nonlinear)*

**VARI\_ELNO\_COQU**

*State of the variables intern in a layer of an element of hull*

**VARI\_ELNO\_ELGA**

*State of the variables intern for the behavior (into nonlinear)*

**VARI\_ELNO\_TUYO**

*State of the variables intern in a pipe section*

**VARI\_NOEU**

*State of the variables intern for the behavior (into nonlinear)*

**VARI\_NOEU\_ELGA**

*State of the variables intern for the behavior (into nonlinear)*

**VARI\_NON\_LOCAL**

*Variables intern nonlocal problem (STAT\_NON\_LINE/*

*MODELE\_NON\_LOCAL)*

**QUICKLY**

*Field speed to the nodes*

**VITE\_ABSOLU**

*Field speed to the nodes (seismic calculation multi-support)*

### **1.3 Thermics**

**Reference symbol**

**Significance**

**DETE\_ELNO\_DLTE** *Derived Eulérienne from the Temperature (obtained starting from the derivative*

*Lagrangian*

**DETE\_NOEU\_DLTE** *Derived Eulérienne from the Temperature (obtained starting from the derivative*

*Lagrangian*

**DLTE\_NOEU**

*Lagrangian derivative of the Temperature*

**DURT\_ELGA\_META** *Hardness calculated starting from the metallurgical state [R4.04.01]*

**DURT\_ELNO\_META** *Hardness calculated starting from the metallurgical state*

**DURT\_NOEU\_META** *Hardness calculated starting from the metallurgical state*

**FLUX\_ELGA\_TEMP**

*Heat flow at the points of Gauss*

**FLUX\_ELNO\_TEMP**

*Heat flow to the nodes by elements*

**FLUX\_NOEU\_TEMP**

*Heat flow to the nodes*

**HYDR\_ELGA**

*Hydration at the points of Gauss*

**METALLURGICAL META\_ELGA\_TEMP** *Phases [R4.04.01]*

**METALLURGICAL META\_ELNO\_TEMP** *metallurgical Phases*

**METALLURGICAL META\_NOEU\_TEMP** *Phases*

**TEMP**

*Temperature (with the nodes)*

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## **1.4 Acoustics**

**Reference symbol**

**Significance**

**INTE\_ELNO\_ACTI**

**Active acoustic intensity**

**INTE\_ELNO\_REAC**

**Reactive acoustic intensity**

**INTE\_NOEU\_ACTI**

**Active acoustic intensity**

**INTE\_NOEU\_REAC**

**Reactive acoustic intensity**

**NEAR**

**Pressure with the nodes**

**PRES\_ELNO\_DBEL**

**Pressure in decibels**

**PRES\_ELNO\_REEL**

**Real part of the field of pressure**

**PRES\_ELNO\_IMAG**

**Imaginary part of the field of pressure**

**PRES\_NOEU\_DBEL**

**Pressure in decibels**

**PRES\_NOEU\_REEL**

**Real part of the field of pressure**

**PRES\_NOEU\_IMAG**

**Imaginary part of the field of pressure**



## **1.5**

### ***/Calculation breaking process of sensitivity (THETA\_GEOM)***

*The Structure of data THETA\_GEOM is obtained by order CALC\_THETA [U4.82.02].*

#### ***Reference symbol***

#### ***Significance***

#### ***GRAD\_NOEU\_THETA***

*Gradient of the field “theta” (used for calculations of sensitivity)*

#### ***THETA***

*Field “theta” of the breaking process [R7.02.01]*

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#### ***Code\_Aster ®***

#### ***Version***

**6.4**

#### ***Titrate:***

***Structure of data evol\_elas***

#### ***Date:***

**26/06/03**

#### ***Author (S):***

**J. PELLET**

#### ***Key: U5.01.11-D Page:***

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#### ***Organization (S): EDF-R & D /AMA***

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***Document: U5.01.11***

***Structure of data evol\_elas***

## ***1 Significance***

***Structure of data gathering the results coming from a calculation in static linear elasticity or quasi-static evolutionary (thermomechanical).***

***2***  
***Operator producing this structure of data***

***Operator Reference***  
***MECA\_STATIQUE***  
***[U4.51.01]***

***Instruction manual***  
***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster*** ®  
***Version***  
***6.4***

***Titrate:***  
***Structure of data evol\_elas***

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***Author (S):***  
***J. PELLET***

**Key: U5.01.11-D Page:**

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### **3 Variables**

**access**

**Variable of access**

**Significance**

**Type**

**NUME\_ORDRE**

**Sequence number of the required field**

**I**

**INST**

**Moment of evolutionary quasi-static calculation**

**R**

**Characteristic:**

**For a static calculation: INST: 0. and NUME\_ORDRE: 0 (thermomechanical stationary)**

### **4 Parameters**

**associated**

**Information concerning the resolution of the linear systems:**

**Parameters Significance**

**Type**

**“METHOD”**

**/“MULT\_FRONT”/“GCPC”/“LDLT”**

**K**

**“STORAGE”**

**/“LIGN\_CIEL”/“MORSE”**

**K**

**“RENUM”**

**method of renumerotation: “MANDELEVIUM”, “MDA”, “MONGREL”,**

**K**

**“RCMK”**

**If METHOD = “GCPC”**

**“ITER\_GCPC”**

*iteration count of the gradient combined to converge*

**I**

**“RESI\_GCPC”**

*residue obtained at the time of convergence*

**R**

**5 Fields**

*accessible*

*There are two types of accessible fields in such a structure of data:*

- on the one hand, the field created systematically by order MECA\_STATIQUE: DEPL,*
- in addition, fields created by the orders of postprocessing CALC\_ELEM, CALC\_NO, POST\_ELEM. The list of these fields is in the document [U5.01.01], paragraph “Mechanical Fields”.*

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**Code\_Aster ®**

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**Titrate:**

**Structure of data evol\_noli**

**Date:**

**01/12/03**

**Author (S):**

**P. Key BADEL**

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**Organization (S): EDF-R & D /AMA**

***Instruction manual***

***U5.0- booklet: Structure of data result***

***U5.01.12 document***

***Structure of data evol\_noli***

***1 Significance***

***Structure of data gathering the results coming from a static nonlinear mechanical calculation or dynamics. It contains also the results resulting from postprocessings.***

***2***

***Operators producing this structure of data***

***Operator Reference***

***STAT\_NON\_LINE***

***[U4.51.03]***

***DYNA\_NON\_LINE***

***[U4.53.01]***

***3***

***Operators enriching this structure of data***

***Operator Reference***

***CALC\_ELEM***

***[U4.81.01]***

***CALC\_NO***

[U4.81.02]

*POST\_ELEM*

[U4.81.22]

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**4 Variables**

*access*

**Variable of access**

**Significance**

**Type**

*NUME\_ORDRE*

*Sequence number of the required field*

*I*

*INST*

*Moment of quasi-static or dynamic calculation*

*R*

**5 Parameters**

*associated*

**Parameter Significance**

**Type**

*ITER\_GLOB*

*Iteration count of Newton*

*I*

*ITER\_LINE*

*Iteration count of linear research carried out at the time of*

*I*

*last iteration of Newton*

*RESI\_GLOB\_RELA*

*Residue relating obtained to convergence*

*R*

*RESI\_GLOB*

*Absolute residue obtained with convergence*

*R*

*CHAR\_MINI*

*Smaller standard of the loading during calculation*

*R*

*RESI\_GLOB\_MOINS*

*Absolute residue obtained with convergence with the preceding step*

*R*

*ETA\_PILOTAGE*

*Multiplicative coefficient of the controlled loadings*

*R*

## **6 Fields**

### ***accessible***

*There are two types of accessible fields in such a structure of data:*

*.*

*on the one hand, fields created by order STAT\_NON\_LINE (resp. DYNA\_NON\_LINE), who creates (or, in the event of continuation, enriches) the concept; these fields are created by defect, they*

*thus exist in any structure of data of this type; they are fields DEPL (resp. DEPL, QUICKLY and ACCE), SIEF\_ELGA, VARI\_ELGA and BEHAVIOR,*

*.*

*in addition, fields created by the orders of postprocessing CALC\_ELEM, CALC\_NO, POST\_ELEM. The list of these fields is in the document [U5.01.01], paragraph "Mechanical Fields". Sight the length of this list, one avoids doublonner here. One will be able to refer with interest to the documentations given to [§3] concerning orders of postprocessings.*

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Titrate:

*Structure of data mode\_stat*

Date:

08/07/03

Author (S):

**J. PIGAT, Y. PONS**

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Organization (S): EDF-R & D /AMA

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***Document: U5.01.13***

***Structure of data mode\_stat***

***1 Significance***

***Structure of data gathering the results coming from a linear static calculation with a system boundary conditions of displacements imposed unit on the supports, or in unit force or in***



***unit acceleration.***

**2**

***Operators producing this structure of data***

***Operator Reference***

***MODE\_STATIQUE***

***[U4.52.14]***

**3**

***Operators using this structure of data***

***Operator Reference***

***CALC\_CHAR\_SEISME***

***[U4.63.01]***

***COMB\_SISM\_MODAL***

***[U4.84.01]***

***DEFI\_BASE\_MODAL***

***[U4.64.02]***

***DYNA\_ALEA\_MODAL***

***[U4.53.22]***

***DYNA\_TRAN\_MODAL***

***[U4.53.21]***

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***Titrate:***

***Structure of data mode\_stat***

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#### ***4 Variables***

***access***

***Variable of access***

***Significance***

***Type***

***NUME\_ORDRE***

***Sequence number of the static mode***

***I***

***NOEU\_CMP***

***Name of the node - name of the imposed ddl***

***K16***

***Characteristic:***

***NUME\_ORDRE > 0***

#### ***5 Parameters***

***associated***

***Parameters Significance***

***Type***

***TYPE\_DEFO***

***Type of the static deformation: DDL\_IMPO, ACCE\_IMPO, K16***

***FORC\_IMPO***

***NUME\_DDL***

***Number of the node and the component in classification***

***I***

***COEF\_X***

***For a constant acceleration, component X of the vector***

***R***

***director***

***COEF\_Y***

***For a constant acceleration, component Y of the vector***

***R***

***director***

***COEF\_Z***

***For a constant acceleration, component Z of the vector***

***R***

***director***

*The values of parameters COEF\_X, COEF\_Y, COEF\_Z are calculated starting from the values given under the key word factor PSEUDO\_MODE of order MODE\_STATIQUE [U4.52.04] at the time of definition of the uniform improvement.*

**6 Fields  
accessible**

*The list of the accessible fields being long, one returns the reader to the document [U5.01.01] which synthesizes in the form of tables the list of the accessible fields for the various structures of data.*

**Instruction manual**

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**Code\_Aster ®**

**Version**

**5.0**

**Titrate:**

**Structure of data mult\_elas**

**Date:**

**24/11/00**

**Author (S):**

**X. DESROCHES**

**Key:**

**U5.01.14-B**

**Page:**

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**Organization (S): EDF/MTI/MMN**

**Instruction manual**

**U5.0- booklet: Structure of data result**

**Document: U5.01.14**

**Structure of data mult\_elas**

**1 Significance**

*Structure of data gathering the results of a calculation in linear elasticity corresponding to one or several different loading cases without thermal evolution.*

**2**

**Operator producing this structure of data**

**Operator**

**Reference**

**MACRO\_ELAS\_MULT**

**[U4.51.02]**

**Instruction manual**

**U5.0- booklet: Structure of data result**  
**HI-75/00/006/A**

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**Code\_Aster** ®

**Version**

**5.0**

**Titrate:**

**Structure of data mult\_elas**

**Date:**

**24/11/00**

**Author (S):**

**X. DESROCHES**

**Key:**

**U5.01.14-B**

**Page:**

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**3 Variables**

**access**

**Variable of access**

**Significance**

**Type**

**NUME\_ORDRE**

**Sequence number of the required field**

**I**

**NOM\_CAS**

**Name of the loading case**

**K16**

**4 Parameters**

**associated**

**Nothing.**

**5 Fields**

**accessible**

**DEPL**

**EQUI\_NOEU\_SIGM**

**ECIN\_ELEM\_DEPL**

**ERRE\_ELGA\_NORE**

**EFGE\_ELNO\_CART**

**ERRE\_ELNO\_ELGA**

**EFGE\_ELNO\_DEPL**

**ERRE\_ELEM\_NOZ1**

**EFGE\_NOEU\_CART**

**ERRE\_ELEM\_NOZ2**

**EFGE\_NOEU\_DEPL**

**FORC\_NODA**  
**EPOT\_ELEM\_DEPL**  
**REAC\_NODA**  
**EPSI\_ELGA\_DEPL**  
**SIEF\_ELGA\_DEPL**  
**EPSI\_ELNO\_DEPL**  
**SIGM\_ELNO\_CART**  
**EPSI\_NOEU\_DEPL**  
**SIGM\_ELNO\_DEPL**  
**EQUI\_ELGA\_EPSI**  
**SIGM\_NOEU\_CART**  
**EQUI\_ELGA\_SIGM**  
**SIGM\_NOEU\_DEPL**  
**EQUI\_ELNO\_EPSI**  
**SIGM\_NOZ1\_ELGA**  
**EQUI\_ELNO\_SIGM**  
**SIGM\_NOZ2\_ELGA**  
**EQUI\_NOEU\_EPSI**

*See [U5.01.01] for the significance of these fields.*

*Instruction manual*

*U5.0- booklet: Structure of data result*

*HI-75/00/006/A*

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**Code\_Aster** ®

*Version*

5.0

*Titrate:*

*Structure of data fourier\_elas*

*Date:*

24/11/00

*Author (S):*

**X. DESROCHES**

*Key:*

U5.01.15-B

*Page:*

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*Organization (S): EDF/MTI/MMN*

**Instruction manual**

**U5.0- booklet: Structure of data result**

**Document: U5.01.15**

**Structure of data fourier\_elas**

**1 Significance**

Structure of data gathering the results, harmonic by harmonic, coming from a calculation from axisymmetric structure in linear rubber band with loading broken up into Fourier series.

**2**

**Operator producing this structure of data**

**Operator**

**Reference**

MACRO\_ELAS\_MULT

[U4.51.02]

*Instruction manual*

*U5.0- booklet: Structure of data result*

*HI-75/00/006/A*

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**Code\_Aster** ®

*Version*

5.0

*Titrate:*

*Structure of data fourier\_elas*

*Date:*

24/11/00

*Author (S):*

**X. DESROCHES**

*Key:*

U5.01.15-B

*Page:*

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### **3 Variables**

#### **access**

#### **Variable of access**

#### **Significance**

#### **Type**

NUME\_ORDRE

Sequence number of the required field

I

NUME\_MODE

Number of the mode of required Fourier

I

### **4 Parameters**

#### **associated**

#### **Parameter**

#### **Significance**

#### **Type**

TYPE\_MODE

Type of the harmonic of Fourier: "SYME", "ANTI" or "ALL"

K8

### **5 Fields**

#### **accessible**

DEPL

EQUI\_ELNO\_SIGM

ECIN\_ELEM\_DEPL

EQUI\_NOEU\_EPSI

EPOT\_ELEM\_DEPL

EQUI\_NOEU\_SIGM

EPSI\_ELGA\_DEPL

FORC\_NODA

EPSI\_ELNO\_DEPL

REAC\_NODA

EPSI\_NOEU\_DEPL

SIEF\_ELGA\_DEPL

EQUI\_ELGA\_EPSI

SIGM\_ELNO\_DEPL

EQUI\_ELGA\_SIGM

SIGM\_NOEU\_DEPL

EQUI\_ELNO\_EPSI

See [U5.01.01] for the significance of these fields.

*Instruction manual*

*U5.0- booklet: Structure of data result*

*HI-75/00/006/A*

---

**Code\_Aster** ®

Version

5.0

Titrate:

*Structure of data comb\_fourier*

Date:

24/11/00

Author (S):

**X. DESROCHES**

Key:

U5.01.16-B

Page:

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Organization (S): EDF/MTI/MMN

**Instruction manual**

**U5.0- booklet: Structure of data result**

**Document: U5.01.16**

**Structure of data comb\_fourier**

**1 Significance**

Structure of data gathering the recombinations of Fourier (for various angles) on displacements, strains and/or stresses coming from an axisymmetric structural analysis linear rubber band with loadings broken up into mode of FOURIER.

**2**

**Operator producing this structure of data**

**Operator**

**Reference**

COMB\_FOURIER

[U4.83.31]

*Instruction manual*

*U5.0- booklet: Structure of data result*

*HI-75/00/006/A*

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**Code\_Aster** ®

Version

5.0

Titrate:

*Structure of data comb\_fourier*

Date:

24/11/00

Author (S):

**X. DESROCHES**

Key:

U5.01.16-B



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### **3 Variables**

**access**

**Variable of access**

**Significance**

**Type**

NUME\_ORDRE

Sequence number of the required field

I

ENG

Angle of the recombination of Fourier (in degrees)

R

### **4 Parameters**

**associated**

Nothing.

### **5 Fields**

**accessible**

DEPL

EPSI\_ELNO\_DEPL

REAC\_NODA

SIEF\_ELGA\_DEPL

SIGM\_ELNO\_DEPL

See [U5.01.01] for the significance of these fields.

*Instruction manual*

*U5.0- booklet: Structure of data result*

*HI-75/00/006/A*

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**Code\_Aster** ®

*Version*

5.0

*Titrate:*

*Structure of data evol\_char*

*Date:*

30/11/00

*Author (S):*

**X. DESROCHES**

*Key:*

U5.01.17-B

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*Organization (S): EDF/MTI/MMN*

**Instruction manual**

## **U5.0- booklet: Structure of data result**

### **Document: U5.01.17**

#### **Structure of data evol\_char**

##### **1 Significance**

Structure of data gathering of the fields of pressure (cham\_no\_PRES\_R) evolving/moving during time.

##### **2**

#### **Operator producing this structure of data**

##### **Operator**

##### **Reference**

LIRE\_RESU

[U7.02.01]

*Instruction manual*

*U5.0- booklet: Structure of data result*

*HI-75/00/006/A*

---

##### **Code\_Aster** ®

*Version*

*5.0*

*Titrate:*

*Structure of data evol\_char*

*Date:*

*30/11/00*

*Author (S):*

**X. DESROCHES**

*Key:*

*U5.01.17-B*

*Page:*

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##### **3**

#### **Operator using this structure of data**

##### **Operator**

##### **Reference**

AFFE\_CHAR\_MECA

[U4.44.01]

##### **4 Variables**

##### **access**

##### **Variable of access**

##### **Significance**

##### **Type**

NUME\_ORDRE

Sequence number of the required field

I

INST  
Moment of calculation  
R

**5 Parameters  
associated**

NEAR  
Nothing.

**6 Fields  
accessible**

See [U5.01.01] for the significance of this field.

*Instruction manual*

*U5.0- booklet: Structure of data result*

*HI-75/00/006/A*

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***Code\_Aster* ®**

*Version*

6.4

*Titrate:*

*Structure of data dyna\_trans*

*Date:*

07/08/03

*Author (S):*

***E. BOYERE***

*Key: U5.01.21-D Page:*

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*Organization (S): EDF-R & D /AMA*

**Instruction manual**

## **U5.0- booklet: Structures of data result**

### **Document: U5.01.21**

#### **Structure of data dyna\_trans**

##### **1 Significance**

**Structure of data gathering the results coming from a linear dynamic mechanical calculation transient on physical basis.**

##### **2**

**Operators producing this structure of data**

###### **Operator Reference**

**DYNA\_LINE\_TRAN**

**[U4.53.02]**

**REST\_BASE\_PHYS**

**[U4.63.21]**

**LIRE\_MISS\_3D**

**[U7.02.31]**

**LIRE\_RESU**

**[U7.02.01]**

##### **3**

**Operators using this structure of data**

###### **Operator Reference**

**CALC\_ELEM**

**[U4.81.01]**

**CALC\_FATIGUE**

**[U4.83.02]**

**CALC\_NO**

**[U4.81.02]**

**DIST\_LIGN\_3D**

**[U4.MK.30]**

**IMPR\_COURBE**

**[U4.33.01]**

**POST\_RELEVE\_T**

**[U4.81.21]**

**RECU\_FONCTION**

**[U4.32.03]**

***Instruction manual***

***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster*** ®

***Version***

**6.4**

***Titrate:***

***Structure of data dyna\_trans***

***Date:***

**07/08/03**

***Author (S):***

**E. BOYERE**

***Key: U5.01.21-D Page:***

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**4 Variables**

**access**

**Variable of access**

**Significance**

**Type**

**NUME\_ORDRE**

**Sequence number of the required field**

**I**

**INST**

**Moment of calculation**

**R**

**Characteristic:**

**The fields corresponding to NUME\_ORDRE = 0 or INST = 0. correspond to the conditions initial of calculation.**

**5 Parameters**

**associated**

**Nothing.**

## **6 Fields accessible**

**The list of the accessible fields is summarized in the table below:**

**Reference symbol**

**Significance**

**Type**

**ACCE**

**field of acceleration relating to the nodes**

**R/C**

**ACCE\_ABSOLU**

**field of absolute acceleration to the nodes**

**R/C**

**DEGE\_ELNO\_DEPL**

**deformation generalized with the nodes by element calculated to leave**

**R**

**displacements**

**DEPL**

**field of displacement to the nodes**

**R/C**

**ECIN\_ELEM\_DEPL**

**kinetic energy by element**

**R**

**EFGE\_ELNO\_CART**

**generalized effort calculated with the nodes by element from**

**R/C**

**displacements in the total Cartesian reference mark**

**EFGE\_ELNO\_DEPL**

**generalized efforts calculated with the nodes by element from**

**R/C**

**displacements in the local reference mark**

**EFGE\_NOEU\_CART**

**generalized efforts realised with the nodes by element from**

**R/C**

**displacements in the total Cartesian reference mark**

**EFGE\_NOEU\_DEPL**

**generalized efforts realised with the nodes by element from**

**R/C**

**displacements in the local reference mark**

**EPOT\_ELEM\_DEPL**

**elastic deformation energy per element**

**R**

**EPSI\_ELGA\_DEPL**

**deformations linearized at the points of Gauss calculated to leave**

**R**

**displacements**

**EPSI\_ELNO\_DEPL**

**deformations linearized with the nodes by element calculated to leave**

**R**

**displacements**

**EPSI\_NOEU\_DEPL**

**linearized deformations realised with the nodes and calculated with**

**R**

**to leave displacements**

**EQUI\_ELGA\_EPSI**

**deformations equivalent to the points of Gauss**

**R**

**INVA\_2: second invariant of**

**INVA\_2SG: second invariant of signed by the trace of**

**PRIN\_1, PRIN\_2, PRIN\_3: principal deformations**

**EQUI\_ELGA\_SIGM**

**constraints equivalent to the points of Gauss**

**R**

**VMIS: constraint of Von Mises**

**VMIS\_SG: second invariant of Von Mises signed by the trace of**

**TRESCA: constraint of Tresca**

**PRIN\_1, PRIN\_2, PRIN\_3: principal constraints**

*Instruction manual*

*U5.0- booklet: Structure of data result HT-66/03/002/A*

---

*Code\_Aster* ®

*Version*

*6.4*

*Titrate:*

*Structure of data dyna\_trans*

*Date:*

*07/08/03*

*Author (S):*

*E. BOYERE*

*Key: U5.01.21-D Page:*

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## **EQUI\_ELNO\_EPSI**

**deformations equivalent to the nodes by element**

**R**

**INVA\_2: second invariant of**

**INVA\_2SG: second invariant of signed by the trace of**

**PRIN\_1, PRIN\_2, PRIN\_3: principal deformations**

## **EQUI\_ELNO\_SIGM**

**constraints equivalent to the nodes by element**

**R**

**VMIS: constraint of Von Mises**

**VMIS\_SG: second invariant of Von Mises signed by the trace of**

**TRESCA: constraint of Tresca**

**PRIN\_1, PRIN\_2, PRIN\_3: principal constraints**

## **EQUI\_NOEU\_EPSI**

**deformations equivalent realised to the nodes**

**R**

**INVA\_2: second invariant of**

**INVA\_2SG: second invariant of signed by the trace of**

**PRIN\_1, PRIN\_2, PRIN\_3: principal deformations**

## **EQUI\_NOEU\_SIGM**

**constraints equivalent realised to the nodes**

**R**

**VMIS: constraint of Von Mises**

**VMIS\_SG: second invariant of Von Mises signed by the trace of**

**TRESCA: constraint of Tresca**

**PRIN\_1, PRIN\_2, PRIN\_3: principal constraints**

## **FORC\_NODA**

**nodal internal forces resulting from the field of deformation**

**R/C**

## **REAC\_NODA**

**nodal forces of reaction (difference between the nodal forces and**

**R/C**

**nonfollowing loadings)**

## **SIEF\_ELGA\_DEPL**

**state of constraints (or generalized efforts) at the points of Gauss**

**R**

**calculated starting from displacements**

## **SIGM\_ELNO\_CART**

**constraints calculated with the nodes by element from**

**R**

**displacements in the total reference mark**

## **SIGM\_ELNO\_DEPL**



**constraints calculated with the nodes by element from**

**R**

**displacements**

**SIGM\_NOEU\_CART**

**constraints realised with the nodes starting from displacements in**

**R**

**the total reference mark**

**SIGM\_NOEU\_DEPL**

**constraints realised with the nodes starting from displacements**

**R**

**SIPO\_ELNO\_DEPL**

**constraints of the efforts of beam to the nodes by element**

**R**

**SIPO\_NOEU\_DEPL**

**constraints of the efforts of beam realised with the nodes**

**R**

**QUICKLY**

**field speed to the nodes**

**R/C**

*Instruction manual*

*U5.0- booklet: Structure of data result HT-66/03/002/A*

---

*Code\_Aster* ®

*Version*

*6.4*

*Titrate:*

*Structure of data dyna\_trans*

*Date:*

*07/08/03*

*Author (S):*

*E. BOYERE*

*Key: U5.01.21-D Page:*

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*Instruction manual*

*U5.0- booklet: Structure of data result HT-66/03/002/A*

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**Code\_Aster** ®

Version

6.4

Titrate:

*Structure of data dyna\_harmo*

Date:

24/06/03

Author (S):

**O. Key NICOLAS**

:

*U5.01.22-D Page*

: 1/2

*Organization (S): EDF-R & D /AMA*

***Instruction manual***

***U5.0- booklet: Structure of data result***

***Document: U5.01.22***

***Structure of data dyna\_harmo***

***1 Significance***

***Structure of data gathering the results coming from a linear dynamic mechanical calculation harmonic.***

**2**

***Operators producing this structure of data***

***Operator Reference***

***DYNA\_LINE\_HARM***

***[U4.53.11]***

***LIRE\_MISS\_3D***

***[U7.02.31]***

***LIRE\_RESU***

***[U7.02.01]***

***REST\_BASE\_PHYS***

***[U4.63.21]***

**3**

***Operators using this structure of data***

***Operator Reference***

***CALC\_ELEM***

***[U4.81.01]***

***CALC\_NO***

***[U4.81.02]***

***POST\_RELEVE\_T***

***[U4.81.21]***

***RECU\_CHAMP***

***[U4.71.01]***

***RECU\_FONCTION***

***[U4.32.03]***

***Instruction manual***

***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster*** ®

***Version***

***6.4***

***Titrate:***

***Structure of data dyna\_harmo***

***Date:***

***24/06/03***

***Author (S):***

***O. Key NICOLAS***

***:***

## ***U5.01.22-D Page***

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### ***4 Variables***

***access***

***Variable of access***

***Significance***

***Type***

***NUME\_ORDRE***

***Sequence number of the required field***

***I***

***FREQ***

***Frequency of excitation***

***R***

***Characteristic:***

***NUME\_ORDRE: 0 and FREQ: 0. correspond to a static answer.***

### ***5 Parameters***

***associated***

***Nothing.***

### ***6 Fields***

***accessible***

***The list of the accessible fields being long, one returns the reader to the document [U5.01.01] which synthesize in the form of tables the list of the accessible fields for the various structures of data.***

***Instruction manual***

***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster ®***

***Version***

***6.4***

***Titrate:***

***Structure of data MODE\_MECA and MODE\_MECA\_C***

***Date:***

***24/06/03***

***Author (S):***

***O. NICOLAS***

***Key: U5.01.23-D Page:***

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***Organization (S): EDF-R & D /AMA***

***Instruction manual***

***U5.0- booklet: Structure of data result***

***Document: U5.01.23***

***Structure of data mode\_meca and mode\_meca\_C***

***1 Significance***

***Structure of data gathering the results coming from a linear modal calculation (clean modes realities or complexes).***

2

***Operators producing this structure of data***

***Operator Reference***

***Creation***

***Modification***

***MODE\_ITER\_INV***

***[U4.52.04] Yes***

***Not***

***MODE\_ITER\_SIMULT***

***[U4.52.03] Yes***

***Not***

***NORM\_MODE***

***[U4.52.11] Yes***

***Yes***

***EXTR\_MODE***

***[U4.52.12] Yes***

***Yes***

***MACRO\_MODE\_MECA***

***[U4.52.02] Yes***

***Not***

***Instruction manual***

***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster ®***

***Version***

***6.4***

***Titrate:***

***Structure of data MODE\_MECA and MODE\_MECA\_C***

***Date:***

***24/06/03***

***Author (S):***

***O. NICOLAS***

***Key: U5.01.23-D Page:***

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3

***Operators using this structure of data***

## ***Operator Reference***

***PROJ\_MATR\_BASE***

***[U4.63.12]***

***PROJ\_VECT\_BASE***

***[U4.63.13]***

***DEFI\_BASE\_MODAL***

***[U4.64.02]***

***CALC\_AMOR\_MODAL***

***[U4.52.13]***

***CALC\_FLUI\_STRU***

***[U4.66.02]***

***CALC\_MATR\_AJOU***

***[U4.66.01]***

***COMB\_SISM\_MODAL***

***[U4.84.01]***

***DYNA\_ALEA\_MODAL***

***[U4.53.22]***

***IMPR\_CLASSI***

***[U7.04.21]***

***MACRO\_MADMACS***

***[U7.03.21]***

***MACRO\_PROJ\_BASE***

***[U4.63.11]***

***MODI\_BASE\_MODAL***

***[U4.66.21]***

***REST\_BASE\_PHYS***

***[U4.63.21]***

***REST\_SPEC\_PHYS***

***[U4.63.22]***

## ***4 Variables***

***access***

***Variable of access***

***Significance***

***Type***

***NUME\_ORDRE***

***Sequence number of the required field (position of the mode in***

***I***  
***calculated part of the spectrum)***

***FREQ***

***Frequency of the mode***



**R**  
**NUME\_MODE**  
*Position of the mode in the total spectrum*  
**I**

**Characteristic:**

**NUME\_ORDRE > 0**

**Instruction manual**  
**U5.0- booklet: Structure of data result HT-66/03/002/A**

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**Code\_Aster ®**  
**Version**  
**6.4**

**Titrate:**  
**Structure of data MODE\_MECA and MODE\_MECA\_C**

**Date:**  
**24/06/03**  
**Author (S):**  
**O. NICOLAS**

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**5 Parameters**  
**associated**

**Parameters Significance**  
**Type**  
**NORMALIZES**  
*Normalizes clean mode*  
**K24**  
**OMEGA2**  
*Square of the pulsation*  
**R**  
**AMOR\_REDUIT**  
*Reduced damping*  
**R**

**ERROR**

*Modal error*

**R**

**MASS\_GENE**

*Mass generalized of the mode*

**R**

**RIGI\_GENE**

*Generalized stiffness of the mode*

**R**

**AMOR\_GENE**

*Generalized damping of the mode*

**R**

**MASS\_EFFE\_DX**

*Effective modal mass in direction DX (translation)*

**R**

**MASS\_EFFE\_DY**

*Effective modal mass in the direction DY (translation)*

**R**

**MASS\_EFFE\_DZ**

*Effective modal mass in direction DZ (translation)*

**R**

**MASS\_EFFE\_DRX**

*Effective modal mass in direction DRX (rotation)*

**R**

**MASS\_EFFE\_DRY**

*Effective modal mass in direction DRY (rotation)*

**R**

**MASS\_EFFE\_DRZ**

*Effective modal mass in direction DRZ (rotation)*

**R**

**FACT\_PARTICI\_DX**

*Factor of participation in direction DX (translation)*

**R**

**FACT\_PARTICI\_DY**

*Factor of participation in the direction DY (translation)*

**R**

**FACT\_PARTICI\_DZ**

*Factor of participation in direction DZ (translation)*

**R**

**FACT\_PARTICI\_DRX** *Factor of participation in direction DRX (rotation)*

**R**

**FACT\_PARTICI\_DRY** *Factor of participation in direction DRY (rotation)*

**R**

***FACT\_PARTICI\_DRZ*** Factor of participation in direction DRZ (rotation)

***R***

***MASS\_EFFE\_UN\_DX***

***Unit effective modal mass in direction DX R***

***(translation)***

***MASS\_EFFE\_UN\_DY***

***Unit effective modal mass in the direction DY R***

***(translation)***

***MASS\_EFFE\_UN\_DZ***

***Unit effective modal mass in direction DZ (translation)***

***R***

***MASS\_EFFE\_UN\_DRX*** Masses modal effective unit in direction DRX (rotation)

***R***

***MASS\_EFFE\_UN\_DRY*** Masses modal effective unit in direction DRY (rotation)

***R***

***MASS\_EFFE\_UN\_DRZ*** Masses modal effective unit in direction DRZ (rotation)

***R***

***MASS\_GENE\_DX***

***Mass generalized in direction DX (translation)***

***R***

***MASS\_GENE\_DY***

***Mass generalized in the direction DY (translation)***

***R***

***MASS\_GENE\_DZ***

***Mass generalized in direction DZ (translation)***

***R***

***Note:***

***The parameters which relate to the degrees of freedom of rotation are not calculated.***

***Instruction manual***

***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster*** ®

***Version***

***6.4***

***Titrate:***

***Structure of data MODE\_MECA and MODE\_MECA\_C***

***Date:***

***24/06/03***

**Author (S):**  
**O. NICOLAS**

**Key: U5.01.23-D Page:**  
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**6 Fields**  
**accessible**

*The list of the accessible fields being long, one returns the reader to the document [U5.01.01] which synthesize in the form of tables the list of the accessible fields for the various structures of data.*

**7 Definition of the modal parameters associated**  
**mode\_meca**

*The clean modes of a structure (not deadened) are defined by the modal equation:*

$$\begin{matrix} \mathbf{K} \\ 2 \\ \mathbf{I} = \mathbf{M} \\ \mathbf{I} \\ \mathbf{I} \\ 2 \end{matrix}$$

*mode being the couple (*

$$\begin{matrix} \mathbf{I} \\ \mathbf{I}, \mathbf{I} \end{matrix} \text{ or } ,$$

$$\begin{matrix} \mathbf{I} \\ 2 \end{matrix}$$

*according to whether one considers the square of the pulsation, or associated frequency.*

**7.1**  
**Property of orthogonality of the clean modes**

*The modes are:  $\mathbf{M}$  - orthogonal and  $\mathbf{K}$  - orthogonal, from where relations*

$$\mathbf{T}_i \mathbf{M} \mathbf{J} = ij.$$

,  $R$

$T_i K_j = ij.$

## 7.2 Parameters generalized

### 7.2.1 Mass and stiffness generalized

One defines the generalized mass and the stiffness of a clean mode of a structure by:

$\mu$   
 $T$   
 $I = I M I$   
 mass generalized (MASS\_GENE)  
 $T$

$ki = I K I$   
 generalized stiffness (RIGI\_GENE)

and we have the relation:  $K$

$2$   
 $I =$   
 $I$   
 $i\mu$

Note:

From the physical point of view, the generalized mass (which is a positive value) can be interpreted like the mass moving

$\mu$   
 $2$   
 $I U F D$   
 where  $U$  is displacement

and more precisely one can note than the potential energy of deformation of the  $i$ ème mode is:

$1 T_i K$   
 $2$   
 $I$

$1$   
 and that the kinetic energy of the structure vibrating according to its  $i$ ème mode is:

$2$   
 $T$

**I I M**

**2**

**I**

**Note:**

**Owing to the fact that the clean modes are defined except for a constant, mass and stiffness generalized depend on the standardization of the mode.**

**Instruction manual**

**U5.0- booklet: Structure of data result HT-66/03/002/A**

---

**Code\_Aster ®**

**Version**

**6.4**

**Titrate:**

**Structure of data MODE\_MECA and MODE\_MECA\_C**

**Date:**

**24/06/03**

**Author (S):**

**O. NICOLAS**

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### **7.2.2 Generalized unit displacement**

**One calls generalized unit displacement or masses generalized of mode I in the direction (unit) D quantity**

**Q**

**T**

**= MR. U**

**where U.E.**

**St the vector unit in the direction D**

**id**

**I**

**D**

**D**

**.**

**Generalized displacement is of unspecified sign, even of zero value and is depend on**

*normalizes clean mode.*

*The concept of generalized displacement is not limited to the translations but can be extended to rotations by considering the following definition:*

*$Q$*

*$T$*

*$I = I$*

*Mr.  $U*d$*

*where  $U*d$  is the matrix whose terms are matrices the  $U.K.$  where  $K$  is a node of the grid (supporting rotations).*

*Let us clarify matrix the  $U.K.$ , if all the nodes of the grid support 3 ddl translation and 3 ddl of rotation; matrices the  $U.K.$  are the following matrices 6x6:*

*1 0 0 0*

*$z_k$*

*-  $y_k$*

*0 1 0 -  $Z$*

*$K$*

*0*

*$x_k$*

*0 0 1  $y$*

*-  $X$*

*0*

*$U$*

*$K$*

*$K$*

*$K =$*

*with  $(x_k, y_k, z_k)$  the co-ordinates of Node  $K$*

*ud.*

*0 0 0 1*

*0*

*0*

*0 0 0 0*

*I*  
*0*

*0 0 0 0*  
*0*  
*1*

*Let us note that implicitly we consider here that the centre of rotation (centre of gravity of structure) is confused with the origin of the co-ordinates.*

### *7.3* *Factors of participation*

*One notes aid the factor of participation of the ième mode in the direction D, by definition:*

*Q*  
*T*  
*MR. U*  
*has*  
*id*  
*I*  
*D*  
*id =*  
*= T*

*I*  
*μ*  
*I*  
*MI*

### *7.4* *Effective modal mass and unit effective modal mass*

*One notes mid the effective modal mass of the ième mode in the direction D, by definition:*

*2*  
*q2*  
*T*  
*M*  
*id*  
*(*  
*U*  
*I*  
*D)*



***mid =***  
***=***  
***T***  
  
***I***  
***μ***  
***I***  
***MI***

***Property [R4.05.03]:***

***The sum of the effective modal masses in a direction is equal to the total mass (MT) structure.***

***Instruction manual***

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***Code\_Aster ®***

***Version***

***6.4***

***Titrate:***

***Structure of data MODE\_MECA and MODE\_MECA\_C***

***Date:***

***24/06/03***

***Author (S):***

***O. NICOLAS***

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***One will thus use rather the concept of effective modal mass unit associated the mode, which is fraction (percentage) of the total mass which is excited by the ième mode in the unit direction D***

***2***  
***m***  
***T***  
***M***  
***\****  
***id***  
***I (***  
***U***  
***I***

**D)**

**mid =**

**=**

**M**

**M**

**T**

**T**

**T**

**I**

**MI**

*The effective modal mass and the effective unit modal mass are independent of standardization of the clean mode.*

**7.5**

*Modal parameters independent of the standardization of the modes*

*As an indication, we give the list of the modal values independent of standardization of modes.*

*· the reduced factor of participation*

**Q**

*- id. max*

**max**

**I**

*where I*

*is largest of the components of I*

**I**

**μ**

**Q**

**IQ**

*· stiffness associated with the reduced factor of participation: - id*

**id**

*. max*

**max**

**I**

**= 2**

**I**

**I**

**μ**

**$I$**   
 **$\mu$**   
 **$1 q^2$**   
 · unit effective modal mass  $m^*$   
 **$id$**   
 **$id = MT i\mu$**

**8 Definition of the modal parameters associated**  
**MODE\_MECA\_C**

*The clean modes of a deadened structure are defined by the modal equation*

$$(2iM+i C+K) I = 0$$

-

**$E$**   
 **$R (I)$**   
*mode being the triplet*

,

,

**$I$**

**$I$**   
 **$I$**

*where*

**$I =$**   
*is the pulsation of the system*  
 **$R (I)$**   
 **$E I)$**   
 -  
 =  
*is reduced damping*

**$I$**   
 **$I$**   
 **$I$**   
*the clean vector or mode of vibration*

*This problem can be put in a form of “generalized problem”*

$$A.z = B.z$$

***K***

***O***

***- C - M***

*where A =*

***, B =***

***, Z =, y =***

***O - M***

***- M***

***O***

***y***

*Consequently, it is possible to define the concepts of mass and generalized stiffness, like factor of participation and effective modal mass by taking matrix A like stamp rigidity and stamp B like stamps of mass.*

*Instruction manual*

*U5.0- booklet: Structure of data result HT-66/03/002/A*

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***Code\_Aster*** ®

***Version***

***6.4***

***Titrate:***

***Structure of data base\_modale***

***Date:***

***26/05/03***

***Author (S):***

***O. BOITEAU Key***

***:***

***U5.01.24-D Page***

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***Organization (S): EDF-R & D /SINETICS***

***Instruction manual  
U5.0- booklet: Structure of data result  
Document: U5.01.24***

***Structure of data base \_modale***

***1 Significance***

***Structure of data gathering of the static modes and the real clean modes to constitute one base modal, used in response by modal recombination and dynamic under-structuring.***

***2  
Operators producing this structure of data***

***Operator Reference  
DEFI\_BASE\_MODAL  
[U4.64.02]  
Instruction manual  
U5.0- booklet: Structure of data result HI-23/03/002/A***

---

***Code\_Aster ®  
Version  
6.4***

***Titrate:  
Structure of data base \_modale***

**Date:**

**26/05/03**

**Author (S):**

**O. BOITEAU Key**

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**3**

***Operators using this structure of data***

***Operator Reference***

***CALC\_ELEM***

***[U4.81.01]***

***CALC\_NO***

***[U4.81.02]***

***DEFI\_BASE\_MODAL***

***[U4.64.02]***

***DYNA\_ALEA\_MODAL***

***[U4.53.22]***

***MACR\_ELEM\_DYNA***

***[U4.65.01]***

***MACRO\_PROJ\_BASE***

***[U4.63.11]***

***MODE\_ITER\_CYCL***

***[U4.52.05]***

***MODI\_BASE\_MODAL***

***[U4.66.21]***

***MODI\_REPERE***

***[U4.74.01]***

***NUME\_DDL\_GENE***

***[U4.65.03]***

***POST\_RELEVE\_T***

***[U4.81.21]***

***PROJ\_VECT\_BASE***

***[U4.63.13]***

***PROJ\_MATR\_BASE***

***[U4.63.12]***

***PROJ\_MESU\_MODAL***

***[U4.73.01]***

***4 Variables***

***access***

*Variable of access*

*Significance*

*Type*

**FREQ**

*Frequency of the mode (0. if static mode)*

**R**

**NOEUD\_CMP**

*Name of a static mode (name of the node - name of the imposed ddl)*

**K16**

**NUME\_MODE**

*Number of a dynamic mode*

**I**

**NUME\_ORDRE**

*Sequence number of a mode of the base*

**I**

*Characteristic:*

*NUME\_MODE and NUME\_ORDRE > 0.*

*5 Parameters*

*associated*

*Parameters Significance*

*Type*

**OMEGA2**

*Square of the own pulsation (0. if static mode)*

**R**

**TYPE\_DEFO**

*“CLEAN” if clean mode*

**K16**

*“CONSTRAINED” if constrained mode*

*“FASTENER” if mode attaches*

**NORMALIZES**

*Standardization used for the clean modes \*\**

**K24**

**RIGI\_GENE**

*Generalized stiffness of mode TK (0. if static mode) \**

**R**

**MASS\_GENE**

***Mass generalized of the mode TM (0. if static mode) \****

***R***

***\* See definitions in MODE\_MECA [U5.01.23].***

***\*\* See definitions in NORM\_MODE [U4.52.11].***

***6 Fields***

***accessible***

***DEPL***

***See [U5.01.01] for the significance of this field.***

***Instruction manual***

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**Code\_Aster** ®

Version

6.4

Titrate:

*Structure of data mode\_gene*

Date:

26/05/03

Author (S):

**O. BOITEAU** Key

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Organization (S): EDF-R & D /SINETICS

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**U5.01.25 document**

***Structure of data mode\_gene***

**1 Significance**

***Generalized clean modes obtained either by a method of iterations opposite, or by a method of subspace.***

2

*Operators producing this structure of data*

*Operator Reference*

*EXTR\_MODE*

*[U4.52.12]*

*MODE\_ITER\_INV*

*[U4.52.04]*

*MODE\_ITER\_SIMULT*

*[U4.52.03]*

*PROJ\_MESU\_MODAL*

*[U4.73.01]*

*Instruction manual*

*U5.0- booklet: Structure of data result HI-23/03/002/A*

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*Code\_Aster* ®

*Version*

*6.4*

*Titrate:*

*Structure of data mode\_gene*

*Date:*

*26/05/03*

*Author (S):*

*O. BOITEAU Key*

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3

*Operators using this structure of data*

*Operator Reference*

*EXTR\_MODE*

*[U4.52.12]*

*MACRO\_PROJ\_BASE*

*[U4.63.11]*

*NUME\_DDL\_GENE*

*[U4.65.03]*

*PROJ\_MATR\_BASE*

*[U4.63.12]*

**PROJ\_VECT\_BASE**

**[U4.63.13]**

**REST\_BASE\_PHYS**

**[U4.63.21]**

**IMPR\_GENE**

**[U4.91.02]**

**4 Variables**

**access**

**Variable of access**

**Significance**

**Type**

**FREQ**

**Frequency of the mode (0. if static mode)**

**R**

**NUME\_MODE**

**Number of a dynamic mode**

**I**

**NUME\_ORDRE**

**Sequence number of a mode of the base**

**I**

**Characteristic:**

**NUME\_MODE and NUME\_ORDRE > 0.**

**5 Parameters**

**associated**

**Parameters Significance**

**Type**

**AMOR\_GENE**

**Modal damping généralisé\***

**R**

**AMOR\_REDUIT**

**Damping réduit\***

**R**

**ERROR**

**Error made on the calculation of the mode \*\*\***

**R**

**FACT\_PARTICI\_DX**

*Factor of participation in direction DX (translation) \**

**R**

**FACT\_PARTICI\_DY**

*Factor of participation in the direction DY (translation) \**

**R**

**FACT\_PARTICI\_DZ**

*Factor of participation in direction DZ (translation) \**

**R**

**ITER\_AJUSTE**

*Iteration count of the algorithm of the secant \*\*\**

**I**

**(MODE\_ITER\_INV + OPTION: "ADJUSTS")**

**ITER\_ARNO**

*Iteration count of the algorithm of Arnoldi \*\*\**

**I**

**(reabsorbed method of MODE\_ITER\_SIMULT)**

**ITER\_BATHE**

*Iteration count total of the algorithm of Bathe & Wilson*

**I**

**(MODE\_ITER\_SIMULT + METHOD: "JACOBI") \*\*\***

**ITER\_INVERSE**

*Iteration count total of the algorithm of the powers*

**I**

**opposite \*\*\***

**(MODE\_ITER\_INV)**

**ITER\_JACOBI**

*Iteration count of the algorithm of JACOBI \*\*\**

**I**

**(MODE\_ITER\_SIMULT + METHOD: "JACOBI")**

**ITER\_QR**

*Iteration count of algorithm QR \*\*\**

**I**

**(MODE\_ITER\_SIMULT + METHOD: "TRI\_DIAG")**

**ITER\_SEPARE**

*Iteration count of the algorithm of dichotomy \*\*\**

**I**

**(MODE\_ITER\_INV + OPTION: "SEPARATE")**

**MASS\_EFFE\_DX**

*Effective modal mass in direction DX (translation) \**

**R**

**MASS\_EFFE\_DY**

*Effective modal mass in the direction DY (translation) \**

**R**

**MASS\_EFFE\_DZ**

**Effective modal mass in direction DZ (translation) \***

**R**

**MASS\_EFFE\_UN\_DX**

**Unit effective modal mass in direction DX**

**R**

**(translation) \***

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**Code\_Aster ®**

**Version**

**6.4**

**Titrate:**

**Structure of data mode\_gene**

**Date:**

**26/05/03**

**Author (S):**

**O. BOITEAU Key**

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**MASS\_EFFE\_UN\_DY**

**Unit effective modal mass in the direction DY**

**R**

**(translation) \***

**MASS\_EFFE\_UN\_DZ**

**Unit effective modal mass in direction DZ**

**R**

**(translation) \***

**MASS\_GENE**

**Modal mass généralisée\***

**R**

**METHOD**

**Modal method used \*\*\***

**K24**

**NORMALIZES**

**Standardization used for the clean modes \*\***

**K24**

**OMEGA2**

***Square of the own pulsation***

***R***

***RIGI\_GENE***

***Modal rigidity généralisée\****

***R***

***\****

***See definitions in MODE\_MECA [U5.01.23].***

***\*\* See definitions in NORM\_MODE [U4.52.11].***

***\*\*\* See definitions in MODE\_ITER\_INV [U4.52.04], MODE\_ITER\_SIMULT [U4.52.03] and in [R5.01.01].***

***Characteristic:***

***The method owing to lack of MODE\_ITER\_SIMULT (METHOD = "SORENSEN") does not have a parameter associated the iteration counts of its processes (total or interns).***

***6 Fields***

***accessible***

***DEPL***

***See [U5.01.01] for the significance of this field.***

***Instruction manual***

***U5.0- booklet: Structure of data result HI-23/03/002/A***

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***Code\_Aster ®***

***Version***

***6.4***

***Titrate:***

***Structure of data mode\_gene***

***Date:***

***26/05/03***

***Author (S):***

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*U5.0- booklet: Structure of data result HI-23/03/002/A*

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*Code\_Aster* ®

*Version*

*6.4*

*Titrate:*

*Structure of data harm\_gene*

*Date:*

*26/05/03*

*Author (S):*

*O. BOITEAU Key*

*:*

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*Organization (S): EDF-R & D /SINETICS*

***Instruction manual  
U5.0- booklet: Structure of data result  
U5.01.26 document***

***Structure of data harm\_gene***

***1 Significance***

***Structure of data gathering of the static modes and the real clean modes to constitute one base modal.***

***2***

***Operators producing this structure of data***

***Operator Reference***

***DYNA\_LINE\_HARM***

***[U4.53.11]***

***LIRE\_RESU***

***[U7.02.01]***

***PROJ\_MESU\_MODAL***

***[U4.73.01]***

***Instruction manual***

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***Code\_Aster ®***

***Version***

***6.4***



***Titrate:***

***Structure of data harm\_gene***

***Date:***

***26/05/03***

***Author (S):***

***O. BOITEAU Key***

***:***

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***3***

***Operator using this structure of data***

***Operator Reference***

***REST\_BASE\_PHYS***

***[U4.63.21]***

***IMPR\_GENE***

***[U4.91.02]***

***4 Variable***

***access***

***Variable of access***

***Significance***

***Type***

***NUME\_MODE***

***Sequence number of a harmonic result***

***I***

***5 Parameter***

***associated***

***Parameters Significance***

***Type***

***FREQ***

***Frequency of calculation***

***R***

**6 Fields  
accessible**

**ACCE  
FREQ  
QUICKLY**

*See [U5.01.01] for the significance of these fields.*

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**Code\_Aster ®  
Version  
6.4**

**Titrate:  
Structure of data mode\_gene**

**Date:  
24/06/03  
Author (S):  
O. Key NICOLAS  
:  
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**Organization (S): EDF-R & D /AMA**

**Instruction manual  
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**Document: U5.01.27**

**Structure of data acou\_harmo**

## **1 Significance**

**Structure of data coming from a harmonic calculation on a model of the “acoustic” phenomenon.**

**2**

**Operators producing this structure of data**

**Operator Reference**

**DYNA\_LINE\_HARM**

**[U4.53.11]**

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**Code\_Aster ®**

**Version**

**6.4**

**Titrate:**

**Structure of data mode\_gene**

**Date:**

**24/06/03**

**Author (S):**

**O. Key NICOLAS**

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### 3 *Operators using this structure of data*

#### *Operator Reference*

***CALC\_ELEM***  
***[U4.81.01]***

***CALC\_NO***  
***[U4.81.02]***

***IMPR\_RESU***  
***[U4.91.01]***

***POST\_RELEVE\_T***  
***[U4.81.21]***

***RECU\_CHAMP***  
***[U4.71.01]***

***RECU\_FONCTION***  
***[U4.32.03]***

***TEST\_RESU***  
***[U4.92.01]***

#### ***4 Variables*** ***access***

***Variable of access***

***Significance***

***Type***

***NUME\_ORDRE***  
***Sequence number of a mode of the base***

***I***  
***FREQ***  
***Frequency of the mode (0. if static mode)***

***R***

**5 Parameters  
associated**

**Nothing.**

**6 Fields  
accessible**

**See document [U5.01.01] which synthesizes in the form of tables the list of the accessible fields for various structures of data.**

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**Code\_Aster ®  
Version  
6.4**

**Titrate:  
Structure of data mode\_acou**

**Date:  
24/06/03  
Author (S):  
O. Key NICOLAS  
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**Organization (S): EDF-R & D /AMA**

***Instruction manual***  
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***Document: U5.01.28***

***Structure of data mode\_acou***

## ***1 Significance***

***Structure of data gathering the results coming from a modal calculation on a model from “acoustic” phenomenon.***

***2***  
***Operators producing this structure of data***

***Operator Reference Modification Creation***

***MODE\_ITER\_INV***

***[U4.52.04] Yes***

***Not***

***MODE\_ITER\_SIMULT***

***[U4.52.03] Yes Not***

***NORM\_MODE***

***[U4.52.11] Yes***

***Yes***

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***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster ®***

***Version***

***6.4***

***Titrate:***

***Structure of data mode\_acou***

***Date:***

***24/06/03***

***Author (S):***

***O. Key NICOLAS***

***:***

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***3***

***Operators using this structure of data***

***Operator Reference***

***CALC\_ELEM***

***[U4.81.01]***

***CALC\_NO***

***[U4.81.02]***

***IMPR\_RESU***

***[U4.91.01]***

***POST\_RELEVE\_T***

***[U4.81.21]***

***RECU\_CHAMP***

***[U4.71.01]***

***TEST\_RESU***

***[U4.92.01]***

***4 Variables***

***access***

***Variable of access***

***Significance***

**Type**

**NUME\_ORDRE**

*Number of the required mode*

**I**

**NUME\_MODE**

*Number of the mode in the calculated spectrum*

**I**

**FREQ**

*Frequency of the mode*

**R**

**Characteristics:**

**NUME\_MODE > 0**

**5 Parameters**

*associated*

**Parameters Standard Significance**

**NORMALIZES**

*Name of the standard of the clean mode*

**K24**

**OMEGA2**

*Square of the pulsation*

**R**

**AMOR\_REDUIT**

*Reduced damping*

**R**

**ERROR**

*Modal error*

**R**

**MASS\_GENE**

*Mass generalized of the mode*

**R**

**RIGI\_GENE**

*Generalized stiffness of the mode*

**R**

**AMOR\_GENE**

*Generalized damping of the mode*

**R**



## ***6 Fields accessible***

*See document [U5.01.01] which synthesizes in the form of tables the list of the accessible fields for various structures of data.*

***Instruction manual***

***U5.0- booklet: Structure of data result HT-66/03/002/A***

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**Code\_Aster** ®

Version

6.4

Titrate:

*Structure of data mode\_flamb*

Date:

26/05/03

Author (S):

**O. BOITEAU** Key

:

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Organization (S): EDF-R & D /SINETICS

**Instruction manual**

**U5.0- booklet: Structure of data result**

**U5.01.09 document**

*Structure of data mode\_flamb*

**1 Significance**

***Clean modes generalized in linear buckling, obtained, is by a method of iterations opposite, is by a method of subspace.***

2

***Operators producing this structure of data***

***Operator Reference***

***MODE\_ITER\_INV***

***[U4.52.04]***

***MODE\_ITER\_SIMULT***

***[U4.52.03]***

***NORM\_MODE***

***[U4.52.11]***

***Instruction manual***

***U5.0- booklet: Structure of data result HI-23/03/002/A***

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***Code\_Aster ®***

***Version***

***6.4***

***Titrate:***

***Structure of data mode\_flamb***

***Date:***

***26/05/03***

***Author (S):***

***O. BOITEAU Key***

***:***

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3

***Operators using this structure of data***

***Operator Reference***

***CALC\_ELEM***

***[U4.81.01]***

***CALC\_NO***

***[U4.81.02]***

***MODI\_REPERE***

***[U4.74.01]***

***NORM\_MODE***

***[U4.52.11]***

***POST\_RELEVE\_T***

## **[U4.81.21]**

### **4 Variables**

*access*

*Variable of access*

*Significance*

*Type*

**NUME\_MODE**

*Number of a mode of buckling*

**I**

**NUME\_ORDRE**

*Sequence number of a mode of the base*

**I**

*Characteristic:*

**NUME\_MODE and NUME\_ORDRE > 0.**

### **5 Parameters**

*associated*

*Parameters Significance*

*Type*

**CHAR\_CRIT**

*Critical load \*\**

**R**

**ERROR**

*Error made on the calculation of the mode \*\**

**R**

**NORMALIZES**

*Standardization used for the propres\* modes*

**K24**

\*

*See definitions in NORM\_MODE [U4.52.11].*

*\*\* See definitions in MODE\_ITER\_INV [U4.52.04], MODE\_ITER\_SIMULT [U4.52.03] and in [R5.01.01].*

### **6 Field**

*accessible*

**DEPL**

*See [U5.01.01] for the significance of this field.*

*Instruction manual*

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**Code\_Aster** ®

**Version**

**6.4**

**Titrate:**

*Structure of data evol\_ther*

**Date:**

**11/07/03**

**Author (S):**

**C. DURAND**

**Key: U5.01.31-C Page:**

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**Organization (S): EDF-R & D /AMA**

*Instruction manual*

*U5.01 booklet: Structure of data result*

*Document: U5.01.31*

*Structure of data evol\_ther*

## ***1 Significance***

***Structure of data gathering the results coming from a thermal calculation (stationary or evolutionary, linear or not), possibly enriched by a metallurgy postprocessing.***

***2***

***Operators producing this structure of data***

***Operator Reference***

***Ther\_Lineaire***

***[U4.54.01]***

***Ther\_Non\_Line***

***[U4.54.02]***

***Ther\_Non\_Line\_Mo***

***[U4.54.03]***

***3***

***Operators enriching this structure of data***

***Operator Reference***

***Calc\_Elem***

***[U4.81.01]***

***Calc\_No***

***[U4.81.02]***

***Calc\_Cham\_Elem***

***[U4.81.03]***

***Calc\_Meta***

***[U4.85.01]***

***Instruction manual***

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***Version***

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***Titrate:***

***Structure of data evol\_ther***

***Date:***

***11/07/03***

**Author (S):**  
**C. DURAND**

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**4 Variables**  
**access**

**Variable of access**

**Significance**

**Type**

**NUME\_ORDRE**

**Sequence number of the required field**

**I**

**INST**

**Moment of calculation (thermal transient)**

**R**

**Characteristic:**

**NUME\_ORDRE = 0 or INST = 0. correspond at the initial state of an evolutionary calculation (stationary calculation, constant temperature or initial field of temperature).**

**5 Parameters**  
**associated**

**Nothing.**

**6 Fields**  
**accessible**

**Reference symbol**

**Significance**

**Type**

**TEMP**

**Field of temperature**

**R**

**HYDR\_ELGA**

*Hydration at the points of Gauss*

**R**

**HYDR\_ELNO\_ELGA**

*Hydration by elements with the nodes*

**R**

**HYDR\_NOEU\_ELGA**

*Hydration with the nodes*

**R**

**FLUX\_ELNO\_TEMP**

*Heat flow to the nodes by elements with the nodes*

**R**

**FLUX\_ELGA\_TEMP**

*Heat flow at the points of Gauss*

**R**

**FLUX\_NOEU\_TEMP**

*Heat flow to the nodes*

**R**

**META\_ELNO\_TEMP**

*Metallurgical phases calculated with the nodes by elements*

**R**

**META\_ELGA\_TEMP**

*Metallurgical phases calculated at the points of Gauss*

**R**

**META\_NOEU\_TEMP**

*Metallurgical phases calculated with the nodes*

**R**

**DURT\_ELGA\_META**

*Hardnesses calculated with the nodes by elements*

**R**

**DURT\_ELNO\_META**

*Hardnesses calculated at the points of Gauss*

**R**

**DURT\_NOEU\_META**

*Hardnesses calculated with the nodes*

**R**

**DETE\_ELNO\_DLTE**

*Derived eulérienne from the temperature expressed with the nodes by*

**R**

*elements*

**DETE\_NOEU\_DLTE**

*Derived eulérienne from the temperature expressed with the nodes*

**R**

**ERTH\_ELEM\_TEMP**



*Indicator of error by elements*

**R**

**ERTH\_ELNO\_ELEM**

*Indicator of error by elements to the nodes*

**R**

*Instruction manual*

*U5.01 booklet: Structure of data result HT-66/03/002/A*

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*Code\_Aster* ®

*Version*

**6.4**

*Titrate:*

*Presentation of the tables*

*Date:*

**27/06/03**

*Author (S):*

**J. Key PELLETT**

**:**

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*Organization (S): EDF-R & D /AMA*

*Instruction manual*

*U5.0- booklet: Structure of data result*

*Document: U5.02.00*

## ***Presentation of the tables***

### ***Summary:***

***This document in a few words presents what is a table in Code\_Aster. It gives the list of the types of tables currently created by the code. For the precise description of each one of these types of tables, it returns the reader with documentation “user” of the order which created the table.***

### ***Instruction manual***

***U5.0- booklet: Structure of data result HT-66/03/002/A***

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***Code\_Aster*** ®

***Version***

***6.4***

### ***Titrate:***

***Presentation of the tables***

### ***Date:***

***27/06/03***

### ***Author (S):***

***J. Key PELLET***

***:***

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### ***1 What is this***

***that one***

***counts?***

***A table is a structure of data of data-processing nature making it possible to store one together of whole values, real, complex or character strings. In Code\_Aster, one recognizes the concepts of the type counts in the name of their type which is form: “”.***

***A table is comparable with a table EXCEL, i.e. one can see it like a list of columns in opposite. Each column has a field name, which we call parameter, and contains similar data of type: I, R, C, K8, K16, K24 or K32.***

### ***Example:***

**NUME\_ORDRE INST NODE G\_LOCAL****1 10.****N1****5.****1 10.****N2****6.****1 10.****N3****7.****1 10.****N4****8.****2 20.****N1****9.****2 20.****N2****9.****2 20.****N3****8.****2 20.****N4****8.****3 30.****N1****7.****3 30.****N2****6.****3 30.****N3****5.**

*One can also see the table as a succession of recordings (which we will call lines).*

*All the lines do not have inevitably the same structure (i.e same parameters). For example:*

**ACTION NUME\_ORDRE INST NODE DX****DY NET SIXX****ENTITLE****1****1**

**10. N1 3. 5.**

**ENTITLE**

**1**

**1**

**10. N2 6. 7.**

**ENTITLE**

**1**

**1**

**10. N3 8. 9.**

**ENTITLE 1**

**2**

**20.**

**N1**

**11.**

**12.**

**ENTITLE 1**

**2**

**20.**

**N2**

**15.**

**13.**

**ENTITLE 1**

**2**

**20.**

**N3**

**19.**

**18.**

**ENTITLE**

**2 2 20.**

**MA1**

**-12.**

**ENTITLE**

**2 2 20.**

**MA2**

**-14.**

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***Code\_Aster*** ®

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***6.4***

***Titrate:***

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***27/06/03***

***Author (S):***

***J. Key PELLET***

***:***

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***2***

***How to discover the structure of a table?***

***A way of discovering the structure of a table is to print it. One then obtains an image “listing” of table above and one can see the names of the parameters of the table.***

***Example***

***command file:***

```
tr2 = POST_RELEVE_T (  
ACTION: (ENTITLES: “ACTION_1” OPERATION: “EXTRACTION”  
WAY: seg1 RESULT: temple  
NOM_CHAM: “TEMP” TOUT_ORDRE: “YES”  
NOM_CMP: “TEMP”));
```

```
IMPR_TABLE (TABLE: tr2);
```

***file RESULT:***

```
ASTER 6.0.15 CONCEPT TR2 CALCULATES THE 14/11/20 A 09:19: 07 OF TYPE  
TABL_POST_RELE
```

```
ENTITLE RESU NOM_CHAM NUME_ORDRE INST
```

**ABSC\_CURV**

**TEMP**

**ACTION\_1 TEMPLE TEMP**

**0**

**0.0E+00**

**0.00E+00**

**1.0E+02**

**ACTION\_1 TEMPLE TEMP**

**0**

**0.0E+00**

**2.50E-02**

**6.0E+01**

**ACTION\_1 TEMPLE TEMP**

**0**

**0.0E+00**

**5.00E-02**

**2.0E+01**

**ACTION\_1 TEMPLE TEMP**

**1**

**5.0E+00**

**0.00E+00**

**1.0E+02**

**ACTION\_1 TEMPLE TEMP**

**1**

**5.0E+00**

**2.50E-02**

**6.0E+01**

**ACTION\_1 TEMPLE TEMP**

**1**

**5.0E+00**

**5.00E-02**

**2.0E+01**

**ACTION\_1 TEMPLE TEMP**

**2**

**1.0E+01**

**0.00E+00**

**1.0E+02**

**ACTION\_1 TEMPLE TEMP**

**2**

**1.0E+01**

**2.50E-02**

**6.0E+01**

**ACTION\_1 TEMPLE TEMP**

2

*1.0E+01*

*5.00E-02*

*2.0E+01*

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*List types of tables existing in Code\_Aster*

*In the table below, we listed the whole of the types of table which can be created by Code\_Aster.*

*Their name begins with the character string “tabl\_”. For each one of these types, one gives it name of the orders which can create tables of this type. The documentation of these orders must normally to describe the significance of the parameters of the produced tables.*

*tabl\_aire\_int POST\_ELEM*

*[U4.81.22]*

*tabl\_calc\_g\_loca CALC\_G\_LOCAL\_T [U4.82.04]*

*tabl\_calc\_g\_th CALC\_G\_THETA\_T*

*[U4.82.03]*

*tabl\_cara\_geom MACR\_CARA\_POUTRE*

*tabl\_char\_limite POST\_ELEM*

*[U4.81.22]*

*tabl\_ener\_cin POST\_ELEM*

**[U4.81.22]**

***tabl\_ener\_elas POST\_ELEM***

**[U4.81.22]**

***tabl\_ener\_pot POST\_ELEM***

**[U4.81.22]**

***tabl\_ener\_totale POST\_ELEM***

**[U4.81.22]**

***tabl\_indic\_ener POST\_ELEM***

**[U4.81.22]**

***tabl\_indic\_seuil POST\_ELEM***

**[U4.81.22]**

***tabl\_intsp DEFI\_INTE\_SPEC***

**[U4.36.02]**

***tabl\_mass\_iner POST\_ELEM***

**[U4.81.22]**

***tabl\_post\_alea POST\_DYNA\_ALEA***

**[U4.84.04]**

***tabl\_post\_beta POST\_K\_BETA***

***tabl\_post\_dyna POST\_DYNA\_MODAL\_T***

**[U4.84.02]**

***tabl\_post\_f\_alea POST\_FATI\_ALEA [U4.84.03]***

***tabl\_post\_fatig POST\_FATIGUE***

**[U4.83.01]**

***tabl\_post\_gouj2e POST\_GOUJ2E***

**[U4.GJ.30]**

***tabl\_post\_k POST\_K1\_K2\_K3***

**[U4.82.05]**

***tabl\_post\_rccm POST\_RCCM***

**[U4.83.11]**

***tabl\_post\_rele POST\_RELEVE\_T [U4.81.21]***

***tabl\_post\_simpli POST\_SIMPLIFIE [U4.PS.10]***

***tabl\_post\_usur POST\_USURE***

**[U4.84.05]**

***tabl\_reca\_weib RECA\_WEIBULL [U4.82.06]***

***tabl\_rice\_tracey POST\_ELEM***

**[U4.81.22]**

***tabl\_texture DEFI\_TEXTURE***

**[U4.43.05]**

***tabl\_trav\_ext POST\_ELEM***

**[U4.81.22]**

***tabl\_trc DEFI\_TRC***

**[U4.43.04]**



***tabl\_weibull POST\_ELEM  
[U4.81.22]***

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***Code\_Aster ®  
Version  
7.4***

***Titrate:  
Operator EXEC\_LOGICIEL***

***Date:  
19/01/05  
Author (S):  
Key J.P. LEFEBVRE  
:  
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***Organization (S): EDF-R & D /AMA***

***Instruction manual  
U7.0- booklet: Data exchanges  
Document: U7.00.01***

***Operator EXEC\_LOGICIEL***

## ***1 Goal***

***To call since Code\_Aster, a software or an order system. External software and order system called must reside and will be carried out on the same machine as Code\_Aster. It is more particularly intended for the development of macro-orders. The mechanism of the fork type used in the version Unix to call achievable allows to recover the whole of the environment cutting process associated with Code\_Aster and more particularly a zone allocated memory identical.***

### ***Instruction manual***

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***Code\_Aster ®***

***Version***

***7.4***

***Titrate:***

***Operator EXEC\_LOGICIEL***

***Date:***

***19/01/05***

***Author (S):***

***Key J.P. LEFEBVRE***

***:***

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## ***2 Syntax***

***EXEC\_LOGICIEL***

***(***

***SOFTWARE***

***= nom\_exe,***

***(TX)***

*ARGUMENT = \_F (*

*NOM\_PARA = will l\_para,*

*(l\_TX)*

)

)

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**Code\_Aster** ®

Version

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Titrate:

Operator EXEC\_LOGICIEL

Date:

19/01/05

Author (S):

Key **J.P. LEFEBVRE**

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### **3 Operands**

#### **3.1 Operand**

##### **SOFTWARE**

**SOFTWARE** = *nom\_exe*

*Name of the order or achievable to call. It is a character string (between `), it is necessary to specify the whole of the way (path) to reach L `achievable. On the machine of reference*

*AlphaServer clayastr, the execution of Code\_Aster is carried out under a temporary repertory, it is thus not always possible to reach into relating to a file.*

**Note:**

*The officially referred software must have an entrance point under one particular repertory managed by the administrator (/aster/outils on clayastr). developer of macro-order must take the precaution to build the name in concaténant the name of the repertory of installation which it will récupérer using a utility so to ensure the portability of it.*

#### **3.2 Word**

*key*

##### **ARGUMENT**

*Allows to define the list of the arguments passed in the achievable one.*

### **3.3 Operand**

#### **NOM\_PARA**

**NOM\_PARA = will l\_para**

**Names or values of the arguments passed to the achievable one. The values passed in the form of character strings, to load of achievable to decode them, they are transmitted such which, the character `` (white) being used as separator, the key word must be repeated time as many as it y has arguments to pass.**

#### **4 Example**

**EXEC\_LOGICIEL is not the only solution to call an order or a program, it is possible while inserting an order python os.system to carry out the same type of operation.**

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**Operator EXEC\_LOGICIEL**

**Date:**

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**Author (S):**

**Key J.P. LEFEBVRE**

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*Code\_Aster* ®

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*Titrate:*

*Procedure PRE\_IDEAS*

*Date:*

*31/01/05*

*Author (S):*

*O. Key NICOLAS*

*:*

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*Organization (S): EDF-R & D /AMA*

***Instruction manual***  
***U7.0- booklet: Data exchanges***  
***Document: U7.01.01***

***Procedure PRE\_IDEAS***

***1 Goal***

***To convert a file of grid of “universal” format IDEAS with the format Aster. It can then be read by Aster via order LIRE\_MAILLAGE.***

***Treated versions I-DEASTM are versions 4, 5 and 6 as well as versions 1. , 2. , 3. , 4. , 5. , 6. , 7. , 8. , 9. and 10. of Master Series.***

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**Author (S):**  
**O. Key NICOLAS**  
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## **2 Syntax**

### **PRE\_IDEAS**

(  
**UNITE\_IDEAS**  
=  
/  
19  
,  
**[DEFECT]**  
/  
**usuper**  
,  
**[I]**

**UNITE\_MAILLAGE =/20**  
,  
**[DEFECT]**  
/  
**uaster**  
,  
**[I]**

**CREA\_GROUP\_COUL =/"YES",**



/  
“NOT”  
,  
[DEFECT]

)

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*U7.0- booklet: Data exchanges*  
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*3 Operands*

*3.1 Operand*

*UNITE\_IDEAS*

*UNITE\_IDEAS*

*=*

*Logical number of unit of file known as “universal” IDEAS. The default value is 19.*

*3.2 Operand*

*UNITE\_MAILLAGE*

## **UNITE\_MAILLAGE**

=

*Logical number of unit of the file of grid Aster. The default value is 20.*

### **3.3 Operand**

#### **CREA\_GROUP\_COUL**

**CREA\_GROUP\_COUL =/“YES”,**

**/**

**“NOT”**

**,**

**[DEFECT]**

*The user can ask for the creation of groups of meshes gathering all the meshes of even color while indicating CREA\_GROUP\_COUL = “YES” in order PRE\_IDEAS. These groups are named COUL\_n or N is the number of the color in IDEAS.*

*In order not to unnecessarily increase the number of groups of meshes and consequently the size file of grid, it is decided automatically not to create the groups of meshes of one even color: CREA\_GROUP\_COUL = “NOT” [DEFECT].*

**Note:**

**1)**

**order**

**PRE\_IDEAS treats only Cartesian frames of reference.**

**2)**

**order**

**PRE\_IDEAS manages one Cartesian frame of reference.**

**3) During the conversion of universal file IDEAS, order PRE\_IDEAS checks if the user defined several frames of reference. If it is the case, a message of alarm the user informs some, to ask him to check that all the systems of co-ordinates are identical.**

## **4 Use**

***On the level of the environment of astk use, file known as “universal” IDEAS must be of type .msup.***

***The document [U3.03.01] described the principles of conversion of under files (dated sets) of the file IDEAS in subfiles Aster and rules of development of the names of nodes, meshes, groups nodes and groups of meshes produced, as well as the direction of connectivity of the meshes.***

***If, in the environment of use, one associated file IDEAS the logical unit 19 (value by defect for the type .msup), one creates the concept Aster grid as follows:***

***PRE\_IDEAS ()***

***email = LIRE\_MAILLAGE ()***

***Instruction manual***

***U7.0- booklet: Data exchanges***

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***Code\_Aster ®***

***Version***

***7.4***

***Titrate:***

***Procedure PRE\_IDEAS***

***Date:***

***31/01/05***

***Author (S):***

***O. Key NICOLAS***

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***Code\_Aster*** ®

***Version***

***7.4***

***Titrate:***

***Procedure PRE\_GIBI***

***Date:***

***08/02/05***

***Author (S):***

***Key COURTEOUS Mr.***

***:***

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***Organization (S): EDF-R & D /AMA***

***Instruction manual  
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Document: U7.01.11***

***Procedure PRE\_GIBI***

***1 Goal***

***To see a file of grid to format GIBI then to write it with the format Aster.***

***The only levels of version of maillor GIBI (maillor of CASTEM 2000) treated are levels 3, 4, 5, 6, 8, 9, 10, 11 and 13. In CASTEM 2000, the file of grid to format GIBI is produced by directive TO SAVE FORMAT.***

***For the rules of transcription of a file of grid of GIBI in Aster to refer to the booklet [U3.04.01].***

***One does not read again any more the files results of maillor GIBI produced by the directive LEAVES, one does not read again not more the files result of maillor GIBI created by the directive TO SAVE which produces files result of binary type (to use well TO SAVE FORMAT).***

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***Code\_Aster ®  
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***Titrate:  
Procedure PRE\_GIBI***

***Date:  
08/02/05  
Author (S):  
Key COURTEOUS Mr.  
:***

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**2 Syntax**

**PRE\_GIBI**

(

**UNITE\_GIBI**

=

/

**19**

,

**[DEFECT]**

/

**unilec**

,

**[I]**

**UNITE\_MAILLAGE**

=

/

**20**

,

**[DEFECT]**

/

**uniecr**

,

**[I]**

)

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**Code\_Aster** ®

**Version**

**7.4**

**Titrate:**

**Procedure PRE\_GIBI**

**Date:**

**08/02/05**

**Author (S):**

**Key COURTEOUS Mr.**

**:**

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**3 Operands**

**3.1 Operand**

**UNITE\_GIBI**

**UNITE\_GIBI = unilec**

**Logical number of the file of result of GIBI (reading), is worth 20 per defect what corresponds to mgib type in the interface astk.**

**3.2 Operand**

**UNITE\_MAILLAGE**

**UNITE\_MAILLAGE = uniecr**

**Logical number of the file grid Aster (writing), is worth 19 by defect which is also the defect LIRE\_MAILLAGE and corresponds to the email type of astk.**

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**Code\_Aster** ®

***Version***

***7.4***

***Titrate:***

***Procedure PRE\_GIBI***

***Date:***

***08/02/05***

***Author (S):***

***Key COURTEOUS Mr.***

***:***

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**Code\_Aster** ®

*Version*

7.4

*Titrate:*

*Operator LIRE\_MAILLAGE (FORMAT "MED")*

*Date:*

15/02/05

*Author (S):*

**COURTEOUS Mr., C. Key DURAND**

:

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*Organization (S): EDF-R & D /AMA*

***Instruction manual***

***U7.0- booklet: Data exchanges***

***Document: U7.01.21***

***Operator LIRE\_MAILLAGE (FORMAT "MED")***

***1 Goal***

*To see a grid in a file with format MED. The key words are extracted from the order LIRE\_MAILLAGE [U4.21.01]. As well as in a file with the format "ASTER", reading of one grid in a file with format MED, makes it possible to constitute a concept of the grid type.*

*MED (Modeling and Data exchanges) is a neutral format of data developed by EDF R & D and the ECA for the data exchanges between computer codes. The data which one can to exchange according to this format are the grids and the fields of results: fields with the nodes, fields*

*by element. Files MED are binary and portable files (being pressed on the library HDF, Hierarchical Dated Format). The reading of a file MED by LIRE\_MAILLAGE, allows to recover a grid produced by any other code able to create a file MED.*

*Version 2.2 of MED is used as well in reading as in writing of files MED for version 7.4 of Aster. However, team MED ensures the upward compatibility between the versions of MED.*

*One can convert a file med 2.1 into med 2.2 with the utility med\_import provided with med 2.2.*

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*Code\_Aster ®*

*Version*

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*Titrate:*

*Operator LIRE\_MAILLAGE (FORMAT "MED")*

*Date:*

*15/02/05*

*Author (S):*

*COURTEOUS Mr., C. Key DURAND*

*:*

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*2 Syntax*

*my [grid] = LIRE\_MAILLAGE*

(  
**UNIT**  
= / 20,  
**[DEFECT]**

**/I,**

**[II]**

**FORMAT**  
=/"**MED**",

**NOM\_MED =**  
**nomamd, [TXM]**

***INFO\_MED***

=

/

1,

***[DEFECT]***

/2,

***INFORMATION***

=

/

1,

***[DEFECT]***

/2,

)

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**Titrate:**

**Operator LIRE\_MAILLAGE (FORMAT “MED”)**

**Date:**

**15/02/05**

**Author (S):**

**COURTEOUS Mr., C. Key DURAND**

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**3 Operands**

**3.1 Operand**

**UNIT**

**UNIT = I**

**Logical number of unit of the file grid to the format med. The default value is 20 which is used for the format Aster.**

**Caution:**

**astk positions to 21 the number associated with a file with grid MED (standard mmed). It is necessary to take care of coherence.**

**3.2 Operand**

**FORMAT**

**FORMAT**

**=/“MED”**

*The operand **FORMAT** makes it possible to specify the format of the file to reading. Format “**MED**” means with*

*procedure **LIRE\_MAILLAGE** which the grid with reading is in a file with format **MED**.*

*As well as for a file with the format **ASTER**, the data read are:*

- the list of the nodes  
number, name, coordinated,*
- the list of the meshes  
number, name, type, name of the nodes,*
- the list of the groups of nodes  
number, name, a number of nodes, names of the nodes,*
- the list of the groups of meshes  
number, name, a number of meshes, names of the meshes.*

*Foot-note:*

*In a file **MED**, there is partition of the nodes and the meshes according to the groups. One partition corresponds to a family **MED**. In a file **MED**, the groups are distributed with centre of the families: families of nodes and families of meshes are thus found there. At the time of the reading of a file **MED**, the lists of the groups of nodes and meshes are made up with the flight by decomposition of the families.*

### **3.3 Operand NOM\_MED**

***NOM\_MED** = nomamd*

*A file **MED** can contain several grids. Each grid is located by its name. For to see a grid in particular, it is necessary to provide its name in argument of this key word **NOM\_MED**. In the absence of key word, the first grid found in the file will be read. It is the solution comfortable when it is known that the file contains only one grid.*

### **3.4 Operand INFO\_MED**

***INFO\_MED***

*=  
/  
1*

**[DEFECT]**

/ 2

*Level of impression in the file “MESSAGE”. This operand supplements the operand INFORMATION of order LIRE\_MAILLAGE and provides information specific to format MED.*

**INFO\_MED: 1**

*no impression*

**INFO\_MED: 2**

*impression in the file “MESSAGE”:*

*correspondence enters the families of file MED and the groups of nodes and meshes.*

**Note:**

*It frequently happens that the name of the grid printed by the library med comprises one nonASCII character what can corrupt the diagnosis posted by the follow-up of the jobs of astk (diagnosis “? ”).*

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**Operator LIRE\_MAILLAGE (FORMAT “MED”)**

**Date:**

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**3.5 Operand**

## ***INFORMATION***

***Level of impression.***

***If: INFORMATION: 2:***

- ***titrate grid,***
- ***a number of nodes,***
- ***numbers total meshes,***
- ***a number of meshes of each type,***
- ***a number of groups of nodes, names of the groups,***
- ***a number of groups of meshes, names of the groups,***
- ***impression of all the elements of each list:***

***list nodes***  
***number, name, coordinated,***  
***list meshes***  
***number, name, type, name of the nodes,***  
***list groups of nodes***  
***number, name, a number of nodes, names of the nodes,***  
***list groups of meshes***  
***number, name, a number of meshes, names of the meshes.***

### ***4 Example***

***GRID = LIRE\_MAILLAGE***

***(***  
***FORMAT***  
***=***  
***“MED”,***  
***UNIT***  
***=***  
***21,***  
***NOM\_MED =***  
***“MAILLAGE\_COMMUN”,***  
***INFO\_MED***



=  
2  
)

5  
***Which is the interest of format MED?***

***MED is a format of file for the data exchanges between codes. Any computer code having an interface MED is able to exchange information with any other code having this same interface.***

***The reading of a file MED by LIRE\_MAILLAGE makes it possible to recover a grid produced by one another code interfaced with MED. This format of data is in particular used for the exchanges of files of grids and results between ASTER and the tool of refinement of grid LOBSTER.***

***One can find documentation on the format of data MED on the code-aster.org site, produced page.***

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7.4***

***Titrate:  
Procedure PRE\_GMSH***

***Date:  
10/02/05  
Author (S):  
COURTEOUS Mr., NR. TARDIEU Key  
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***Organization (S): EDF-R & D /AMA***

***Instruction manual  
U7.0- booklet: Data exchanges  
Document: U7.01.31***

***Procedure PRE\_GMSH***

***1 Goal***

***To see a file of grid to format GMSH then to write it with the format Aster.  
GMSH is a tool of modelling, grid and post treatment diffused under licence GNU LPG with the  
address  
<http://www.geuz.org/gmsh/>.***

***Note:***

***The transformation of linear meshes into quadratic meshes is ensured by the order  
CREA\_MAILLAGE (cf [U4.23.02]).***

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Author (S):***

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## **2 Syntax**

**PRE\_GMSH**  
(

**UNITE\_GMSH**  
=  
/  
19,  
**[DEFECT]**  
/  
**unilec,**  
**[I]**

**UNITE\_MAILLAGE**  
=  
/  
20,  
**[DEFECT]**  
/  
**uniecr,**  
**[I]**

)  
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**3 Operands**

**3.1 Operand**

**UNITE\_GMSH**

**UNITE\_GMSH = unilec**

**Logical number of the file of result of GMSH (reading).**

**3.2 Operand**

**UNITE\_MAILLAGE**

**UNITE\_MAILLAGE = uniecr**

**Logical number of the file grid Aster (writing).**

**4 Use**

**The entities created by GMSH are not named but are not numbered.**

**All the groups of elements of numbers 1, 2,... created in GMSH (“physical”) are transformed in groups of meshes (GROUP\_MA) bearing name GM1, GM2,...**

*On the level of the interface astk, the file of grid produced by GMSH (which gives him the extension .msh)*

*is read again by PRE\_GMSH on the logical unit 19 per defect.*

*Normally, the data files of grid GMSH are of .geo type (i.e. files of geometry) while the files of grid are of .msh type.*

*Nevertheless, in the list of the tests of the code, the files of geometry are typified .datg and the files of grid .mgib. To find them, one can thus make a research on the site of Code\_Aster with words PRE\_GMSH or GMSH.*

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*Code\_Aster* ®

*Version*

*8.2*

*Titrate:*

*Operator LIRE\_RESU*

*Date:*

*31/01/06*

*Author (S):*

*J. PELLET, F. LEBOUVIER Key*

*:*

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*Organization (S): EDF-R & D /AMA, Delta CAD*

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*U7.0- booklet: Data exchanges*

**Document: U7.02.01**

**Operator LIRE\_RESU**

## **1 Goal**

**To see fields and to store them in a structure of data of the result type**

**The type of the format of the file read is: either universal format IDEAS, or format ENSIGHT, or it format MED.**

**Product a structure of data of the type result (evol\_noli, evol\_ther,...).**

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**Code\_Aster ®**

**Version**

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**Titrate:**

**Operator LIRE\_RESU**

**Date:**

**31/01/06**

**Author (S):**

**J. PELLET, F. LEBOUVIER Key**

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## **2 Syntax**

**general**

*resu = LIRE\_RESU (*

*# Choice of the format of the file to reading:*

*/FORMAT*

*= "IDEAS"*

*,*

*NOM\_CHAM*

*=*

*l\_nomch*

*,*

*[l\_Kn]*

*UNIT =/iunit,*

*[I]*

*/*

*19,*

*[DEFECT]*

*FORMAT\_IDEAS = \_F (...*

*# to see [§ 3.2.2])*

*/FORMAT*

*= "IDEAS\_DS58"*

*,*

*NOM\_CHAM*



```
=  
l_nomch  
,  
[l_Kn]  
REDEFI_ORIENT = (_F (  
CODE_DIR = /1,  
/2,  
/3,  
DIRECTION = (dx, Dy, dz), [l_R]  
NODE = l_no,  
[l_noeud]  
)),
```

```
/  
FORMAT  
=  
“ENSIGHT”  
,  
NOM_CHAM
```

```
=  
l_nomch  
,  
[l_Kn]  
NOM_FICHER  
=  
file,  
[KN]
```

```
/  
FORMAT  
=  
“MED”  
,
```

**UNIT =/iunit,**  
**[I]**  
**/**  
**81,**  
**[DEFECT]**

**FORMAT\_MED =**  
**(\_F (**

**NOM\_CHAM =**  
**nomch,**

**[KN]**

**NOM\_CHAM\_MED**  
**= nommed**

**,**  
**[KN]**

**NOM\_CMP = lcmp,**  
**[l\_Kn]**

**NOM\_CMP\_MED**  
**=**  
**lcmpmed,**  
**[l\_Kn]**

**NOM\_MAIL\_MED = nomamed,**

**[KN]**  
**),)**

*Is # Which structure of data necessary to create? :*

```
TYPE_RESU =  
/"EVOL_ELAS",  
/  
"EVOL_CHAR"  
,  
/  
"EVOL_THER"  
,  
/  
"EVOL_NOLI"  
,  
/  
"DYNA_TRANS"  
,  
/  
"DYNA_HARMO"  
,  
/  
"HARM_GENE"  
,  
/  
"MODE_MECA"  
,  
#
```

```
If  
TYPE_RESU=  
"EVOL_NOLI"  
:
```

```
NB_VARI=  
nbvar,  
[I]
```

#

**If**

**TYPE\_RESU=**

**“MODE\_MECA”**

**:**

**MATR\_A= matr\_rigi**

**,**  
**[matr\_asse\_DEPL\_R]**

**MATR\_B= matr\_mass**

**,**  
**[matr\_asse\_DEPL\_R]**

**# different information:**

**/GRID**

**=**

**my**

**,**

**[grid]**

/  
**MODEL**  
=  
**Mo**  
,  
*[model]*  
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Operator *LIRE\_RESU*

Date:

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Author (S):

**J. PELLET, F. LEBOUVIER** Key

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*# choice of the sequence numbers to reading:*

*/TOUT\_ORDRE = "YES"*

*, [DEFECT]*

*/*

*NUME\_ORDRE =*

*lordr*

*,*

*[l\_I]*

*/*

*LIST\_ORDRE =*

*lordr*

*,*

*[listis]*

/  
*INST*  
=  
*linst*  
,*[l\_R]*

/  
*LIST\_INST*  
=  
*linst*  
,*[listr8]*

/  
*FREQ*  
=  
*lfreq*  
,*[l\_R]*

/  
*LIST\_FREQ*  
=  
*lfreq*  
,*[listr8]*

/ *PRECISION*

=

/

*prec,*

[*R*]

/

*1.D-03*

,

[*DEFECT*]

/

*CRITERION =*

/

*“RELATIVE”*

,

[*DEFECT*]

/

*“ABSOLUTE”*

,

*TITRATE*

=

*l\_titre,*

[*l\_Kn*]



)

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*Author (S):*

***J. PELLET, F. LEBOUVIER*** *Key*

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### ***3 Operands***

#### ***3.1 Operands***

***FORMAT/UNIT/NOM\_FICHER***

***/FORMAT = “IDEAS” or “IDEAS\_DS58”***

***Reading of the file to format IDEAS.***

***UNIT***

***Logical number of unit of the file to universal format IDEAS, by defect 19.***

***/FORMAT = “MED”***

***Reading of the file to format MED.***

***UNIT***

*Logical number of unit of the file to format MED, by defect 81.*

*/FORMAT = "ENSIGHT"*

*Reading of files to the Enight format, relates to the reading of fields of pressure to the nodes and TYPE\_RESU is associated = "EVOL\_CHAR" and NOM\_CHAM = "NEAR".*

*NOM\_FICHER*

*File name (in small letters and between quotes) Enight of the type "Measured Results" (see Enight To use Manual pages 3-49, 3-50) containing in particular:*

*.  
the name of the file "Measured Geometry" containing of the numbers of followed nodes their co-ordinates,*

*.  
the name of (or of) the file (S) "Variable Scalar" containing the values of pressure with the nodes specified in the file "Measured Geometry".*

*Note:*

*The logical number of unit can be associated a file using the order  
DEFI\_FICHER [U4.12.03].*

### *3.2 Operands*

*if*

*FORMAT = "IDEAS"*

*The datasets 58 are not read (but only the datasets 55,57 and 2414)*

#### *3.2.1 Word*

*key*

*FORMAT\_IDEAS*

##### *3.2.1.1 Objective*

*The fields with reading in the universal file are written in the form of datasets. Each dataset is composed of a heading "indentivity card" and of a whole of values (results to the nodes or by element with the nodes). This indentivity card is made up of several recordings "record", composed of fields "field". The objective of this key word is to make it possible the user to define its clean "indentivity card" by specifying its own search criteria.*

**Note:**

*A certain number of “identity cards” are defined by defect [§6]. They can “to overload” by using key word **FORMAT\_IDEAS**.*

**3.2.1.2 Syntax**

**FORMAT\_IDEAS**

= (**\_F** (  
**NOM\_CHAM** =  
*nomch*, [*kN*]

**NUME\_DATASET**

= /55,  
/57,  
/2414,

/ **RECORD\_3** = *r3*,

[*l\_I*]

/  
**RECORD\_6**

=  
*r6*,  
[*l\_I*]

/  
**RECORD\_9**

=  
*r9*,  
[*l\_I*]

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**POSI\_ORDRE = Po,**

**[l\_I]**

**/POSI\_INST**

**= pi,**

**[l\_I]**

**/**

**POSI\_FREQ**

**=**

**PF,**

**[l\_I]**

***NOM\_CMP =  
lcmp,  
[l\_Kn]  
)***,

### ***3.2.1.3 Operands***

***NOM\_CHAM = nomch***

***Reference symbol of the field for which the user defines the search criteria. See the key word NOM\_CHAM out of the key words factors [§3.5.1].***

***NUME\_DATASET***

***=***

***Number of the dataset from which will be extracted the results:***

***.  
55  
: values with the nodes,***

***.  
57  
: values with the nodes by element***

***.  
2414: values***

***/ RECORD\_3***

***/ RECORD\_6***

***/ RECORD\_9***

***Each one of these key words is composed of the word RECORD and a number. The number indicates it number of the recording for which one will define the search criteria. Each operand allows to define to the maximum 10 whole values.***

***Ex:***

***RECORD\_6 = (1, 4, 9999, 8, 2, 6),***

***In this example, if the dataset read contains on the level of the recording n\*6 the values (1 4 9999 8 2 6), it will be retained for the continuation of research. Value 9999 is an allowing joker***

*to be unaware of the value read in the dataset.*

### ***/POSI\_ORDRE***

*Vector of two entreties allowing to locate the sequence number*

*V (1): N° of the recording*

*V (2): Position of the sequence number*

### ***/POSI\_INST***

*Vector of two entreties allowing to locate the moment*

*V (1): N° of the recording*

*V (2): Position of the moment*

### ***/POSI\_FREQ***

*Vector of two entreties allowing to locate the frequency*

*V (1): N° of the recording*

*V (2): Position of the frequency*

### ***NOM\_CMP***

*Name of the components to reading.*

*Ex: NOM\_CMP = (“DX”, “DY”, “DZ”, “XXX”, “DRX”, “XXX”, “DRZ”),*

*The character string “XXX” is a joker making it possible to be unaware of the component during the reading values.*

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***Code\_Aster*** ®

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***Titrate:***

***Operator LIRE\_RESU***

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**Author (S):**

**J. PELLET, F. LEBOUVIER** Key

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***If the number of CMPS to reading is higher than the number of CMPS present in the file .unv, those are ignored.***

***Important remark:***

***When a cham\_elem is read, this one is dimensioned in accordance with the finite elements model (see key word MODELS below). For example, if one reads a field of forced on a model 2D, the components carried by the elements will be SIXX, SIYY, SIXY and SIZZ. If in file IDEAS, one finds the CMPS: SIXX, SIZZ, SIXZ, CMPS SIXZ will be ignored. On the other hand, all CMPS not found in file (SIYY and SIXY in our example) will be put at zero.***

### **3.3 Operands**

***if***

***FORMAT = "IDEAS\_DS58"***

***Only the datasets 58 are read.***

***One reads only the fields corresponding to:***

***NOM\_CHAM= "DEPL", "QUICKLY", "ACCE", "SIEF\_NOEU", "EPSI\_NOEU\_DEPL".***

#### **3.3.1 Word**

***key***

***REDEFI\_ORIENT***

***This key word factor makes it possible to possibly redefine the significant direction of the sensor in some***

***points of measurement. This redefinition is treated currently only for NOM\_CHAM = "DEPL", "QUICKLY" and "ACCE". One redefines as many orientations as necessary. If this key word misses, one***

***adopt the usual convention recalled in the following table:***

***Code***

***"DEPL", "QUICKLY", "ACCE"***

***"SIEF\_NOEU"***

***"EPSI\_NOEU\_DEPL"***

***direction***

***1***

***DX SIXX***

***EPXX***

***2***

***DY SIYY***

***EPYY***

***3***

***DZ SIZZ***

***EPZZ***

***4***

***SIXY***

***EPXY***

***5***

***SIXZ***

***EPXZ***

***6***

***SIYZ***

***EPYZ***

### ***3.3.1.1 Operands***

***CODE\_DIR = /1,***

***/2,***

***/3,***

***Code describing the direction of measurement, given in the heading of the dataset 58***

***DIRECTION = (dx, Dy, dz),***

***Directing vector, expressed in the total reference mark, indicating the significant direction to associate***

***CODE\_DIR***

***NODE = l\_no,***

***List nodes where CODE\_DIR must be associated the directing vector DIRECTION.***

### ***3.4 Operands***

***if***

***FORMAT = "MED"***

#### ***3.4.1 Operand***

***NOM\_CHAM***

***NOM\_CHAM***

***= nomch,***



**Reference symbol of the field to reading. One can read the fields with the nodes a priori, the fields by elements with nodes (ELNO) or constant (ELEM). See key word NOM\_CHAM out of the key words factors [§3.5.1]**

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**Version**

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**Operator LIRE\_RESU**

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**Author (S):**

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### **3.4.2 Operand**

**NOM\_CHAM\_MED**

**NOM\_CHAM\_MED**

**= nommed,**

**Name according to convention MED of the field to reading in the file. It is a chain of 32 characters.**

### **3.4.3 Operands**

**NOM\_CMP, NOM\_CMP\_MED**

**NOM\_CMP = lcmp,**

**NOM\_CMP\_MED**

**=**

**lcmpmed,**

**These two lists must be of the same length. One reads in file MED the components listed in lcmpmed, then one affects them in the components within the meaning of Code\_Aster, of even row in the list lcmp.**

*The names of components MED are limited to 16 characters.*

*If these 2 lists miss, it is supposed that the names of the CMPS are the same ones for MED and for Aster.*

### **3.4.4 Operand**

**NOM\_MAIL\_MED**

*NOM\_MAIL\_MED = nomamed,*

*If this operand misses, one seeks the field related to the first grid in the file. It is it who does when the file contains one grid.*

*If the file contains several grids, one specifies here which is associated the field that one wants to see.*

## **3.5 Others operands**

### **3.5.1 Operands**

**TYPE\_RESU/NOM\_CHAM**

**TYPE\_RESU**

*Type of the structure of data result created.*

*NOM\_CHAM = l\_nomch*

*This key word is obligatory for all the formats safe for format MED where it is prohibited.*

*Reference symbol of the fields to reading. It is under this (or these names) that the fields will be stored in the structure of data result.*

*A priori, for format "IDEAS", one can read the fields with the nodes (NOEU) or constant by element (ELEM) or by nodes with elements (ELNO). For a type of structure of data result, the list of the possible fields is given in the documents of the booklet [U5].*

*For format "ENSIGHT", one can read only the fields of pressure ("NEAR") of the SD of the type evol\_char.*

*For format "IDEAS\_DS58", one does not treat for the moment the fields with the following nodes: displacement, speed, acceleration, constraint and deformation.*

### **3.5.2 Operand**

**NB\_VARI**

***NB\_VARI = nbvar,***

***A number of variables intern with reading for the fields of internal variables (VARI\_R).***

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### ***3.5.3 Operands***

***MATR\_A and MATR\_B***

***MATR\_A = matr\_rigi,***

***MATR\_B = matr\_mass,***

***When one reads again a concept of the mode\_meca type and that one wants to be useful oneself of this mode\_meca***

***in certain operators (for example PROJ\_MATR\_BASE), it is necessary that:***

- the mode\_meca produces reference the 2 matr\_asse (rigidity and mass) which was used for to calculate,***
- the fields of the mode\_meca are numbered same manner as the unknown factors of these 2 matr\_asse.***

***So that this coherent classification is established in LIRE\_RESU, these 2 key words should be used optional MATR\_A and MATR\_B (see for example the test sdnv102a).***

**Caution:**

*This possibility is available only to format “IDEAS”.*

**3.5.4 Operands****GRID/MODEL**

**/GRID =**

*my,*

*Grid on which one affects the fields read.*

**/**

**MODEL**

**= Mo,**

*Name of the model where are defined the types of finite elements affected on the grid. If one wants to see a cham\_elem, it is necessary to give the name of the model.*

**3.5.5 Operands**

**TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/INST/LIST\_INST/FREQ**

**/LIST\_FREQ/PRECISION/CRITERION**

*Selection in a structure of data result [U4.71.00].*

**3.5.6 Reading****MODE\_MECA**

*One can read clean modes stored with format IDEAS. But to be able to re-use them in operators of dynamics (in particular DYNA\_TRAN\_MODAL), one needs the assembled matrices (rigidity and mass) associated these modes. Key words MATR\_A and MATR\_B (pointing out those of MODE\_ITER\_SIMULT) make it possible to inform these two matrices.*

*Behind MATR\_A, one gives the name of the matrix of rigidity, behind MATR\_B that of the matrix of mass.*

**3.5.7 In connection with an alarm**

*It can happen that the values read on the file cannot be recopied in the fields of Produced SD\_RESULTAT. For example, a field of pressure existing on surface meshes, can be recopied on a model containing only elements 3D. In this case, the code emits one message of alarm resembling:*

**<A> <LIRE\_RESU> <LRCEME>**

**NONAFFECTED VALUES IN THE FIELD: 3699**  
**VALUES READ IN THE FILE: 3699**

### **3.5.8 Operand**

**TITRATE**

**TITRATE**

*Titrate that one wants to give to the result [U4.03.01].*

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### **4 Examples**

#### **4.1**

**Example 1: reading of a result of the type “dyna\_trans”**

**One reads on universal file IDEAS, the fields of displacement, speed and acceleration with moments 1. , 2. , 3. , 4. and 5. ,**

**resu = LIRE\_RESU**

**(FORMAT**

**= “IDEAS”**

**,**

**MODEL**

**=**

```
Mo,  
TYPE_RESU  
=  
“DYNA_TRANS”  
,  
NOM_CHAM  
=  
(  
“DEPL”  
,  
“QUICKLY”  
,  
“ACCE”  
),
```

**INST**

**= ( 1. , 2. , 3. , 4. , 5. ),**

**)**

#### ***4.2 Example 2: reading of a result of the type “evol\_noli” in defining the search criteria***

***One reads on universal file IDEAS, the internal fields of variables and deformations at the moment 15. by taking account of search criteria user.***

```
INIT =LIRE_RESU (MODEL
```

```
=  
Mo,
```

**FORMAT = "IDEAS",**  
**TYPE\_RESU**  
**=**  
**"EVOL\_NOLI"**  
**,**  
**NOM\_CHAM**  
**=**  
**("VARI\_ELNO", "EPSA\_ELNO"),**  
**NB\_VARI =**  
**2,**  
**INST**  
**=**  
**15.,**  
**FORMAT\_IDEAS= (\_F**  
**(NOM\_CHAM**  
**= "VARI\_ELNO",**  
**NUME\_DATASET**  
**=**  
**57,**  
**RECORD\_6**  
**=**  
**(1,4,3,9999,2,6),**  
**POSI\_ORDRE =**  
**(7,4,)**  
**POSI\_INST**  
**=**  
**(8**  
**1)**  
**NOM\_CMP =**  
**("V1", "V2", "V3", "V4",),),**

**\_F**  
**(NOM\_CHAM**  
**= "EPSA\_ELNO",**  
**RECORD\_6**  
**=**  
**(1,4,4,3,2,6),**

**NOM\_CMP =**  
**(“EPXX”, “XXX”, “EPZZ”,**  
**“EPXY”, “EPXZ”, “EPYZ”))),**

)  
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**Files IDEAS with reading**  
**-1**

**57% VALUES WITH THE NODES OF THE ELEMENTS**  
**ASTER 3.05.30 CONCEPT U CALCULATES IT - FIELD BY ELEMENT WITH THE NODES OF**  
**NAME**

**FIELD BY ELEMENT WITH THE NODES OF REFERENCE SYMBOL VARI\_ELNO\_ELGA -**  
**VARI\_1 (ELNO)**

**ASTER 3.05.30 CONCEPT U CALCULATES THE 29/12/95 A 09:56: 55 OF TYPE EVOL\_NOLI**  
**FIELD BY ELEMENT WITH THE NODES OF REFERENCE SYMBOL VARI\_ELNO\_ELGA**

**Record 6 1 4 3 0 2 6**

**Record 7 2 1 1 1 POSI\_ORDRE (7,4)**

**Record 8 0.15000E+02**

**POSI\_INST (8,1)**

**1 1 8.6% MESH MA2**



**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**2.07919E-05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**-1**  
**-1**

**57% VALUES WITH THE NODES OF THE ELEMENTS**

**ASTER 3.05.30 CONCEPT U CALCULATES IT - FIELD BY ELEMENT WITH THE NODES OF NAME**

**FIELD BY ELEMENT WITH THE NODES OF NAME SYMB - EPXX EPXY EPYY EPXZ EPYZ EPZZ (ELNO)**

**ASTER 3.05.30 CONCEPT U CALCULATES THE 29/12/95 A 09:56: 55 OF TYPE EVOL\_NOLI FIELD BY ELEMENT WITH THE NODES OF REFERENCE SYMBOL EPSA\_ELNO**

**1 4 4 3 2 6**

**2 1 1 1**

**0.15000E+02**

**1 1 8.6% MESH MA2**

**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00**  
**-1**

**4.3 Example 3: reading of a result of the type “evol\_ther” in defining the search criteria**

**One reads on universal file IDEAS, the field of temperature for moment 0.8 by taking account of search criteria user.**

**TEMP**

**=**

**LIRE\_RESU**

**(GRID = email,**

**UNIT**

**=**

**19,**

**FORMAT = "IDEAS",**

**TYPE\_RESU**

**=**

**"EVOL\_THER"**

**,**

**NOM\_CHAM**

**=**

**"TEMP",**

**INST**

**=**

**0.8,**

**FORMAT\_IDEAS**

**=\_F (**

**NOM\_CHAM**

**=**

**"TEMP"**

**,**

**NUME\_DATASET**

**=**

**2414,**

**RECORD\_3**

**=**

**(1),**

**RECORD\_9**

**=**

**(2,4,1,5,2,1),**

**POSI\_ORDRE =**

**(10,7),**

**POSI\_INST**

**=**

**(12,1),**

),

)

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**Operator LIRE\_RESU**

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**Author (S):**

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**2414**

**36**

**B.C. 0, TIME = 0.8, TEMPERATURE\_36**

**Record 3**

**1**

**ASTER 5.01.00 CONCEPT TEMPLE CALCULATES - FIELD WITH THE NODES OF...**

**FIELD WITH THE NODES OF REFERENCE SYMBOL TEMP - TEMP**

**ASTER 5.01.00 CONCEPT TEMPLE CALCULATES THE 18/12/98 A 15:19: 49 OF...**

**FIELD WITH THE NODES OF REFERENCE SYMBOL TEMP**

**SEQUENCE NUMBER: 35 INST: 8.00000E-01**

**Record 9**

**2 4 1 5 2 1**

**Record 10**

**-11 0 1 0 1 0 35 0**

**Record 11**

**1500 0**

**POSI\_ORDRE (10,7)**

**Record 12**

**8.00000E-01 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.**

**Record 13**

**0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.**

**1**

**POSI\_INST (12,1)**

**2.00000E+02**

**-----**

**205**

**1.00000E+02**

**-1**

#### **4.4 Example 4: reading of a result of the type "evol\_char" to the format "ENSIGHT"**

**One reads on file ENSIGHT all the fields of pressure**

**close = LIRE\_RESU**

**(FORMAT**

**= "ENSIGHT"**

**,  
NOM\_FICHER**

**=  
"face6.result"**

**,  
MODEL**

**=  
Mo,**

**TYPE\_RESU**

**=  
"EVOL\_CHAR"**

**,  
NOM\_CHAM**

**=  
"CLOSE"**

**,  
TOUT\_ORDRE =  
"YES"**

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*Files ENSIGHT with reading*

*FILE face6.result*

\*\*\*\*\*

*1*

*0*

*1*

*3*

*.50000E-03 .10000E-02 .15000E-02*

*1 1*

*face6.geom*

*presface6. \*\*\* pressure*

*FILE face6.geom*

\*\*\*\*\*

*File Ensignt measured geometry file  
particles coordinates*

*10*

*13 1.48000e+03-7.77010e+02  
7.42010e+02*

*14 1.48000e+03-7.77010e+02  
7.42010e+02*

*15 1.48000e+03-7.77010e+02  
7.42010e+02*

*16 1.48000e+03-7.77010e+02  
7.42010e+02*

*17 1.48000e+03-7.77010e+02  
7.42010e+02*

*18 1.48000e+03-7.77010e+02  
7.42010e+02*

*19 1.48000e+03-7.77010e+02  
7.42010e+02*

*20 1.48000e+03-7.77010e+02  
7.42010e+02*

*21 1.48000e+03-7.77010e+02  
7.42010e+02*

*22 1.48000e+03-7.77010e+02  
7.42010e+02*

*FILE presface6. \*\*\**

\*\*\*\*\*

*presface6.001*

*.10000E+00  
.10000E+00 .10000E+00 .10000E+00 .10000E+00  
.10000E+00  
.10000E+00 .10000E+00  
.10000E+00*

*presface6.002*

*.10000E+01  
.10000E+01 .10000E+01 .10000E+01 .10000E+01  
.10000E+01  
.10000E+01 .10000E+01*

**.10000E+01**

**presface6.003**

**.10000E+02**

**.10000E+02 .10000E+02 .10000E+02 .10000E+02**

**.10000E+02**

**.10000E+02 .10000E+02**

**.10000E+02**

**4.5**

**Example 5: reading of a evol\_ther to format MED**

**LIRE\_RESU (FORMAT = "MED", GRID = MA,**

**UNIT = 21, TOUT\_ORDRE = "YES", TYPE\_RESU = "EVOL\_THER",  
FORMAT\_MED**

**=  
\_F  
(  
NOM\_CHAM  
=  
TEMP,  
NOM\_CHAM\_MED  
=  
"THERDEP\_TEMP",  
)**

**)  
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Operator LIRE\_RESU

Date:

31/01/06

Author (S):

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**Appendix 1: FORMAT\_IDEAS: default values**

*In this paragraph, we present for each field (NOM\_CHAM) the search criteria per defect used to locate in the universal file the results to read.*

**CHAM\_NO**

**NOM\_CHAM**

**“DEPL” “QUICKLY” “ACCE” “TEMP”**

**NUME\_DATASET**

55 55 55 55

**RECORD\_3**

**RECORD\_6**

1 4 3 8 2 6

1 4 3 11 2 6 1 4 3 12 2 6

2 4 1 5 2 1

**RECORD\_9**

**POSI\_ORDRE**

7 4

7 4

7 4

7 4



***POSI\_INST***

8 1

8 1

8 1

8 1

***POSI\_FREQ***

***“DX” “DY”***

***“DX” “DY”***

***“DX” “DY”***

***“TEMP” “TEMP\_INF”***

***NOM\_CMP***

***“DZ” “DRX”***

***“DZ” “DRX”***

***“DZ” “DRX”***

***TEMP\_SUP***

***“DRY” “DRZ”***

***“DRY” “DRZ”***

***“DRY” “DRZ”***

***CHAM\_ELEM***

***NOM\_CHAM***

***“VARI\_ELNO” “EPSA\_ELNO”***

***“SIEF\_ELNO” “CLOSE”***

***NUME\_DATASET***

57 57

57 57

***RECORD\_3***

***RECORD\_6***

1 4 3 0 2 6

1 4 4 3 2 6

1 4 4 2 2 6 1 4 1 15 2 1

***RECORD\_9***

***POSI\_ORDRE***

7 4

7 4

7 4

7 4

***POSI\_INST***

8 1

8 1

8 1

8 1

***POSI\_FREQ***

***“V1” “V2”***

***“EPXX”***

***“SIXX”***

***“CLOSE”***

***NOM\_CMP***

***“V3” “V4”***

***“EPXY”***

***“SIXY”***

***“V5” “V6”***

***“EPYY”***

***“SIYY”***

***“EPXZ”***

***“SIXZ”***

***“V7” “V8”***

***“EPYZ”***

***“SIYZ”***

... ..

***“EPZZ”***

***“SIZZ”***

***“V9” “V30”***

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***Operator LIRE\_CHAMP***

***Date:***

***22/02/06***

***Author (S):***

***COURTEOUS Mr., G. Key NICOLAS***

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***Organization (S): EDF-R & D /AMA, SINETICS***

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***Document: U7.02.02***

***Operator LIRE\_CHAMP***

***1 Goal***

***To see a field in a file with format MED and to store it in a concept.***

***The field is indicated in the file by its name and possibly by a temporal parameter.***

*The produced concept is of the type corresponding to what was required.*

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***2 Syntax***

***champ\_lu = LIRE\_CHAMP (***

***FORMAT***

***=***

***“MED”***

***,***

***[DEFECT]***

***TYPE\_CHAM***

***=/“NOEU\_TEMP\_R”***

***,***

***[TXM]***

***/***

***“NOEU\_DEPL\_R”***

***,***

***[TXM]***

***/***

*etc*

...

**GRID**

=

*my*

,

*[grid]*

*[K]*

**NOM\_MED**

=

*nommed*

,

*[TXM]*

*# Selection of the temporal parameter*

/

**NUME\_ORDRE**

=

*order*

,

*[I]*

/

**NUME\_PT**

=

*not*

*of*

*time*

,

*[I]*

/

**INST**

=

*inst,*

*[R]*

**I PRECISION**

=

/

**PREC,**

**[R]**

/  
**1.0E-3, [DEFECT]**

**I CRITERION =/"RELATIVE", [DEFECT]**

**/"ABSOLUTE",**

*# Choice of the components to reading: the same ones as the field in ASTER*

*or a precise list*

**/NOM\_CMP\_IDEM**  
**= "YES",**

**[TXM]**

/  
**NOM\_CMP =**  
**lcmp,**  
**[l\_TXM]**

**NOM\_CMP\_MED**  
**=**

*lcmpmed,*  
*[l\_TXM]*

*NOM\_MAIL\_MED*

=  
*nomamed*

,  
*[TXM]*

*UNIT*

=/  
*unit*

,  
*[I]*

/  
*81*

,  
*[DEFECT]*

*INFORMATION =*

/  
*1*

,  
*[DEFECT]*

/  
*2*

,  
)

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### **3 Operands**

#### **3.1 Operand**

##### **FORMAT**

**FORMAT = "MED"**

*Choice of the format of the file containing the field with reading.*

*Note:*

*Only format MED is operational today.*

#### **3.2 Operand**

##### **TYPE\_CHAM**

**TYPE\_CHAM =**

**/"NOEU\_TEMP\_R",**

**/**

**"NOEU\_DEPL\_R"**

**,**

**/**

**etc**

**...**

*One indicates the type of the concept here to be produced. The name of the type is built with logic usual Code\_Aster. The first 4 characters are "NOEU", "ELEM", "ELNO" or "ELGA". One find "\_ then". The following sequence defines the type of field: "TEMP", "DEPL", "SIEF", etc... the name ends in "\_R", "\_F" or "\_C" according to the data-processing type of the values.*

*Example: "NOEU\_TEMP\_R", "NOEU\_DEPL\_R", "ELGA\_SIEF\_R" etc...*

*Caution:*

*There is no consistency check! One can create a concept temperature very well in*

*reading again a field which was a displacement with the writing of the file.*

**Note:**

*It can happen that values read in the file are not affected in the field final. For example, if one reads a field of pressure on elements TETRA4 whereas it must be affected on meshes of edge (because it is its nature), one will be informed by this type of alarm:*

**<A> <LIRE\_RESU> <LRCEME>**

**NONAFFECTED VALUES IN THE FIELD: 3699**

**VALUES READ IN THE FILE: 3699**

### **3.3 Operand**

#### **GRID**

**GRID = my**

*Name of the grid ASTER on which the field with reading will be expressed.*

### **3.4 Operand**

#### **NOM\_MED**

**NOM\_MED**

**=**

**nommed**

*Name according to convention MED of the field to reading in the file. It is a chain of 32 characters.*

### **3.5**

#### **Selection of the temporal parameter**

*If the field were written in the file without reference to a temporal parameter, nothing is to be mentioned*

*in this reading command. If not it is necessary to specify about which moment it is. That is done by designation of, a step sequence number of time or a one moment value of filing. To refer with the document [U4.71.00] for the details on these key words.*

### **3.6 Operand**

#### **NOM\_CMP\_IDEM**

**/NOM\_CMP\_IDEM = "YES"**

*Indicate that one must read in file MED the components whose same name appears in the list of the components of the field within the meaning of Code\_Aster.*

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**Code\_Aster** ®

**Version**

**8.2**

**Titrate:**

**Operator LIRE\_CHAMP**

**Date:**

**22/02/06**

**Author (S):**

**COURTEOUS Mr., G. Key NICOLAS**

**:**

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### **3.7 Operands**

**NOM\_CMP, NOM\_CMP\_MED**

**/NOM\_CMP = lcmp**

**,**

**NOM\_CMP\_MED = lcmpmed**

**,**

**These two lists must be of the same length. One reads in file MED them components listed in lcmpmed, then one affects them in the components to the direction of Code\_Aster, of the same row in the list lcmp.**

### **3.8 Operand**

**NOM\_MAIL\_MED**

**NOM\_MAIL\_MED = nomamed**

**If this operand misses, one seeks the field related to the first grid in the file. It is it who does when the file contains one grid.**

**If the file contains several grids, one specifies here which is associated the field that one wants to see.**

### **3.9 Operand UNIT**

**UNIT**  
**= unit**

**Number of the logical unit of the file, corresponds to the value provided in astk or while using order DEFI\_FICHER.**

### **3.10 Operand INFORMATION**

**INFORMATION =/1**

**,**  
**/**  
**2**  
**,**

**If INFORMATION is worth 2, some impressions of débogage take place.  
If not, nothing takes place**

### **4 Example**

**tempdeux = LIRE\_CHAMP (  
GRID  
=  
mdeux,  
NOM\_MED =  
"RESUUN\_TEMP",  
NUME\_ORDRE =  
2,  
TYPE\_CHAM  
=  
"NOEU\_TEMP\_R",**

)

*This order will create a field with the nodes of tempdeux name and type NOEU\_TEMP\_R. grid support is mdeux. The values are those stored under name RESUUN\_\_TEMP in file MED provided on unit 81 with the sequence number 2.*

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*Code\_Aster* ®

*Version*

*7.4*

*Titrate:*

*Operator LIRE\_TABLE*

*Date:*

*07/01/05*

*Author (S):*

*C. Key DURAND*

*:*

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*Organization (S): EDF-R & D /AMA*

*Instruction manual*

*U7.0- booklet: Data exchanges*

**Document: U7.02.03**

**Operator LIRE\_TABLE**

**1 Goal**

**To see a file containing a table.**

**This order only makes it possible to read a table written in a file under the format ASTER.**

**This file can come from a IMPR\_TABLE to the format ASTER or perhaps a modified unspecified file so as to give him the characteristics obligatory of the format ASTER.**

**Product a concept of the type counts.**

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**Code\_Aster ®**

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**Titrate:**

**Operator LIRE\_TABLE**

**Date:**

**07/01/05**

**Author (S):**

**C. Key DURAND**

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## 2 Syntax

***Tb [table] = LIRE\_TABLE (***

***UNIT = ific, [I]***

***FORMAT = "ASTER", [DEFECT]***

***NUME\_TABLE***

***= / 1 ,***

***[DEFECT]***

***/***

***nume***

***,***

***[I]***

***TYPE\_TABLE =/"TABLE", [DEFECT]***

***/"TABL\_POST\_RELE"***

***,***

***[K]***

*/"TABL\_POST\_ALEA"*

,

*/"TABL\_POST\_USUR"*

,

*/"TABL\_CARA\_GEOM"*

,

*SEPARATOR = sep,*

*[K]*

*TITRATE*

=

*titrate,*

*[l\_K]*

)

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*Version*

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*Titrate:*

*Operator LIRE\_TABLE*



**Date:**  
**07/01/05**  
**Author (S):**  
**C. Key DURAND**  
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### **3 Operands**

#### **3.1 Operand** **UNIT**

*Logical number of unit of the file containing the tables with reading.*

#### **3.2 Operand** **FORMAT**

*Name of the format under which the table of the file was written. Only the format ASTER is authorized. These characteristics are illustrated by the following table:*

**#DEBUT\_TABLE**  
**#TITRE aster 6.03.01 concept S1\_G of the type**  
**#TITRE TABL\_POST\_RELE**  
**ENTITLW WAY SEGMENT**  
**RESU NOM\_CHAM**  
**INST**  
**SIXX**  
**K8**  
**K16 I**  
**K8 K16**  
**R**  
**R**  
**TOTAL**  
**CHEM1**  
**1 SIG SIGM\_ELNO\_DEPL 0.00000E+00 1.48981E+07**  
**TOTAL**  
**CHEM1**  
**- SIG**  
**-**  
**1.00000E+00 2.48981E+07**

**TOTAL**  
**CHEM1**  
**2 SIG SIGM\_ELNO\_DEPL 1.00000E+00 3.48981E+07**

...

**#FIN\_TABLE**

*Any table with the format ASTER begin with the key word #DEBUT\_TABLE and ends in #FIN\_TABLE.*

*In fact the limitations make it possible to know where the reading starts and where it stops. #DEBUT\_TABLE is then followed by lines of titles which are obligatorily preceded by the word key #TITRE.*

*Follow then a line containing all the names of the parameters, then a line containing all them types of these parameters. These types belong obligatorily to the following list: K8, K16, K24, K32, K80, I, R.*

*The following lines give the value of all the parameters.*

*Among the values one can find (-), who means that there is no value for this parameter.*

### **3.3 Operand**

**NUME\_TABLE**

*It is possible to read a table among several in a file. The number of the ième table is indicated with reading. By defect, the first table with the format ASTER will be read.*

### **3.4 Operand**

**TYPE\_TABLE**

*This key word makes it possible to typify the table, for the orders using this information. The default value is "TABLE".*

### **3.5 Operand**

**SEPARATOR**

*Several consecutive separators count only for one. One needs a separator before the first column and after the last.*

### **3.6 Operand**

**TITRATE**

*Titrate attached to the concept produced by this operand [U4.03.01].*

*This title is added to the title already present in the table read.*

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*Titrate:*

*Operator LIRE\_TABLE*

*Date:*

*07/01/05*

*Author (S):*

*C. Key DURAND*

*:*

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*4 Examples*

*The orders which follow are extracted from case-test ZZZZ128B.*

*4.1*

*Creation of a table to the format "ASTER" with IMPR\_TABLE*

*In this example, one writes to several tables with the format "ASTER" in a file.*

*TT=POST\_RELEVE\_T (ACTION=\_F (ENTITLES = "RESU\_U2",*

*NODE = ("B", "It", "Of", "E", "F"),*

*RESULT = U2,*

*NOM\_CHAM = "DEPL",*

*TOUT\_ORDRE = "YES",*

*TOUT\_CMP = "YES",*

*OPERATION = "EXTRACTION"))*

*IMPR\_TABLE (UNITE=37,*

*TABLE=TT,*

*FORMAT=' ASTER')*

**IMPR\_TABLE (UNITE=37,  
TABLE=TT,  
FORMAT=' ASTER',  
NOM\_PARA= ("NODE", "INST", "ABSC\_CURV",  
"DX", "DY", "DZ", "DRX"),  
)**

#### **4.2**

**Reading of tables to the format "ASTER" with LIRE\_TABLE**

**TT2=LIRE\_TABLE (UNITE=37,  
FORMAT=' ASTER',  
NUME\_TABLE=1,  
SEPARATEUR=' ',  
TYPE\_TABLE=' TABL\_POST\_USUR',  
TITRE=' VALIDATION OF LIRE\_TABLE',)**

**TT\_RED=LIRE\_TABLE (UNITE=37,  
FORMAT=' ASTER',  
NUME\_TABLE=2,  
SEPARATEUR=' ',  
TYPE\_TABLE=' TABL\_POST\_RELE',  
TITRE=' VALIDATION OF LIRE\_TABLE',  
)**

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**Code\_Aster** ®

*Version*

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*Titrate:*

*Operator LIRE\_PLEXUS*

*Date:*

19/01/05

*Author (S):*

**S. POTAPOV, J.M. PROIX** *Key*

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*Organization (S): EDF-R & D /AMA*

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***Document: U7.02.11***

***Operator LIRE\_PLEXUS***

## ***1 Goal***

***To see the file of results to format IDEAS produced by software EUROPLEXUS.***

***Allows to recover a transitory field of fluid pressure in a piping calculated using one telegraphic hydrodynamic model (plane waves) of PLEXUS. The constant field of pressure definite by element in calculation EUROPLEXUS is projected on a mechanical grid correspondent of Code\_Aster using the elements hulls (DKT or COQUE\_3D) and/or PIPE.***

***Product a concept of the evol\_char type.***

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***Titrate:***

***Operator LIRE\_PLEXUS***

***Date:***

***19/01/05***

***Author (S):***

***S. POTAPOV, J.M. PROIX Key***

***:***

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## ***2 Syntax***

***presplex [evol\_char] = LIRE\_PLEXUS***

***(UNIT***

***=***

/  
***iunit,***  
***[I]***  
/  
***19,***  
***[DEFECT]***  
***FORMAT***  
=  
***“IDEAS”,***  
***[DEFECT]***

***MAIL\_PLEXUS***  
=  
***mplexus,***  
***[GRID]***

***GRID***  
=  
***master, [GRID]***

***MODEL***  
=  
***modaster,***  
***[MODEL]***

***/TOUT\_ORDRE = “YES”,***

/  
**NUME\_ORDRE =**  
**lordre, [L\_I]**

/  
**LIST\_ORDRE =**  
**lenti,**  
**[LISTIS]**

/  
**INST =**  
**linst,**  
**[L\_R]**

/  
**LIST\_INST**  
**=**  
**linst,**  
**[LISTR8]**

**/ PRECISION**  
**=**  
**/**  
**prec,**  
**[R]**



/  
**1.D-03, [DEFECT]**

**/ CRITERION =/"RELATIVE", [DEFECT]**

/  
**"ABSOLUTE",**

**TITRATE**  
**=**  
**l\_titre,**  
**[L\_KN]**

)

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**Operator LIRE\_PLEXUS**

**Date:**

**19/01/05**

**Author (S):**

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**3 Operands**

**3.1 Operands**

**FORMAT/UNIT**

**FORMAT = "IDEAS"**

**Reading of the file to format IDEAS.**

**UNIT = iunit**

**Logical number of unit of the file to universal format IDEAS, by defect 19.**

**3.2 Operand**

**MAIL\_PLEXUS**

**MAIL\_PLEXUS = mplexus**

**Telegraphic hydrodynamic grid of EUROPLEXUS on which one reads the field of pressure function time.**

**3.3 Operand**

**GRID**

**GRID = master**

**Grid for the calculation of Code\_Aster on which one projects the field of pressure read.**

**3.4 MODEL operand**

**MODEL = modaster**

**Name of the model where are defined the types of finite elements affected on the grid of Code\_Aster.**

### **3.5 Operands**

**TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/INST/  
LIST\_INST/PRECISION/CRITERION**

**Selection in a structure of data result [U4.71.00].**

### **3.6 Operand**

**TITRATE**

**TITRATE = l\_titre**

**Titrate that one wants to give to the result [U4.03.01].**

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**Titrate:**

**Operator LIRE\_PLEXUS**

**Date:**

**19/01/05**

**Author (S):**

**S. POTAPOV, J.M. PROIX Key**

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### **4 Examples**

#### **4.1**

**Example: reading of a grid EUROPLEXUS**

**One reads on universal file IDEAS (logical unit 19) the telegraphic hydrodynamic grid of EUROPLEXUS and one transform it with the format of Code\_Aster written on the unit 22. Grid EUROPLEXUS with the format of Code\_Aster then is read again and placed in the concept of the type**

*grid.*

*PRE\_IDEAS (UNITE\_IDEAS=19, UNITE\_MAILLAGE=22)  
mplexus = LIRE\_MAILLAGE (UNITE=22,)*

## 4.2

*Example: creation of a result of the type “evol\_char”*

*One reads on universal file IDEAS the fluid field of pressure function of time. This field, definite on the telegraphic hydrodynamic grid of EUROPLEXUS (with the format of Code\_Aster), is then projected on the mechanical grid of Code\_Aster for every moment of definition.*

*presplex = LIRE\_PLEXUS (UNIT*

*= 19,  
FORMAT  
=  
“IDEAS”,  
MAIL\_PLEXUS  
=  
mplexus,  
GRID  
=  
master,  
MODEL  
=  
modaster,  
TOUT\_ORDRE =  
“YES”,*

*)*

## 4.3

*Example: use of the result of the type “evol\_char”*

*The concept “evol\_char” previously definite is used under key word PRES\_CALCULEE for to manufacture a loading.*

*tank = AFFE\_CHAR\_MECA (MODEL = modaster,*

*...*

*PRES\_CALCULEE*

*= presplex,*

*)*

*Other examples of use of operator LIRE\_PLEXUS can be consulted in the files orders of the case-test ZZZZ112, modelings A, B, C [V1.01.112].*

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*Code\_Aster* ®

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*Titrate:*

*Operator LIRE\_MISS\_3D*

*Date:*

*01/02/05*

*Author (S):*

*G. DEVESA Key*

*:*

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*Organization (S): EDF-R & D /AMA*

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***Operator LIRE\_MISS\_3D***

### ***1 Goal***

***To restore on physical basis a harmonic or transitory answer resulting from MISS3D.***

***The base of projection of base\_modale type is extracted starting from a concept macr\_elem\_dyna.***

***The data of the computer code of interaction ground-structure MISS3D are provided by the operator IMPR\_MISS\_3D [U7.04.11].***

***Product a result of the dyna\_harmo type (respectively dyna\_tran) according to whether evolution in generalized co-ordinates is harmonic (respectively transitory).***

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***Titrate:***

***Operator LIRE\_MISS\_3D***

***Date:***

***01/02/05***

**Author (S):**

**G. DEVESA Key**

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**2 Syntax**

**evol [\*] = LIRE\_MISS\_3D (**

**MACR\_ELEM\_DYNA**

**=**

**macro\_dyna,**

**[macr\_elem\_dyna]**

**TYPE\_RESU**

**=**

**/**

**“TRANS”,**

**[DEFECT]**

**/**

**“HARMO”,**

**UNIT**

**=**

**/**

**links,**

**[I]**

/  
27,  
**[DEFECT]**

**NAME**  
=  
**name**  
,  
**[KN]**  
**TITRATE**  
=  
**titrate,**  
**[l\_Kn]**

)

**If TYPE\_RESU = "TRANS" then [\*] = dyna\_tran**  
**If TYPE\_RESU = "HARMO" then [\*] = dyna\_harmo**  
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**Titrate:**  
**Operator LIRE\_MISS\_3D**

**Date:**



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**Author (S):**

**G. DEVESA Key**

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### **3 Operands**

#### **3.1 Operand**

**MACR\_ELEM\_DYNA**

**MACR\_ELEM\_DYNA = macro\_dyna**

*Name of the concept macr\_elem\_dyna with which is associated the modal base, made up of modes clean and static modes, for the restitution in physical base of the evolution in co-ordinates generalized read with the format of code MISS3D.*

#### **3.2 Operand**

**TYPE\_RESU**

**TYPE\_RESU**

*Indicate the type of the evolution in generalized co-ordinates resulting from MISS3D.*

*“TRANS”: transitory evolution (actual values)*

*“HARMO”: harmonic evolution (complex values)*

#### **3.3 Operand**

**UNIT**

**UNIT = links**

*Logical number of unit for the reading with the format of code MISS3D of an evolution in generalized co-ordinates.*

#### **3.4 Operand**

**NAME**

**NAME = name**

*Name in the temporary repertory of calculation of the evolution in generalized co-ordinates read with format of code MISS3D. This operand is necessary only for calculations without*

*continuation on a basis of data where launching of calculation by MISS3D by means of macro-order MACRO\_MISS\_3D [U7.03.11] is followed in the same data file by the call to LIRE\_MISS\_3D.*

*In this case, name arises in the form “nom\_proj.0i.type\_resu” where respectively:*

.  
*nom\_proj is the name of the draft study defined by the operand PROJECT of MACRO\_MISS\_3D,*

.  
*0i is an indication of result of MISS3D corresponding to the ième occurrence of IMPR\_MISS\_3D,*

.  
*type\_resu is worth respectively “you for a transitory evolution and “H” for one harmonic evolution.*

### **3.5 Operand TITRATE**

**TITRATE = title**

*Allows the user to document the evolution restored on the physical basis.*

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**Date:**

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*Operator LIRE\_IMPE\_MISS*

*Date:*

*31/01/06*

*Author (S):*

*G. DEVESA Key*

*:*

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*Organization (S): EDF-R & D /AMA*

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***Operator LIRE\_IMPE\_MISS***

## ***1 Goal***

***To build an assembled matrix projected on a basis of RITZ starting from a file of impedances of ground calculated by software MISS3D. The projected matrix result will be used by the operator of harmonic calculation in generalized components DYNA\_LINE\_HARM [U4.53.11]).***

***Product a concept generalized vector of matr\_asse\_gene\_C type.***

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***Titrate:***

***Operator LIRE\_IMPE\_MISS***

***Date:***

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**Author (S):**

**G. DEVESA Key**

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**2 Syntax**

***matgene [matr\_asse\_gene\_C] = LIRE\_IMPE\_MISS***

**(BASE**

**=**

**Ba,**

**[base\_modale]**

***NUME\_DDL\_GENE***

=

***nu\_gene,***  
***[nume\_ddl\_gene]***

***FREQ\_EXTR***

=

***freq,***  
***[R]***

***UNITE\_RESU\_IMPE***

***=/uresimp, [I]***

/

***30,***  
***[DEFECT]***

)

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Operator *LIRE\_IMPE\_MISS*

Date:

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Author (S):

**G. DEVESA** Key

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### **3 Operands**

#### **3.1 Operand**

**BASE**

**BASE = Ba**

*Concept of the base\_modale type which contains the vectors defining the subspace of projection.*

#### **3.2 Operand**

**NUME\_DDL\_GENE**

**NUME\_DDL\_GENE = nu\_gene**

*Generalized classification built on the basis Ba.*

#### **3.3 Operand**

**FREQ\_EXTR**

**FREQ\_EXTR = freq**

*Actual value of the frequency of extraction of the matrix of impedance of ground.*

#### **3.4 Operand**

**UNITE\_RESU\_IMPE**

***UNITE\_RESU\_IMPE = uresimp***

***Logical unit of the matrix of impedance of ground calculated by MACRO\_MISS\_3D option  
MISS\_IMPE.***

***This matrix can either be already calculated and given like entry in the profile of study, or  
result of MACRO\_MISS\_3D in the same command file.***

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***Titrate:***

***Operator LIRE\_IMPE\_MISS***

***Date:***

***31/01/06***

***Author (S):***

***G. DEVESA Key***

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*Titrate:*

*Operator LIRE\_FORC\_MISS*

*Date:*

*31/01/06*

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*G. DEVESA Key*

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## ***Operator LIRE\_FORC\_MISS***

### ***1 Goal***

***To build an assembled vector projected on a basis of RITZ starting from a file of seismic forces of ground calculated by software MISS3D. The vector projected result will be used by the operator of calculation***

***harmonic in generalized components DYNA\_LINE\_HARM [U4.53.11]).***

***Product a concept generalized vector of vect\_asse\_gene\_C type.***

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### ***2 Syntax***

***vecgene [vect\_asse\_gene\_C] = LIRE\_FORC\_MISS***

**(BASE**

=

**Ba,**

**[base\_modale]**

**NUME\_DDL\_GENE**

=

**nu\_gene,**

**[nume\_ddl\_gene]**

**FREQ\_EXTR**

=

**freq,**

**[R8]**

**UNITE\_RESU\_FORC**

**=/uresfor, [I]**

**/**

**30,**

**[DEFECT]**

**NOM\_CHAM =/"DEPL", [DEFECT]**

**/**

**"QUICKLY",**

**/**

**"ACCE",**

**NOM\_CMP**

**=**

**/**

**"DX",**

**/**

**"DY",**

**/**

**"DZ",**

**)**

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### **3 Operands**

#### **3.1 Operand**

**BASE**

**BASE = Ba**

**Concept of the base\_modale type which contains the vectors defining the subspace of projection.**

#### **3.2 Operand**

**NUME\_DDL\_GENE**

**NUME\_DDL\_GENE = nu\_gene**

**Generalized classification built on the basis Ba.**

#### **3.3 Operand**

**FREQ\_EXTR**

**FREQ\_EXTR = freq**

**Actual value of the frequency of extraction of the seismic forces of ground.**

### **3.4 Operand**

**UNITE\_RESU\_FORC**

**UNITE\_RESU\_IMPE = uresfor**

*Logical unit of the file of the seismic forces of ground previously calculated by MISS3D with MACRO\_MISS\_3D in postprocessing and data like entry in the profile of study.*

### **3.5 Operand**

**NOM\_CMP**

**NOM\_CMP =**

**/**

**“DX”,**

**/**

**“DY”,**

**/**

**“DZ”,**

*Name of the component corresponding to a direction of incidental seismic field.*

### **3.6 Operand**

**NOM\_CHAM**

**NOM\_CMP =**

**/**

**“DEPL”,**

**/**

**“QUICKLY”,**

**/**

**“ACCE”,**

*Field name giving the nature of the unit incidental seismic field imposed (for example “ACCE” if imposed unit acceleration).*

.

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## ***1 Goal***

***To adapt a grid with the software LOBSTER.***

***This operation is placed after the first calculation on a formed grid of segments, mesh-points, triangles, quadrangles, tetrahedrons. An indicator of the error will have been calculated. According to its value***

***net by mesh, the software LOBSTER will modify the grid. It is also possible to interpolate fields with the nodes or constant by elements of the old grid towards the new one.***

***One can connect calculation and adaptation progressively process of improvement of calculation. However, this process cannot be stopped then begun again by a “CONTINUATION”. All must have place on the way.***

***The software LOBSTER is presented on the site:***

***<http://www.code-aster.org/outils/homard>***

***One finds a description of the technique used there to modify the grids as well as examples.***

***More on LOBSTER, one can refer to the documents quoted in bibliography.***

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## ***2 Syntax***

***MACR\_ADAP\_MAIL (***

*# characteristic of the adaptation*

*ADAPTATION =*

*\_F (*

*# choice of the type of adaptation*

*/FREE =/"RAFF\_DERA"*

*/*

*"REFINEMENT"*

*/*

*"DERAFFINEMENT"*

*/UNIFORM =/"REFINEMENT"*

*/*

*"DERAFFINEMENT"*

*/*

*"NOTHING"*

*# grid to be modified*

*MAILLAGE\_N = man*

*[grid]*

*# new grid*

*MAILLAGE\_NP1*

*=*

*Co*

*(manp1) [K8]*

*# If the adaptation is free*

## *# choice of the structure containing the indicator*

/  
**RESULTAT\_N =**  
*resun*  
*[evol\_elas]*  
*[evol\_thme]*  
*[evol\_noli]*  
*[evol\_ther]*

**INDICATOR =**  
*indic*  
*[K16]*

/  
**CHAM\_GD =**  
*cham\_gd\_i*  
*[cham\_gd]*

**NOM\_CMP\_INDICA = cmp**  
*[K8]*

## *Selection of the temporal parameter*

/  
**NUME\_ORDRE**

=  
*order*  
*[I]*

/  
**INST**

=  
*moment*  
*[R]*

**I PRECISION**

=

/  
*prec*  
[R]  
/  
*1.0E-3*  
[DEFECT]

*I CRITERION =/“RELATIVE”*  
[DEFECT]  
/  
“ABSOLUTE”

#  
*If*  
*refinement*

*/CRIT\_RAFF\_PE*  
*= crp*  
[R]

/  
*CRIT\_RAFF\_REL*  
*=*  
*crr*  
[R]

/  
*CRIT\_RAFF\_ABS*  
*=*  
*CRA*  
[R]

# *Finsi*  
#  
*If*  
*déraffinement*

*/CRIT\_DERA\_PE*

= *cdp*

[R]

/

*CRIT\_DERA\_REL*

=

*cdr*

[R]

/

*CRIT\_DERA\_ABS*

=

*half-value layer*

[R]

*# Finsi*

*# Finsi*

*# If refinement, free or uniform*

*NIVE\_MAX*

=

*nivmax*

[I]

*# Finsi*

*# So déraffinement, free or uniform*

*NIVE\_MIN*

=

*nivmin*

[I]

*# Finsi*

)

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*# Followed by a border*

*MAILLAGE\_FRONTIERE*

=

*maf*

*[grid]*

*GROUP\_MA*

=

*l\_grma [l\_gr\_maille]*

*# Updated of fields on the new grid*

*MAJ\_CHAM = \_F (*

*# choice of the structure containing the field to be updated*

*/*

*RESULT*

=

*resu*

*[evol\_elas]*

*[evol\_thme]*

*[evol\_noli]*

*[evol\_ther]*

*NOM\_CHAM*

=

*nomsymb [K16]*

/

*CHAM\_GD =*

*cham\_gd [cham\_gd]*

*Selection of the temporal parameter*

/

*NUME\_ORDRE*

=

*order*

*[I]*

/

*INST*

=

*moment*

*[R]*

*I PRECISION*

=

/

*prec*

*[R]*

/

*1.0E-3*

*[DEFECT]*

*I CRITERION =/"RELATIVE"*

*[DEFECT]*

/

*"ABSOLUTE"*

*CHAM\_MAJ*

=

*Co*

*(chpmaj)*

*[K8]*

*TYPE\_CHAM*

=/“*NOEU\_TEMP\_R*”

/“*NOEU\_DEPL\_R*”

/

*etc*

...

)

*NON\_SIMPLEXE* =/0

/1

/

2

*[DEFECT]*

*NUMBERS*

=

/

“*YES*”

*[DEFECT]*

/

“*NOT*”



*QUALITY* =/"YES"

/

"NOT"

[DEFECT]

*CONNEXITY*

=/"YES"

/

"NOT"

[DEFECT]

*CUT*

=

/

"YES"

/

"NOT"

[DEFECT]

*INTERPENETRATION*

=/"YES"

/

"NOT"

[DEFECT]

*LANGUAGE*

=

/

"FRENCH" [DEFECT]

"FRENCH"

"ENGLISH"

"ENGLISH"

*VERSION\_HOMARD* =/"V7\_7"

[DEFECT]

/

"V7\_N"

/

"V7\_N\_PERSO"

*INFORMATION* =/1 [DEFECT]

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### **3**

#### ***Description of an adaptation of grid***

#### **3.1**

##### ***Diagram general of an adaptation***

*The principle of a calculation with adaptation of grid is as follows:*

*Phase 1:*

*Reading of the initial grid,  $m_0$*

*Definition of materials*

*Phase 2:*

*·*  
*definition of the model, the loadings on this grid  $m_0$*

*·*  
*mechanical calculation producing a  $resu_0$  result*

*·*  
*calculation of an indicator of error,  $ERR_0$*

*This initial phase is the standard phase of any calculation*

*Phase 3:*

*Adaptation. One recovers a new grid,  $m1$*

*Phase 4:*

*.  
definition of the model, the loadings on the grid  $m1$ ,*

*.  
mechanical calculation producing a  $resu1$  result,*

*.  
calculation of an indicator of error,  $ERR1$ .*

*Phase 4 is the copy of phase 2. The only thing which changed is the grid. So all them concepts while depending must be taken again. Today, there is no possibility nor of re-using them old concepts, nor to destroy them automatically.*

*Then, one can continue, as many once as one wants, the tandem phase 3/phase 4. In the absence of structure of loop in the process control language, the user must duplicate itself them instructions.*

*See the reference [bib1] for a general presentation of the adaptation of grid and LOBSTER, accompanied by examples.*

**Caution:**

*This sequence of calculations and adaptations should not be stopped then begun again by one "CONTINUATION".*

## **3.2**

### **Operation of the macro-order**

*Phase 3 carries out the adaptation of the grid. It is activated by the macro-order  $MACR\_ADAP\_MAIL$ , described in this document. It has as an essential argument the name of the concept of grid running and the name which one will give to the concept of the future grid. The other obligatory data*

*is the type of adaptation which one wishes: free, i.e. according to the values which one takes indicator of error on the elements of the grid, or uniform, i.e. all the elements are treaties in the same way.*

*The other data depend then on the options selected.*

*In complement with the adaptation, LOBSTER can provide on request of the assessments on the quality of elements of the grid, the connexity of the field of calculation, sizes characteristic or a control of noninterpenetration of the elements. This information is obtained by the activation of the key words*

*associated.*

*In a general way, the essential impressions provided by LOBSTER are inserted in the file “mess” with the execution. In the event of error, or in mode of information 2, more detailed impressions have place.*

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## **4 Operands**

### **4.1 Key word**

**ADAPTATION**

**ADAPTATION = \_F (**

*This operand makes it possible to define the type of adaptation wished. The selection is done initially among two types: free or uniform.*

#### **4.1.1 Operand**

**FREE**

**/FREE**

**=/"RAFF\_DERA"**

**/**

**"REFINEMENT"**

**/**

**"DERAFFINEMENT"**

*This operand is employed to make free adaptation of a grid. In other words, the decision of (die) refining an element is caught according to the value of an indicator of error calculated before.*

*The choice can be done between three alternatives:*

.

**“RAFF\_DERA”**: *the grid is refined and déraffiné according to the indicator of error,*

**“REFINEMENT”**: *only the function of refinement is activated. Elements with low level of error are not déraffinés,*

**“DERAFFINEMENT”**: *it is the reverse, only the function of déraffinement is activated. The elements on high level of error are not refined.*

#### **4.1.2 Operand UNIFORM**

**/UNIFORM**  
**=/“REFINEMENT”**  
**/**  
**“DERAFFINEMENT”**  
**/**  
**“NOTHING”**

*This operand is employed to make a uniform adaptation of a grid. In others terms, all the elements of the grid are treated same manner, without holding account of an indicator of error. The choice can be done between three alternatives:*

**“REFINEMENT”**: *all the elements are refined,*

**“DERAFFINEMENT”**: *all the elements are déraffinés,*

**“NOTHING”**: *all the elements are preserved; the grid is the same one at the exit as with the entry.*

#### **4.1.3 Operand MAILLAGE\_N**

**MAILLAGE\_N = man**

*Grid of the type [grid] to adapt. Attention, the adaptation can relate only to simplexes: segments, mesh-points, triangles, quadrangles or tetrahedrons, in degree 1 or 2. If one provides a comprising grid of other elements, two cases of figure are possible: that is to say a stop in error, that is to say an adaptation on the zone in simplex and a restitution with identical of the remainder of grid. The choice between these two operating modes is made by the key word **NON\_SIMPLEXE**.*

#### **4.1.4 Operand**

##### **MAILLAGE\_NP1**

**MAILLAGE\_NP1 = Co**  
**(manp1)**

*The name of the concept of the type [grid] which will contain the grid resulting from the adaptation. This name must respect the usual constraints of the names of concept (8 characters to the maximum) and to be never used.*

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#### **4.1.5 Operand**

##### **RESULTAT\_N**

**RESULTAT\_N = resun**

*This operand makes it possible to indicate the concept of the type [result] which contains the indicator of error to use for free adaptation.*

#### **4.1.6 Operand**

##### **INDICATOR**

**INDICATOR = indic**

*One specifies here which is the indicator of error which is used for the adaptation.*

**Caution:**

*The field must be present in the result; if it misses, it is not calculated of office.*

*The user has the choice of the indicator: maybe of the fields already defined out of standard in Aster (cf [U4.81.02] and [U4.81.03], is a personalized field. With him to choose what is relevant for its calculation.*

**4.1.7 Operand**

**CHAM\_GD**

$CHAM\_GD = cham\_gd\_i$

*This operand makes it possible to indicate the concept of the type [cham\_gd] which contains the indicator of error with to use for free adaptation.*

**4.1.8 Operand**

**NOM\_CMP\_INDICA**

$NOM\_CMP\_INDICA = cmp$

*Name of the component of the indicating field which must be used to control the adaptation of grid.*

**4.1.9 Selection of the temporal parameter**

*If the structure of result contains the field of indicator of error only for one sequence number, nothing is to be specified. In fact the values of the field to this sequence number will be used. If not, it is necessary to specify about which number it is. That is done by the designation of a sequence number or of a value of moment. To refer to the document [U4.71.00] for the details on these key words.*

**4.1.10 CRIT\_RAFF\_xxxx operand**

*In the case of free adaptation implying of the refinement of grid, it is necessary to define a high criterion of the error. All the elements for which the indicator of error is higher than this criterion will be refined. It is important to look at a posteriori the pace of the frequency of errors. That is possible thanks to impressions carried out by LOBSTER in the file mess. One will find there in particular a table presenting this distribution in the form of histogram; to see chapter 5 for an example with accompanying notes.*

*For the choice of the criterion, three alternatives are possible:*



#### **4.1.10.1 Operand CRIT\_RAFF\_PE**

**/CRIT\_RAFF\_PE = crp**

**The criterion is defined by a proportion of elements to refine. It is a real number included/understood between 0 and 1. The process is as follows:**

**·**  
**calculation of the number of elements  $N$  corresponding to the proportion defined by  $crp$  is**  
 **$N = crp \times \text{numbers total elements}$**

**·**  
**refinement of  $N$  elements with the strongest error.**

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#### **4.1.10.2 Operand CRIT\_RAFF\_ABS**

**/CRIT\_RAFF\_ABS = CRA**

**The criterion is defined by an absolute value of the error. All elements with an error higher than this value will be refined.**

#### **4.1.10.3 Operand CRIT\_RAFF\_REL**

***/CRIT\_RAFF\_REL = crr***

***The criterion is defined by a relative value of the error. It is a number ranging between 0 and 1. The process is as follows:***

***.  
calculation of the minimal and maximum values of the indicator of error,***

***.  
calculation of the value corresponding to the proportion of error:  $v = v_{min} + crr (v_{max} - v_{min})$ ,***

***.  
refinement of all the elements whose error is higher than this value.***

#### ***4.1.11 CRIT\_DERA\_xxxx operand***

***In the case of free adaptation implying of déraffinement, it is necessary to define a low criterion of error. All the elements whose error is lower than this criterion will be déraffinés. Three alternatives are possible.***

##### ***4.1.11.1 Operand CRIT\_DERA\_PE***

***/CRIT\_DERA\_PE = cdp***

***The criterion is defined by a proportion of elements to refine. It is a number ranging between 0 and 1. The process is as follows:***

***.  
calculation of the number of elements  $N$  corresponding to the proportion defined by  $cdp$  is  $N = cdp \times \text{numbers total elements}$***

***.  
déraffinement  $N$  elements with the weakest error.***

##### ***4.1.11.2 Operand CRIT\_DERA\_ABS***

***/CRIT\_DERA\_ABS = half-value layer***

***The criterion is defined by an absolute value of the error. All elements with an error lower than this value will be déraffinés.***

##### ***4.1.11.3 Operand CRIT\_DERA\_REL***

***/CRIT\_DERA\_REL = cdr***

*The criterion is defined by a relative value of the error. It is a number ranging between 0 and 1.  
The process is as follows:*

- .  
calculation of the minimal and maximum values of the indicator of error,*
- .  
calculation of the error value  $V$  corresponding to the proportion of cdr error such as:  
 $v = v_{min} + cdr (v_{max} - v_{min})$ ,*
- .  
déraffinement of all the elements whose error is lower than this value.*

#### **4.1.12 Operand NIVE\_MAX**

***NIVE\_MAX = nivmax***

*It is the maximum level of refinement of the grid. In other words an element of the initial grid could not be divided more nivmax time as a whole of the process.*

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#### **4.1.13 Operand NIVE\_MIN**

***NIVE\_MIN = nivmin***

***It is the minimal level of déraffinement grid. I.e. only elements resulting of at least nivmin cuttings of grid can be déraffinés.***

## **4.2 Word**

*key*

**MAILLAGE\_FRONTIERE**

**MAILLAGE\_FRONTIERE = maf**

*In dimension 2, the choice of this option makes it possible the process of adjustment to follow the curve*

*edges of the grid. One provides here a Code\_Aster concept of the grid type which contains one fine grid of the edges of the geometry. This grid is thus made a priori only of segments.*

*Their lengths are much lower than those of the segments of edge of the grid to adopt. If it process of adjustment is brought to cut a segment of edge, the new node will be placed on grid of the border. Thus the angles will progressively be softened adaptations.*

*The location of the various edges is done by the groups according to the following rule: the segments which*

*form an edge are gathered in a group which bears the same name in the grid of calculation and in the grid of the border.*

*One will look at the case-tests ZZZZ121d and ZZZZ175a for examples of follow-up of border.*

### **4.2.1 Operand**

**GROUP\_MA**

**GROUP\_MA = l\_grma**

*If this option misses, the follow-up of the border is done for all the groups defined in grid of the border. If one wishes to restrict this follow-up with part of the border, one gives here the list of the groups of segments which define this part of border.*

## **4.3 Word**

*key*

**MAJ\_CHAM**

**MAJ\_CHAM = \_F (**

*This key word is to be employed once as many as one has fields to update old grid towards the adapted grid.*

### **4.3.1 Operand**

**RESULT**

**RESULT**

**= resu**

*Name of the concept [result] containing the field to be updated.*

### **4.3.2 Operand** **NOM\_CHAMP**

**NOM\_CHAMP**  
=  
**nomsymb [K16]**

*Reference symbol of the field which one wishes to express on the new grid.*

### **4.3.3 Operand** **CHAM\_GD**

**CHAM\_GD**  
=  
**cham\_gd**

*Name of the concept [cham\_gd] containing the field to be updated.*

### **4.3.4 Selection of the temporal parameter**

*The selection of the sequence number associated with the field to be interpolated is done by the designation of a number of order or a value of moment. To refer to the document [U4.71.00] for the details on these key words.*

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### **4.3.5 Operand**

#### **CHAM\_MAJ**

**CHAM\_MAJ**

**= Co**

**(chpmaj)**

**[K8]**

*Name of the concept which will contain the field expressed on the new grid. This concept does not have not to exist. It will be automatically created.*

### **4.3.6 Operand**

#### **TYPE\_CHAM**

**TYPE\_CHAM**

**=/"NOEU\_DEPL\_R"**

**/**

**"NOEU\_TEMP\_R"**

**/**

**etc**

**...**

*One indicates the type of the concept here to be updated on the new grid. The name of this type is built with the usual logic of Code\_Aster. The first 4 characters are "NOEU", "ELEM", "ELNO" or "ELGA". One finds "\_ then". The following sequence defines the type of field: "TEMP", "DEPL", etc the name ends in "\_R" for a real field.*

*Example: "NOEU\_TEMP\_R", "NOEU\_DEPL\_R", etc*

**Caution:**

*There is no consistency check between the type requested and the true type of field to be interpolated.*

### **4.4 Operand**

#### **NUMBERS**

**Note:**

*One will consult the document [U7.03.02] describing order MACR\_INFO\_MAIL for comments on the restitutions of the operands QUALITY, INTERPENETRATION, NUMBERS, CONNEXITY and SIZE.*

## **NUMBERS**

=

/

**“YES”**

**[DEFECT]**

/

**“NOT”**

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, an assessment of the numbers of nodes and elements are printed on the file of messages.*

## **4.5 Operand**

### **QUALITY**

#### **QUALITY**

=

/“YES”

/

**“NOT”**

**[DEFECT]**

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, an assessment of the quality of the elements is printed on the file of message.*

*The quality of a triangle is defined as being the relationship between the length on the largest side and*

*the radius of the inscribed circle. The quality of a quadrangle is defined like the quotient of the product of*

*the biggest length and of the averages on the sides and the diagonals by smallest of*

*surfaces of the triangles intern with the quadrangles. In the same way, the quality of a tetrahedron is defined*

*as being the relationship between the length on the largest side and the ray of the registered sphere.*

*These*

*reports/ratios are standardized to be worth 1 in the case of an equilateral triangle, of a square, or one equilateral tetrahedron. For any nonequilateral element, quality is higher than 1. See reference [bib1] for detailed explanations.*

*The result is presented in the form of tables, with the extreme values.*

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---

**Code\_Aster** ®

**Version**

**8.2**

***Titrate:***

***Macro-order MACR\_ADAP\_MAIL***

***Date:***

***31/01/06***

***Author (S):***

***G. Key NICOLAS***

***:***

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***4.6 Operand***

***INTERPENETRATION***

***INTERPENETRATION***

***=/"YES"***

***/***

***"NOT"***

***[DEFECT]***

***If the choice is "NOT", nothing occurs.***

***If the choice is "YES", it is checked that the grid is correct from the point of view of covering: no triangle is with horse on another triangle, no quadrangle is not with horse on another quadrangle, no tetrahedron enters another tetrahedron.***

***4.7 Operand***

***CUT***

***CUT***

***=***

***/***

***"YES"***

***/***

***"NOT"***

***[DEFECT]***

***If the choice is "NOT", nothing occurs.***

***If the choice is "YES", an assessment of the sizes of the under-fields is printed on the file of messages. A under-field is defined like a whole of of the same meshes dimension and belonging to the same groups.***

***4.8 Operand***



## **CONNEXITY**

### **CONNEXITY**

=

/

**“YES”**

/

**“NOT”**

**[DEFECT]**

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, an assessment of the connexities is printed on the file of messages. One specifies*

*then if the segments, the elements 2D (joined together triangles and quadrangles) or the tetrahedrons are*

*of only one holding or divided into several blocks.*

### **4.9 Operand**

#### **LANGUAGE**

##### **LANGUAGE**

=

/

**“FRENCH” [DEFECT]**

**“FRENCH”**

**“ENGLISH”**

**“ENGLISH”**

*This operand specifies the language in which the messages resulting from LOBSTER are printed.*

### **4.10 Operand**

#### **VERSION\_HOMARD**

##### **VERSION\_HOMARD**

=

**“V7\_7”**

**[DEFECT]**

**“V7\_N”**

**“V7\_N\_PERSO”**

*This operand makes it possible to select the LOBSTER version which is used for the adaptation.*

*By defect, LOBSTER 7.7 is launched. It is the version of reference. Choice “V7\_N” activates version 7.n of LOBSTER which is the version of development. Active choice “V7\_N\_PERSO” a version of development specific to the user. This option in fact is reserved for the team of*

*development of LOBSTER to develop new functionalities.*

**4.11 Operand  
INFORMATION**

**INFORMATION**

**=  
/ 1**

**/ 2**

*If INFORMATION is worth 2, the entirety of the LOBSTER exit is included in the file of message.  
If not, nothing in particular takes place.*

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**:**

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**4.12 Operand  
NON\_SIMPLEXE**

**NON\_SIMPLEXE**

**= / 0**

/ 1  
/  
2  
[DEFECT]

*In its current version, LOBSTER can read all the types of elements but does not make carry the adaptation that on some: mesh-points, segments, triangles, quadrangles and tetrahedrons. By retaining option 0, the transmission of a grid containing another thing that simplexes a stop in error will involve.*

*By choosing option 1, one will be able to transmit a grid comprising any type of element. The adaptation will relate only to the zone in simplexes or quadrangles. So consequently from propagation of refinement, a zone in hexahedron or pentahedron came to be touched, there is a stop in error. If not, when refinement is limited to the zone in simplexes or in quadrangles, the other elements are restored without change.*

*With option 2, one authorizes refinement only on all the elements which LOBSTER can treat: mesh-points, segments, triangles, quadrangles and tetrahedrons. The presence of hexahedrons or of pentahedrons will cause a stop in error. It is the default option.*

## *5 Example*

*One will look with profit the command files associated with the ZZZZ121a case-tests, B, C, D. They the processes of adjustment of grid in the form of a loop in Python language express.*

*Here an example of parameter setting of the macro-order.*

```
MACR_ADAP_MAIL (
ADAPTATION =
_F
(
FREE
=
"RAFF_DERA",
MAILLAGE_N
=
mun,
MAILLAGE_NP1
=
CO
("mdeux"),
RESULTAT_N
```

=  
**remeun,**  
**INDICATOR**  
=  
**“ERRE\_ELGA\_NORE”,**  
**NOM\_CMP\_INDICA**  
=  
**“ERREST”**  
**NUME\_ORDRE**  
=  
**3,**  
**CRIT\_RAFF\_PE**  
=  
**0.01,**  
**CRIT\_DERA\_PE**  
=  
**0.25,**  
**NIVE\_MAX**  
=  
**5**

),  
**MAJ\_CHAM**  
=  
**\_F**  
(  
**RESULT**

=  
**rethun,**  
**NOM\_CHAM**  
=  
**“TEMP”,**  
**TYPE\_CHAM**  
=  
**“NOEU\_TEMP\_R”,**

**INST**  
=  
**12.5,**  
**CHAM\_MAJ**  
  
=  
**CO**  
**(“tempdeux”)**

),  
**QUALITY**  
=  
**“YES”,**  
**INTERPENETRATION**  
=  
**“NOT”**

)

*This sequence will adapt the grid contained in the concept mun and will restore a concept grid of mdeux name. The adaptation is done by refinement and déraffinement free, according to the indicator of error contents in field ERRE\_ELGA\_NORE of the remeun result, at the 3rd moment; the component used is ERREST. The elements will be classified according to their level of error decreasing. The first % will be refined; the 25% the last will be candidates with déraffinement. No element of the final grid will not have to be resulting of more than 5 refinements.*

*The field TEMP of the rethun result at the moment 12,5 is expressed on the grid mun. It will be expressed on the mdeux grid in the shape of the field of temperature to the tempdeux nodes.*

*A summary of the quality of the elements of the new grid is produced. One does not control interpenetration of the elements.*

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*Here an example of the table presenting the distribution of the indicator of error on the grid.*

\*\*\*\*\*

**\* Indicators of error on the grid of calculation \***

**\* Error on the 956 triangles \***

\*\*\*\*\*

**\* Minimum: 40.577 Maximum: 71888. \***

\*\*\*\*\*

\*\*\*\*\*

**\* Function of distribution \***

**\* \***

**\* Values \* a Number of elements \***

**\* Minis << Maximum \* by class \* office plurality \***

**\*\* 10 \*\* 4 \* in %. numbers \* in %. numbers \***

\*\*\*\*\*

**\* 0.00 < 0.36 \* 89.33 . 854 \* 89.33 . 854 \***

**\* 0.36 < 0.72 \* 9.62 . 92 \* 98.95 . 946 \***

**\* 0.72 < 1.08 \* 0.21 . 2 \* 99.16 . 948 \***

**\* 1.08 < 1.44 \* 0.10 . 1 \* 99.27 . 949 \***

**\* 1.44 < 1.80 \* 0.31 . 3 \* 99.58 . 952 \***

**\* 1.80 < 2.16 \* 0.10 . 1 \* 99.69 . 953 \***

**\* 2.16 < 2.52 \* 0.00 . 0 \* 99.69 . 953 \***

\* 2.52 < 2.88 \* 0.00 . 0 \* 99.69 . 953 \*  
 \* 2.88 < 3.24 \* 0.00 . 0 \* 99.69 . 953 \*  
 \* 3.24 < 3.60 \* 0.00 . 0 \* 99.69 . 953 \*  
 \* 3.60 < 3.96 \* 0.00 . 0 \* 99.69 . 953 \*  
 \* 3.96 < 4.32 \* 0.00 . 0 \* 99.69 . 953 \*  
 \* 4.32 < 4.68 \* 0.10 . 1 \* 99.79 . 954 \*  
 \* 4.68 < 5.04 \* 0.00 . 0 \* 99.79 . 954 \*  
 \* 5.04 < 5.40 \* 0.00 . 0 \* 99.79 . 954 \*  
 \* 5.40 < 5.76 \* 0.00 . 0 \* 99.79 . 954 \*  
 \* 5.76 < 6.12 \* 0.00 . 0 \* 99.79 . 954 \*  
 \* 6.12 < 6.48 \* 0.00 . 0 \* 99.79 . 954 \*  
 \* 6.48 < 6.84 \* 0.10 . 1 \* 99.90 . 955 \*  
 \* 6.84 < 7.20 \* 0.10 . 1 \* 100.00 . 956 \*  
 \* 7.20 < inf. \* 0.00 . 0 \* 100.00 . 956 \*

\*\*\*\*\*

100  
 90  
 80  
 ents  
 70  
 60  
 50  
 40  
 30  
 20

*Percentage of élém*

10  
 0  
 , 72  
 , 44  
 , 16  
 , 88  
 , 60, 96  
 , 68  
 , 40  
 , 12  
 , 84  
 < 0  
 < 1  
 < 2  
 < 2  
 < 3 < 3

< 4  
< 5  
< 6  
< 6  
**00 < 0,36**  
**36 72 < 1,08**  
**08 44 < 1,80**  
**80 16 < 2,52**  
**52 88 < 3,24**  
**24 60 96 < 4,32**  
**32 68 < 5,04**  
**04 40 < 5,76**  
**76 12 < 6,48**  
**48 84 < 7,20**

0,  
0,  
0,  
1,  
1,  
1,  
2,  
2,  
2,  
3,  
3,  
3,  
4,  
4,  
5,  
5,  
5,  
6,  
6,  
6,

***Beach of error***

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***The diagnosis on the distribution of the indicator of error on the grid points out initially the values extremes met in calculation in progress. Here the minimum is 40,577 and the maximum of 71888. Then one presents the distribution by equidistant section starting from the optimum value, 0. It is seen that***

***854 triangles have an error lower than  $0,36*10^4$ , i.e. 89,33% of the total number of triangles. 92 triangles have an error ranging between  $0,36*10^4$  and  $0,72*10^4$ , is 9,62% of the total number of triangles. In cumulated, one thus notes that 946 (=854+92) triangles have an error lower than  $0,72*10^4$ , is 98,95% of the total. And so on. For example, 99,58% of the elements have an error lower than  $1,80*10^4$ .***

***On the preceding figure, one can see the representation in the form of histogram of the percentages elements in each beach of error concerned. As it could also to note in the preceding table, one notes that very few elements concentrate a strong error. By visualizing a representation of the cumulated percentage of elements in a beach of error given, one with the following figure.***

***102******100******ents******98******96******94******breadth of élém******U******92******90******88******86******84******Cum percentage***

82  
, 72  
, 44  
, 16  
, 88  
, 60, 96  
, 68  
, 40  
, 12  
, 84  
< 0  
< 1  
< 2  
< 2  
< 3 < 3  
< 4  
< 5  
< 6  
< 6  
00 < 0,36  
36 72 < 1,08  
08 44 < 1,80  
80 16 < 2,52  
52 88 < 3,24  
24 60 96 < 4,32  
32 68 < 5,04  
04 40 < 5,76  
76 12 < 6,48  
48 84 < 7,20  
0,  
0,  
0,  
1,  
1,  
1,  
2,  
2,  
2,  
3,  
3,  
3,  
4,  
4,

5,  
5,  
5,  
6,  
6,  
6,

### ***Beach of error***

***From this frequency of errors, one can deduce two consequences on the strategies from refinement. If one asks for a refinement on a relative criterion of the error, key word CRIT\_RAFF\_REL, that returns to***

***to select the elements the elements which are on the right vertical line passing by it criterion. For example if one asks CRIT\_RAFF\_REL = 0.85, one will select all the elements whose L`error is higher than  $0,85*71888$ , that is to say 61105. It is noted that that corresponds to very little***

***elements: 2 only exceed this value, i.e. 0,2% of the total.***

***If one asks for a refinement on a percentage of elements, key word CRIT\_RAFF\_PE, that returns to to select the elements the elements which are above the horizontal line passing by this criterion. For example if one asks CRIT\_RAFF\_PE = 0.85, one will select the 15% the worst elements, is 143 elements. Among these, "the least worse" has an error lower than 3600, is 20 times smaller than the maximum.***

***The consequence of these remarks is that it is advisable to make a first analysis of the distribution of the error before choosing the type and the values of the criteria of refinement. It is indeed useless, even***

***expensive in term of increase in the size of grid, to refine in zones where the error is not not very strong. The adaptation will be all the more powerful as one will have known to reduce the elements to strong***

***error until obtaining a balance of the frequency of errors in the grid.***

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## **6 Bibliography**

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**[2]**

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**[3]**

**G. NICOLAS: “Software LOBSTER - Volume 3 Interfaces with the computer codes”, report/ratio EDF HI-23/04/February 7, 2005.**

**[4]**

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*Organization (S): EDF-R & D /SINETICS*

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***Document: U7.03.02***

***Macro-order MACR\_INFO\_MAIL***

***1 Goal***

***To give information on the quality of a grid.***

***This macro-order makes it possible to obtain information on a grid, of degree 1 or 2, container mesh-points, segments, triangles, quadrangles or tetrahedrons. The impression is directed on the file of messages.***

***One finds initially an assessment total of the grid: dimension, degree, a many nodes, number extreme elements, dimensions.***

***Then four information is accessible in an optional way:***

- .  
a summary on the quality of the elements,***
- .  
a control of nonthe interpenetration of the elements,***
- .  
an assessment on the connexity of the grid,***
- .  
a summary of the size of different the under-field.***

***This analysis is made by the software of adaptation of grid LOBSTER. For more details, to see: <http://www.code-aster.org/outils/homard> or to refer to the documents quoted in bibliography.***

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Author (S):  
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***2 Syntax***

**MACR\_INFO\_MAIL (**

**GRID**

=

**my**

**[grid]**

**NON\_SIMPLEXE =/0**

**/ 1**

**/**

**2**

**[DEFECT]**

**NUMBERS**

**="/“YES”**

**[DEFECT]**

**/**

**“NOT”**

**QUALITY =/“YES”**

**[DEFECT]**

**/**

**“NOT”**

**CONNEXITY =/“YES”**

**[DEFECT]**

**/**

**“NOT”**

**CUT**

**="/“YES”**

**[DEFECT]**

**/**

**“NOT”**

**INTERPENETRATION**

=

/

**“YES”**

**[DEFECT]**

/

**“NOT”**

**MAILLAGE\_FRONTIERE = maf**

**[grid]**

**GROUP\_MA**

=

**l\_grma [l\_gr\_maille]**

**LANGUAGE**

**=/“FRENCH” [DEFECT]**

**“FRENCH”**

**“ENGLISH”**

**“ENGLISH”**

**VERSION\_HOMARD =/“V7\_7”**

**[DEFECT]**

**“V7\_N”**

**“V7\_N\_PERSO”**

**INFORMATION =/1 [DEFECT]**

/2

),

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### **3 Operands**

#### **3.1 Operand**

**GRID**

**GRID = my**

**Grid of the type [grid] to analyze. Attention, the analysis will relate only to the nodes, them mesh-points, segments, triangles, quadrangles or tetrahedrons, in degree 1 or 2. If one provides a comprising grid of other elements, two cases of figure are possible: that is to say one stop in error, is an adaptation on the zone in simplex and a restitution with identical of the remainder grid. The choice between these two operating modes is made by the key word NON\_SIMPLEXE.**

#### **3.2 Operand**

**NON\_SIMPLEXE**

**NON\_SIMPLEXE**

**= / 0**

**/ 1**

**/**

**2**

**[DEFECT]**

*In its current version, LOBSTER can read all the types of elements but does not make carry the analysis*

*that on some: mesh-points, segments, triangles, quadrangles and tetrahedrons.*

*By retaining option 0, the transmission of a grid containing another thing that simplexes a stop in error will involve.*

*By choosing option 1, one will be able to transmit a grid comprising any type of element. The analysis will relate only to the zone in simplexes or quadrangles.*

*With option 2, one authorizes the analysis only for one grid which contains exclusively elements which LOBSTER can treat: segments, triangles, quadrangles and tetrahedrons. The presence hexahedrons or pentahedrons will cause a stop in error. It is the default option.*

**3.3 Operand NUMBERS**

NUMBERS

=

/

“YES”

[DEFECT]

/

“NOT”

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, an assessment of the numbers of nodes and elements are printed on the file of messages.*

**3.4 Operand QUALITY**

QUALITY

=

/

“YES”

[DEFECT]

/

“NOT”

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, an assessment of the quality of the elements is printed on the file of message.*

*The quality of a triangle is defined as being the relationship between the length on the largest side and the radius of the inscribed circle. The quality of a quadrangle is defined like the quotient of the product of*

*the biggest length and of the averages on the sides and the diagonals by smallest of surfaces of the triangles intern with the quadrangles. In the same way, the quality of a tetrahedron is defined as being the relationship between the length on the largest side and the ray of the registered sphere. These reports/ratios are standardized to be worth 1 in the case of an equilateral triangle, of a square, or one equilateral tetrahedron. For any nonequilateral element, quality is higher than 1. See reference [bib1] for detailed explanations. The result is presented in the form of tables, with the extreme values.*

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### **3.5 Operand**

#### **INTERPENETRATION**

*INTERPENETRATION*

=

/

“YES”

[DEFECT]

/

“NOT”

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, it is checked that the grid is correct from the point of view of covering: no triangle is with horse on another triangle, no quadrangle is not with horse on another*

*quadrangle, no tetrahedron enters another tetrahedron.*

### **3.6 Operand CONNEXITY**

*CONNEXITY*

=

/

*“YES”*

*[DEFECT]*

/

*“NOT”*

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, an assessment of the connexities is printed on the file of messages. One specifies then if the segments, the elements 2D (joined together triangles and quadrangles) or the tetrahedrons are*

*of only one holding or divided into several blocks.*

### **3.7 Operand CUT**

*CUT*

=

/

*“YES”*

*[DEFECT]*

/

*“NOT”*

*If the choice is “NOT”, nothing occurs.*

*If the choice is “YES”, an assessment of the sizes of the under-fields is printed on the file of messages. A under-field is defined like a whole of of the same meshes dimension and belonging to the same groups.*

### **3.8 Operand MAILLAGE\_FRONTIERE**

*MAILLAGE\_FRONTIERE = maf*

*In dimension 2, the choice of this option means that the segments forming the edge of the grid of calculation are attached to a fine description of this edge. This fine grid of the edge is transmitted here. bond is done by membership of the segments to the same groups.*

### **3.9 Operand**

## **GROUP\_MA**

*GROUP\_MA = l\_grma*

*If this option misses, the link between the segments is established for all the groups present in grid of the border. If the link is established only for some groups, they are indicated here.*

### **3.10 Operand LANGUAGE**

*LANGUAGE*

*=*

*/*

*“FRENCH” [DEFECT]*

*“FRENCH”*

*“ENGLISH”*

*“ENGLISH”*

*This operand specifies the language in which the messages resulting from LOBSTER are printed.*

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### **3.11 Operand**

**VERSION\_HOMARD**

*VERSION\_HOMARD*

*=*

“V7\_7”  
[DEFECT]  
“V7\_N”  
“V7\_N\_PERSO”

*This operand makes it possible to select the LOBSTER version which is used for this analysis. By defect, LOBSTER 7.7 is launched. It is the version of reference. Choice “V7\_N” activates version 7.n of LOBSTER which is the version of development. Active choice “V7\_N\_PERSO” a version of development specific to the user. This option in fact is reserved for the team of development of LOBSTER to develop new functionalities.*

### **3.12 Operand INFORMATION**

*INFORMATION*

=  
/ 1

/ 2

*If INFORMATION is worth 2, the entirety of the LOBSTER exit is included in the file of message. If not, nothing in particular takes place.*

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**Code\_Aster** ®

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*Titrate:*  
*Macro-order MACR\_INFO\_MAIL*

*Date:*  
31/01/06  
*Author (S):*  
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#### 4 Example

```

MACR_INFO_MAIL (GRID = HAMMER,
CUT
=
"YES",
CONNEXITY
=
"YES",
INTERPENETRATION
=
"YES",
QUALITY =
"YES"
)

```

*This sequence will write information general (dimension, degree, a number of nodes and elements,...) then a diagnosis on the quality and the interpenetration of the elements used in grid HAMMER as well as the size and the connexity of the various under-fields. The version of LOBSTER by defect is used.*

#### ANALYZE GRID

=====

*Grid has to analyze*

*Creation date: Thursday September 2, 2004 has 9. 57 mn 11 S*

*Dimension: 2*

*Degree: 1*

*It is a starting grid.*

*Maximum direction | Unit | Minimum |*

-----

*X | Unknown | 0.0000 | 20.000*

*y | Unknown | 0.0000 | 11.000*

*The diagnoses on the interpenetrations of elements points out the precision retained for the control of coincidence of the nodes.*

# **INTERPENETRATION OF THE ELEMENTS**

=====

## ***... Coincidence of the nodes***

-----

***Two nodes are known as coincidents if the absolute deviation between their co-ordinates is lower a: 0.10E-39***

## ***... Interpenetration of the edges***

-----

## ***... Interpenetration of the triangles***

-----

\*\*\*\*\*  
 \* \*  
 \* ***No problem was meets.*** \*  
 \* \*  
 \*\*\*\*\*

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***The diagnosis on the quality of the elements points out initially the extreme values recorded in***



*analyzed grid. Here the minimum is 1,0044, very near to the absolute minimum theoretical which is 1, and the maximum met is 1,5788. Then one presents the distribution by equidistant section to leave the optimum value, 1. It is seen that 16 triangles have a quality ranging between 1 and 1,05, that is to say*

*13,56% of the total number of triangles. 26 triangles have a quality ranging between 1,05 and 1,10, are*

*22,03% of the total number of triangles. In cumulated, one thus notes that 42 (=16+26) triangles have one*

*quality better than 1,10, is 35,59% of the total. And so on. For example, 98,31% of the elements have a quality better than 1,45.*

## **QUALITY OF THE ELEMENTS**

=====

\*\*\*\*\*

*\* Quality of the triangles of the grid of calculation \**  
*\* Recall: quality is equal to the report/ratio of the diameter \**  
*\* of the triangle on the radius of the inscribed circle, \**  
*\* standardizes has 1 for a regular triangle. \**

\*\*\*\*\*

*\* Minimum: 1.0044 Maximum: 1.5788 \**

\*\*\*\*\*

\*\*\*\*\*

*\* Function of distribution \**

*\* \**

*\* Values \* a Number of elements \**  
*\* Minis << Maximum \* by class \* office plurality \**  
*\*\* in %. numbers \* in %. numbers \**

\*\*\*\*\*

*\* 1.00 < 1.05 \* 13.56 . 16 \* 13.56 . 16 \**  
*\* 1.05 < 1.10 \* 22.03 . 26 \* 35.59 . 42 \**  
*\* 1.10 < 1.15 \* 22.03 . 26 \* 57.63 . 68 \**  
*\* 1.15 < 1.20 \* 18.64 . 22 \* 76.27 . 90 \**  
*\* 1.20 < 1.25 \* 9.32 . 11 \* 85.59 . 101 \**  
*\* 1.25 < 1.30 \* 6.78 . 8 \* 92.37 . 109 \**  
*\* 1.30 < 1.35 \* 3.39 . 4 \* 95.76 . 113 \**  
*\* 1.35 < 1.40 \* 1.69 . 2 \* 97.46 . 115 \**  
*\* 1.40 < 1.45 \* 0.85 . 1 \* 98.31 . 116 \**  
*\* 1.45 < 1.50 \* 0.00 . 0 \* 98.31 . 116 \**  
*\* 1.50 < 1.55 \* 0.00 . 0 \* 98.31 . 116 \**  
*\* 1.55 < 1.60 \* 1.69 . 2 \* 100.00 . 118 \**  
*\* 1.60 < 1.65 \* 0.00 . 0 \* 100.00 . 118 \**

\* 1.65 < 1.70 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 1.70 < 1.75 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 1.75 < 1.80 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 1.80 < 1.85 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 1.85 < 1.90 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 1.90 < 1.95 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 1.95 < 2.00 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.00 < 2.05 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.05 < 2.10 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.10 < 2.15 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.15 < 2.20 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.20 < 2.25 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.25 < 2.30 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.30 < 2.35 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.35 < 2.40 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.40 < 2.45 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.45 < 2.50 \* 0.00 . 0 \* 100.00 . 118 \*  
\* 2.50 < inf. \* 0.00 . 0 \* 100.00 . 118 \*  
\*\*\*\*\*

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*On the following figure, one can see the representation in the form of histogram of the percentages elements in each beach of quality concerned.*

25  
 20  
 ents  
 15  
 10  
 5  
*Percentage of élém*  
 0  
 1  
 2  
 4  
 5  
 6  
 5/1,  
 1,00/1,05  
 1,05/1,  
 1,15/1,  
 1,20/1,25  
 1,30/1,35  
 1,35/1,  
 1,4  
 1,50/1,55  
 1,60/1,  
*Beach of quality*

*Information on the number of entities of calculation is classified by type: nodes, mesh-points, edges, etc. One makes the sorting between the elements of edges and the others.*

**A NUMBER OF ENTITIES OF CALCULATION**

=====

\*\*\*\*\*

*\* Nodes \**

\*\*\*\*\*

*\* Numbers total \* 76 \**

\*\*\*\*\*

\*\*\*\*\*

*\* Edges \**

\*\*\*\*\*

*\* Numbers total \* 32 \**

*\*. of which edges isolees \* 0 \**

*\*. of which edges of edge of areas 2D \* 32 \**

*\*. of which edges intern with the faces/volumes \* 0 \**

\*\*\*\*\*

\*\*\*\*\*

*\* Triangles \**

\*\*\*\*\*

*\* Numbers total \* 118 \**

\*\*\*\*\*

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*The control of the connexity makes it possible to make sure that the field of calculation is only one piece. It*

*can arrive that this field is in several disjoined parts, for example for problems of contact. But the diagnosis of several pieces often reveals a problem during creation of grid: under-parts were badly restuck. And as the visual monitoring always does not allow to realize it, calculation is false... while seeming to be right. The worst situation which can to arrive. It is thus strongly recommended to use this option.*

**CONNEXITY OF THE ENTITIES OF CALCULATION**

=====

\*\*\*\*\*

*\* The triangles are in only one block. \**

\*\*\*\*\*

*The posting of the sizes of the under-parts of the grid is done by dimensions. Tri A place roughly speaking*

*according to the groups of meshes declared; there can be a finer subdivision when the groups recut. This presentation makes it possible to control that one has quite with a grid what one wanted.*

*In*

*private individual, that allows to flush out errors of sticking together or creation of groups at the time of*

*creation of the grid. Here still, it is strongly recommended to use this option.*

**SIZES OF THE SOUS-DOMAINES OF CALCULATION**

=====

**Direction | Unit**

-----

*X | Unknown*

*y | Unknown*

\*\*\*\*\*

**\* Under-fields 2D \***

\*\*\*\*\*

**\*Numero\* Name \* Surface \***

\*\*\*\*\*

**\* -12 \* MANCHE \_\_\_\_\_ \* 20.000 \***

**\* -11 \* MASSE \_\_\_\_\_ \* 128.00 \***

\*\*\*\*\*

**\* Total: \* 148.00 \***

\*\*\*\*\*

\*\*\*\*\*

**\* 1D Under-fields \***

\*\*\*\*\*

**\*Name\* Length \***

\*\*\*\*\*

**\* -2 \* BORD\_2 \_\_\_\_\_ \* 10.000 \***

**\* -1 \* BORD\_1 \_\_\_\_\_ \* 4.0000 \***

<b>* -3 * BORD_3</b>	<b>* 16.000 *</b>
<b>* -5 * BORD_5</b>	<b>* 8.0000 *</b>
<b>* -4 * BORD_4</b>	<b>* 26.246 *</b>

\*\*\*\*\*

**\* Total: \* 64.246 \***

\*\*\*\*\*

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*Author (S):*

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*Organization (S): EDF-R & D /AMA*

***Instruction manual***

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***Document: U7.03.03***

***Methods Python of piloting of GMSH***

***Summary:***

***This document introduces the supervisor making it possible to control GMSH since Python, and thus***

*since the file of  
order Aster.*

*This supervisor produces any type of grids 2D by using software GMSH ([www.geuz.org/gmsh](http://www.geuz.org/gmsh)). He is in particular used in Aster by the tool for postprocessing interactive STANLEY in order to generate elements of grids for postprocessing, but can be extended to other applications: parametric grid, mending of meshes, etc*

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*1 Mode  
of employment*

*There are four stages to follow to produce a grid with supervisor GMSH:*

- Définition of the geometry;*
- Définition of the discretizations;*
- Création of grid GMSH and the group *\_ma* and associated Physical objects;*
- Importation of grid GMSH in Aster.*

*Simple example of use:*

*In the following example, one uses the functionalities of the supervisor to generate the grid of one*



## ***rectangular plate:***

### ***Geometry***

***From sup\_gmsh importation \****

***larg = 5.  
H\_beton = 3.  
H\_S1 = 4.  
t\_beton = 25.  
prog\_S1 = 1.1***

***One imports the module and one defines some parameters.***

### ***# Geometry***

***O = Not (0, 0)  
With = Not (larg, 0)  
B = Not (larg, H\_beton)  
C = Not (0, H\_beton)  
D = Not (0, - H\_S1)  
E = Not (larg, - H\_S1)***

***OA = Line (O, A)  
AB = Line (A, B)  
BC = Line (B, C)  
OC = Line (O, C)***

***OD = Line (O, D)  
OF = Line (D, E)  
AE = Line (A, E)***

***S2 = Surface (OA, AB, BC, OC)  
S1 = Surface (OD, OF, AE, OA)***

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***One creates points, lines between the points and of surfaces starting from the lines.***

***# Discretization***

***OA.Transfinite (1)***  
***BC.Transfinite (1)***  
***DE.Transfinite (1)***

***N\_beton = int (H\_beton/t\_beton + 0.5)***  
***AB.Transfinite (N\_beton)***  
***OC.Transfinite (N\_beton)***

***N\_S1 = Progress (H\_S1, r=prog\_S1, h=t\_beton)***  
***OD.Transfinite (N\_S1, prog\_S1)***  
***AE.Transfinite (N\_S1, prog\_S1)***

***S2.Transfinite ()***  
***S1.Transfinite ()***

***One defines the discretization of the lines and surfaces.***

***# Grid***

***mesh = Mesh ()***  
***mesh. Physical ("FUND", OF)***  
***mesh. Physical ("LAT\_G", OC, OD)***  
***mesh. Physical ("LAT\_D", AB, AE)***  
***mesh. Physical ("INTERFAC", OA)***  
***mesh. Physical ("HIGH", BC)***  
***mesh. Physical ("S2", S2)***

## ***mesh. Physical (“S1”, S1)***

***One creates the object grid and one defines the groups of meshes which will be group\_ma in the SD grid Aster and of Physical in GMSH (the latter will be named GM1, GM2, etc...).***

```
MA = mesh.LIRE_GMSH (  
MODI_QUAD = “YES”  
)
```

***Importation of the grid in Aster: MA is an Aster grid.***

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***2  
List functions available***

***The list of the functions is extracted directly from the source, sup\_gmsh.py, which explains why it is in English.***

***2.1***

## *Classify generic for the geometrical objects*

### *class Geometric:*

#### *private attribute*

*parameters: dictionnary of the attributes (except relation and parameters itself)*

*see \_\_getattr\_\_ and \_\_setattr\_\_*

#### *Attributes*

*num: index among gmsh objects*

*Mandeleivium: mesh descriptor*

*mesh: related mesh object*

*relation: model object in box of coincidence*

#### *Public methods*

*Is\_point: return true is the object inherits of the Not class*

*Is\_line: return true is the object inherits of the Line class*

*Is\_surface: return true is the object inherits of the Surface class*

*Is\_volume: return true is the object inherits of the class Volume*

*Is\_same\_dimension: return true is both objects are of the same dimension*

*(not, line, surface gold volume)*

*in - > object to compares to coil*

*Duplicate: duplicate year object and bases its mesh\_descriptor*

*one the mesh\_descriptor of the model*

*Coincide: assert that year object is coincident with has model one*

*All the attributes are then automatically read from*

*the model object (see \_\_setattr\_\_ and \_\_getattr\_\_).*

*in - > model object*

#### *Private method*

#### *Root:*

*Provides the root object of year object, IE the object itself yew there is No relation*

*however the deepest model in box of relation.*

*Geometric\_coincide: check yew has geometrical coincidence is possible*

*return information butt the coincidence, false else.*

*in - > model object*

*Deep\_coincide: proceed recursively to depending ensure coincidence of the sub-objects*

*in - > model object*

*in - > corresponds (information returned by Geometric\_coincide)*

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*\_\_setattr\_\_ : distinguish two sets of attributes*

*relation (to express train has relation with has model object in box of coincidence)*

*all the other attributes which are stored in the dictionnary parameters*

*instead of the usual \_\_dict\_\_ yew there is No relation (see Coincide)*

*and in the model object yew there has coincidence*

*\_\_getattr\_\_ : yew the object is related (relation <> None) the attribute is read*

*in the model object. Else, it is read in the current object, actually*

*in the dictionnary parameters (see \_\_setattr\_\_)*

*Thanks to thesis two overloaded methods, the access to the attributes is usual yew*

*there is No relation whereas the attributes of the model object are accessed*

*transparently yew there has relation.*

*\_\_cmp\_\_ :*

*The comparison of two objects involves possible coincidence. It is No more the object ids*

*that are compared goal the object roots (.relation yew any).*

*Gmsh: produce the source codes for Gmsh*

*in - > mesh*

*Gmsh\_send: send has line code to the gmsh to interpret*

*in - > line\_code (string)*

*Intermediate\_meshing: produce the source codes for the intermediate objects*

*in - > mesh*

*Object meshing: produce the source codes for the current object*

*VAR - > object number (modified yew several objects are created)*

## 2.2

*Functions for the objects NOT*

*class Not (Geometric):*

*Public methods*

*\_\_init\_\_:*

*in - > coordinates (the 3rd is zero by default)*

*Size: set the size of the neighbouring elements*

*in - > size*

*Attractor: define the not have year attractor*

*in - > scale\_x: size amplification Factor in the X-direction*

*in - > scale\_y: size amplification Factor in the there-direction*

*in - > distance: influence distance for the disturbance*

*Attributes*

*coor: coordinates*

*size: neighbouring element size*

*attractor: parameters of the attractor*

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## **2.3**

### **Functions for the LINE objects**

**class Line (Geometric):**

#### **LINE OBJECT**

##### **Public methods**

**Attractor: define the not have year attractor**  
**in - > scale\_x: size amplification Factor in the X-direction**  
**in - > scale\_y: size amplification Factor in the there-direction**  
**in - > distance: influence distance for the disturbance**

**class Circle (Line):**

#### **CIRCLE OBJECT**

**def Curve (l\_x, l\_y, l\_z=None):**

**CURVE OBJECT (in - > list of points)**

## **2.4**

### **Functions for the objects SURFACES**

**class Surface (Geometric):**

**SURFACE OBJECT (inherit from the Geometric class)**

##### **Public methods**

**\_\_init\_\_:**  
**in - > lines: external bounday of the surface (lines should Be connected)**

**Holes:** *set the internal holes (surfaces)*  
*in - > holes: list of holes*

**Boundary:** *checks that the boundary has closed loop and returns the orientation of the edges*

**Ruled:** *the surface is declares has ruled one*

**Relocate:** *relocate the surface*  
*in - > tran: (numpy) vector of translation*

**Recombine:** *recombine the surface (try to mesh with quadrangles instead of triangles)*

**Transfinite:** *The mesh to Be transfinite declares*

### **Attributes**

**lines:** *list of external boundary lines*

**holes:** *list of internal holes (surfaces)*

**ruled:** *indicates (false gold true) yew the surface has ruled surface*

**loops:** *list of boundary (external and internal) loops (computed when meshing)*

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**2.5**

**Functions for the operations on the grids**

**class Mesh\_Descriptor:**



**Attributes**

*relation* Another mesh descriptor provides the mesh parameters  
*parameters* dictionary of the mesh parameters  
*size* Not size  
*transfinite* Transfinite mesh (0 gold 1)  
*number* Number of elements along has line (transfinite)  
*progression* Progression of element size (transfinite)  
*recombine* Recombine mesh gold not

**Specific access:**

*md.parameter\_name = xxx* - > the relation is destroyed (set to None)  
*xxx = md.parameter\_name* - > yew there has relation, the effective parameter is looked for recursively

*Deep copying: relation is set to the model instead of has has true Copy*

**class Mesh:**

```
def __init__(coil, algo = 2, gmsh='gmsh'):
def Physical (coil, name, *l_obj): creation of Physical (GMSH object)
def Save (coil, file = "fort.geo"): save the geo file
def View (coil): launch GMSH with the current geo file
def Create (coil, file = "fort.19"): save the geo file and create the msh file
def Name (coil, MA, CREA_GROUP_NO): create the group_ma and/or the group_no
def LIRE_GMSH (coil,
UNITE_GMSH = 19,
UNITE_MALLAGE = 20,
MODI_QUAD = "NOT",
CREA_GROUP_NO = "YES"
):
```

*Reading of the grid (format Aster) from its definition  
(format sup\_gmsh)*

*UNITE\_GMSH = logical* Number of unit for the file msh  
*UNITE\_MALLAGE = logical* Number of unit for the file email  
*MODI\_QUAD = "YES"* if line->quad, "NOT" if not  
*CREA\_GROUP\_NO = "YES"* if the group\_no are created, "NOT" if not

## **2.6**

### ***Functions for the geometrical transformations***

***def VectorProduct (U, v):***

***def VectorNorm (U):***

***class Rotation:***

***in - > A, C, B***

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***01/02/05***

***Author (S):***

***G. DEVESA Key***

***:***

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***Macro-order MACRO\_MISS\_3D***

***1 Goal***

***To launch by EXEC\_LOGICIEL the modules of MISS3D.***

***The system around the computation software MISS3D (interaction ground structure or ground-fluid-structure) is***

***constituted of a module of generating preprocessing of data for MISS3D, the module of calculation MISS3D itself and of a module of postprocessing to make the results useable for Code\_Aster.***

***The call to this macro-order fits between the call to operators IMPR\_MACR\_ELEM format “MISS\_3D” [U7.04.33], IMPR\_MISS\_3D [U7.03.11] and LIRE\_MISS\_3D [U7.02.31].***

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## ***2 Syntax***

***MACRO\_MISS\_3D***

(

***OPTION***

***=\_F (/ALL = "YES",***

***/***

***MODULATE =/"PRE\_MISS",***

***/***

***"MISS\_EVOL",***

***/***

***"MISS\_IMPE",***

)

***UNITE\_IMPR\_ASTER***

***=***

/  
*uimpast,*  
**[I]**  
/  
25,  
**[DEFECT]**

*UNITE\_OPTI\_MISS*  
=  
*uopmiss,*  
**[I]**  
/  
26,  
**[DEFECT]**

*UNITE\_MODELE\_SOL*  
=  
/  
*umodsol,*  
**[I]**  
/  
27,  
**[DEFECT]**

*UNITE\_RESU\_IMPE*  
=  
*uresimp,*  
**[I]**  
/  
30,  
**[DEFECT]**

***PROJECT***

=

***project***

,

***[KN]***

***REPERTORY***

=

***repertory,***

***[KN]***

***VERSION***

=

***/***  
***“V1\_2”, [DEFECT]***

***/***

***“V1\_3”,***

***)***

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**Code\_Aster** ®

Version

7.4

Titrate:

Macro-order *MACRO\_MISS\_3D*

Date:

01/02/05

Author (S):

**G. DEVESA** Key

:

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### **3 Operands**

#### **3.1 Key word**

**OPTION**

*This key word makes it possible to indicate the modules which one will call in the system around MISS3D.*

#### **3.1.1 Operand**

**ALL**

*/ALL = "YES"*

*This operand indicates that one will call the complete sequence of system MISS3D: modulate generating preprocessing of data for MISS3D, module of calculation MISS3D and modulate postprocessing to make the results useable for Code\_Aster.*

#### **3.1.2 Operand**

**MODULATE**

*/  
MODULATE =/"PRE\_MISS"*

*/  
"MISS\_EVOL"*

*/  
"MISS\_IMPE"*

*Module “PRE\_MISS” indicates that one calls only the module generating preprocessing data for MISS3D.*

*Module “MISS\_EVOL” indicates that one calls only the module of calculation MISS3D then it modulate postprocessing to make the results useable for Code\_Aster. It module comes in complement from the precedent.*

*Module “MISS\_IMPE” indicates that one calculates only the impedances of ground by frequency.*

### **3.2 Operand**

**UNITE\_IMPR\_ASTER**

**UNITE\_IMPR\_ASTER = uimpast**

*Logical number of unit on which one recovers the file of Code\_Aster-MISS3D interface filled by operators IMPR\_MACR\_ELEM format “MISS\_3D” [U7.04.33] and IMPR\_MISS\_3D [U7.03.11].*

### **3.3 Operand**

**UNITE\_OPTI\_MISS**

**UNITE\_OPTI\_MISS = uopmis**

*Logical number of unit of the file containing of the specific data of calculation for MISS3D: type of interface (ISS or ISFS), type of foundation, frequencies of calculation.*

### **3.4 Operand**

**UNITE\_MODELE\_SOL**

**UNITE\_MODELE\_SOL = umodsol**

*Logical number of unit of the file containing the data of description of the stratifications of ground and of the spectral parameters of calculation of the functions of Green.*

### **3.5 Operand**

**UNITE\_RESU\_IMPE**

**UNITE\_RESU\_IMPE = uresimp**

*Logical number of unit of the file containing the impedances of ground per frequency results of MISS3D. This file is filled only if one calls upon module “MISS\_IMPE”.*

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**3.6 Operands**

**PROJET/REPertoire**

*One creates for the files given and results of MISS3D by the operand REPERTORY a repertory entered by its complete way on the processing machine. These files will start with one name-radical given by the operand PROJECT.*

**3.7 Operand**

**VERSION**

**VERSION**

**=**

**/“V1\_2”**

**/“V1\_3”**

*Name of the version of MISS3D. By defect version AQ “V1\_2”.*

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**Version**

**8.2**

**Titrate:**

***Procedure IMPR\_FICO\_HOMA***

***Date:***

***31/01/06***

***Author (S):***

***G. Key NICOLAS***

***:***

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***Organization (S): EDF-R & D /SINETICS***

***Instruction manual***

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***Document: U7.04.01***

***Procedure IMPR\_FICO\_HOMA***

***1 Goal***

***To print the file of LOBSTER configuration.***

***This procedure makes it possible to write the whole of the data necessary to the LOBSTER execution:***

***.***

***type of use,***

***.***

*thresholds of refinement and déraffinement of grid,*

*analyze grid.*

**Note:**

*A priori, this procedure should never be employed directly by an end-user.*

*It is activated through the macro-orders of adaptation of grid.*

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**2 Syntax**

**IMPR\_FICO\_HOMA**

(

**TREATMENT =**

**\_F (**

**# choice of a type of treatment**

/

**ADAPTATION =/"RAFF\_DERA"**

,

/

**“REFINEMENT”**

,

/

**“DERAFFINEMENT”**

,

/

**UNIFORM**

=

/

**“REFINEMENT”**

,

/

**“DERAFFINEMENT”**

,

/

**“NOTHING”**

,

/

**INFORMATION**

=

**“YES”**

,

*# Name MED of the grid in entry*

*NOM\_MED\_MAILLAGE\_N = nmmaillagen,*

**[TXM]**

*# If ADAPTATION or UNIFORM*

*# name MED of the grid at exit*

*NOM\_MED\_MAILLAGE\_NP1 = nmmaillagenp1*

,

**[TXM]**

*# number of the current iteration*

*NITER = niter,*

*[I]*

*MAJ\_CHAM =/"YES",*

*/*

*"NOT"*

*,*

*[DEFECT]*

*#*

*Finsi*

*# If ADAPTATION = "REFINEMENT" or ADAPTATION = "RAFF\_DERA"*

*/CRIT\_RAFF\_PE*

*= crp*

*,*

*[R]*

*/*

*CRIT\_RAFF\_ABS*

*=*

*CRA*

*,*

*[R]*

*/*

*CRIT\_RAFF\_REL*

*=*

*crr*

*,*

*[R]*

**# Finsi**

**# If ADAPTATION = “DERAFFINEMENT” or ADAPTATION = “RAFF\_DERA”**

**/CRIT\_DERA\_PE**

**= cdp**

**,**

**[R]**

**/**

**CRIT\_DERA\_ABS**

**=**

**half-value layer**

**,**

**[R]**

**/**

**CRIT\_DERA\_REL**

**=**

**cdr**

**,**

**[R]**

**# Finsi**

**# If refinement, adaptive or uniform**

**NIVE\_MAX**

**=**

**nivmax**

**,**

**[I]**

**# Finsi**

**# So déraffinement, adaptive or uniform**

**NIVE\_MIN**

**=**

**nivmin**

**,**



**[I]**

**# Finsi**

**# If ADAPTATION, names of fields MED related to the indicator**

**NOM\_MED =  
nmindica**

,  
**[TXM]**

**COMPONENT =  
mcindica**

,  
**[TXM]**

**RESULT**

=  
**nrindica**

,  
**[TXM]**

**NOM\_CHAM**

=  
**nhindica**

,  
**[TXM]**

**Selection of the temporal parameter**

/  
**NUME\_ORDRE**

=  
**noindica**

**[I]**

/  
**INST**

=  
**inst**

**[R]**

**I PRECISION**

=

/

**prec**

**[R]**

/

**1.0E-3**

**[DEFECT]**

**I CRITERION =/"RELATIVE"**

**[DEFECT]**

/

**"ABSOLUTE"**

**# Finsi**

)

**# Followed by a border**

**NOM\_MED\_MAILLAGE\_FRONTIERE**

=

**maf**

**[TXM]**

**GROUP\_MA**

=

**l\_grma [l\_gr\_maille]**

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**# Updated of fields on the new grid**

**MAJ\_CHAM = \_F (**

**NOM\_MED =**

**nmchamp**

**[TXM]**

**Selection of the temporal parameter**

**/**

**RESULT**

**=**

**resu**

**[evol\_elas]**

**[evol\_noli]**

**[evol\_ther]**

**[evol\_thme]**

**NOM\_CHAM**

**=**

**nom symb [K16]**

/  
**NUME\_ORDRE**  
=  
**order**  
**[I]**  
/  
**INST**  
=  
**moment**  
**[R]**

**I PRECISION**  
=  
/  
**prec**  
**[R]**  
/  
**1.0E-3**  
**[DEFECT]**

**I CRITERION** =/"RELATIVE"  
**[DEFECT]**  
/  
"ABSOLUTE"

)

**# Management of the types of elements**

**NON\_SIMPLEXE**  
=  
/  
**0**  
**[DEFECT]**

**/ 1**

**/ 2**

**ANALYZE =**

**\_F (**

**/A NUMBER**

**=**

**/"YES"**

**,**  
**[DEFECT]**

**"NOT",**

**/**  
**QUALITY =/"YES"**

**,**  
**[DEFECT]**

**/**  
**"NOT"**

**,**  
**/**

***INTERPENETRATION***

=

/

***“YES”***

,

***[DEFECT]***

/

***“NOT”***

,

/

***CONNEXITY =/“YES”***

,

***[DEFECT]***

/

***“NOT”,***

/

***CUT  
=/“YES”***

,

***[DEFECT]***

***“NOT”,***

)

**LANGUAGE**

=

/

**“FRENCH”**

,

**[DEFECT]**

/

**“FRENCH”**

,

/

**“ENGLISH”**

,

/

**“ENGLISH”**

,

**INFORMATION =/1, [DEFECT]**

/

**2**

,

**# Reference symbol of the files necessary to LOBSTER**

**FICHER\_CONF**

=

**f\_conf**

**[TXM]**

**FICHER\_DONN**

=

**f\_donn**

**[TXM]**

)  
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### **3 Operands**

#### **3.1 Key word**

**TREATMENT**

**TREATMENT = \_F (**

***This operand makes it possible to choose the mode of use of LOBSTER. The selection is done initially among three headings: free adaptation of a grid, uniform adaptation of a grid, information on a grid.***

#### **3.1.1 Operand**

**ADAPTATION**

**/ADAPTATION =/"RAFF\_DERA",**

**/**

**"REFINEMENT"**

**,**

**/**

**"DERAFFINEMENT"**

**,**

***This operand is employed to make free adaptation of a grid. In other words,***



*the decision of (die) refining an element is caught according to the value of an indicator of error calculated before.*

*The choice can be done between three alternatives:*

*“RAFF\_DERA”: the grid is refined and déraffiné according to the indicator of error,*

*“REFINEMENT”: only the function of refinement is activated. Elements with low level of error are not déraffinés,*

*“DERAFFINEMENT”: it is the reverse, only the function of déraffinement is activated. The elements on high level of error are not refined.*

### **3.1.2 Operand UNIFORM**

*/UNIFORM =  
/“REFINEMENT”,  
/  
“DERAFFINEMENT”  
,  
/  
“NOTHING”  
,*

*This operand is employed to make a uniform adaptation of a grid. In others terms, all the elements of the grid are treated same manner, without holding account of an indicator of error. The choice can be done between three alternatives:*

*“REFINEMENT”: all the elements are refined,*

*“DERAFFINEMENT”: all the elements are déraffinés,*

*“NOTHING”: all the elements are preserved; the grid is the same one at the exit as with the entry.*

### **3.1.3 Operand INFORMATION**

*/  
INFORMATION*

=  
"YES"

*In this case, LOBSTER does not adapt the grid but delivers information on sound contents.*

### **3.1.4 Operand**

**NOM\_MED\_MAILLAGE\_N**

**NOM\_MED\_MAILLAGE\_N = nmmaillagen**

*It is the name according to conventions' MED under which the grid of entry in the file is known transferred between Code\_Aster and LOBSTER.*

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### **3.1.5 Operand**

**NOM\_MED\_MAILLAGE\_NP1**

**NOM\_MED\_MAILLAGE\_NP1 = nmmaillagenp1**

*It is the name according to conventions' MED under which will be recorded the grid of exit in file transferred between LOBSTER and Code\_Aster. This data is obligatory when one is done adaptation, free or uniform.*

### **3.1.6 Operand**

**NITER**

***NITER = niter***

***Number of the iteration of the grid of entry in LOBSTER.***

***This number is worth 0 for a grid not having undergone any adaptation. It is worth N for a grid obtained after N adaptations. This data is obligatory when an adaptation, free is made or uniform.***

***3.1.7 Operand***

***MAJ\_CHAM***

***MAJ\_CHAM =***

***/“YES”,***

***/***

***“NOT”***

***,***

***So “YES”, the function of update of fields on the new grid will be activated in LOBSTER.***

***So “NOT”, nothing is done.***

***3.1.8 Operands of the indicator***

***It is necessary to transmit to LOBSTER the characteristics of the indicator of error. It is obligatory to specify***

***under which field name and which name of component the indicator is stored in file MED.***

***Then the alternative is as follows:***

***.***

***that is to say the sequence number was provided in the options of MACR\_ADAP\_MAIL; it is necessary then***

***to inform NUME\_ORDRE,***

***.***

***that is to say one moment was provided in the options of MACR\_ADAP\_MAIL; it is then necessary to inform it***

***key word INST,***

***.***

***either nothing was provided; Aster will choose that which exists for the field specified by RESULT and***

***NOM\_CHAM.***

***3.1.8.1 Operand***

***NOM\_MED***

***NOM\_MED = nmindica***

*Name according to conventions' MED of the field of the indicator of error such as it was written in file transferred between Code\_Aster and LOBSTER. It is a chain of 32 characters.*

### **3.1.8.2 Operand COMPONENT**

*COMPONENT = ncindica*

*Name of the component of the field of the indicator of error which will be actually used for to adapt the grid. It is a chain of 8 characters.*

### **3.1.8.3 Operand NUME\_ORDRE**

*NUME\_ORDRE*

*=*

*noindica*

*It is the sequence number of the field of indicator of error in its file MED.*

### **3.1.8.4 Operand INST**

*INST = inst*

*It is the moment when the indicator of error is retained.*

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**3.1.8.5 Operand  
PRECISION**

**PRECISION = prec**

*Allows to test the equality between the actual value of the moment requested and that presents in file.*

**3.1.8.6 Operand  
CRITERION**

**CRITERION = crit**

*Specify if the test of equality takes place in absolute or relative.*

**3.1.8.7 Operand  
RESULT**

**RESULT  
= nrindica**

*It is the name of the concept result associated with the indicator of error.*

**3.1.8.8 Operand  
NOM\_CHAM**

**NOM\_CHAM  
= nhindica**

*It is the field name symbolic system associated with the indicator with error.*

**3.1.9 Operand  
CRIT\_RAFF\_xxxx**

*In the case of free adaptation implying of the refinement of grid, it is necessary to define a high criterion of error. All the elements whose error is higher than this criterion will be refined. Three alternatives are possible:*

**3.1.9.1 Operand  
CRIT\_RAFF\_PE**

***/CRIT\_RAFF\_PE = crp***

***The criterion is defined by a proportion of elements to refine. It is a real number included/understood between 0 and 1. The process is as follows:***

•  
***calculation of the number of elements  $N$  corresponding to the proportion defined by  $crp$  is***  
 ***$N = crp \times$  numbers total elements,***

•  
 ***$N$  elements with the strongest error will be refined.***

### ***3.1.9.2 Operand***

***CRIT\_RAFF\_ABS***

***/CRIT\_RAFF\_ABS = CRA***

***The criterion is defined by an absolute value of the error. All elements with an error higher than this value will be refined.***

### ***3.1.9.3 Operand***

***CRIT\_RAFF\_REL***

***/CRIT\_RAFF\_REL = crr***

***The criterion is defined by a relative value of the error. It is a number ranging between 0 and 1. The process is as follows:***

•  
***calculation of the minimal and maximum values of the indicator of error,***

•  
***calculation of the value corresponding to the proportion of error:  $v = v_{min} + crr (v_{max} - v_{min})$ ,***

•  
***all the elements whose error is higher than this value will be refined.***

### ***3.1.10 CRIT\_DERA\_xxxx operand***

***In the case of free adaptation implying of déraffinement, it is necessary to define a low criterion of error. All the elements whose error is lower than this criterion will be déraffinés. Three alternatives are possible.***

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### **3.1.10.1 Operand CRIT\_DERA\_PE**

**/CRIT\_DERA\_PE = cdp**

**The criterion is defined by a proportion of elements in déraffiner. It is a number included/understood enters**

**0 and 1. The process is as follows:**

**.  
calculation of the number of elements  $N$  corresponding to the proportion defined by  $cdp$  is  $N = cdp \times$  numbers total elements**

**.  
 $N$  elements with the weakest error will be déraffinés.**

### **3.1.10.2 Operand CRIT\_DERA\_ABS**

**/CRIT\_DERA\_ABS = half-value layer**

**The criterion is defined by an absolute value of the error. All elements with an error lower than this value will be déraffinés.**

### **3.1.10.3 Operand CRIT\_DERA\_REL**

**/CRIT\_DERA\_REL = cdr**

*The criterion is defined by a relative value of the error. It is a number ranging between 0 and 1. The process is as follows:*

*· calculation of the minimal and maximum values of the indicator of error,*

*· calculation of the error value  $V$  corresponding to the proportion of  $cdr$  error such as:  $v = v_{min} + cdr (v_{max} - v_{min})$ ,*

*· all the elements whose error is lower than this value will be *déraffinés*.*

### ***3.1.11 Operand NIVE\_MAX***

***NIVE\_MAX = nivmax***

*It is the maximum level of refinement of the grid. In other words an element of the initial grid could not be divided more  $nivmax$  time as a whole of the process.*

### ***3.1.12 Operand NIVE\_MIN***

***NIVE\_MIN = nivmin***

*It is the minimal level of *déraffinement* grid. I.e. only elements resulting of at least  $nivmin$  cuttings of grid can be *déraffinés*.*

### ***3.1.13 Operand NOM\_MED\_MAILLAGE\_FRONTIERE***

***NOM\_MED\_MAILLAGE\_FRONTIERE = nmmaf***

*It is the name under which the grid of the border in file MED is known.*

### ***3.1.14 Operand GROUP\_MA***

***GROUP\_MA = l\_grma***

*Give the list of the groups of meshes defining the border.*

## ***3.2 Word***

*key*

***MAJ\_CHAM***

***MAJ\_CHAM = \_F (***

*This key word is to be employed once as many as one has fields to update between the old one grid and adapted grid.*



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**3.2.1 Operand**

**NOM\_MED**

**NOM\_MED**

**=**

**nmchamp**

**Name MED of the field to be updated.**

**3.2.2 Selection of the temporal parameter**

**The selection of the sequence number associated with the field to be interpolated is done by the designation of a number of order or a value of moment or by locating the field in the structure of result.**

**3.2.2.1 Operand**

**RESULT**

**/RESULT = resu**

**Name of the concept [result] containing the field to be updated.**

**3.2.2.2 Operand**

**NOM\_CHAM**

***NOM\_CHAM = nomch***

***Reference symbol of the field to be updated.***

### ***3.2.2.3 Operand***

***NUME\_ORDRE***

***/  
NUME\_ORDRE***

***=  
nochamp***

***It is the sequence number of the field to be updated in its file MED.***

### ***3.2.2.4 Operand***

***INST***

***/INST = inst***

***It is the moment when the field is retained.***

## ***3.3 Word***

***key  
NON\_SIMPLEXE***

***NON\_SIMPLEXE***

***=  
/  
0  
[DEFECT]***

***1***

2

*In its current version, LOBSTER can read all the types of elements but does not make carry the analysis that on some: mesh-points, segments, triangles, quadrangles and tetrahedrons.*

*By retaining option 0, the transmission of a grid containing another thing that simplexes a stop in error will involve.*

*By choosing option 1, one will be able to transmit a grid comprising any type of element. The analysis will relate only to the zone in simplexes or quadrangles.*

*With option 2, one authorizes the analysis only for one grid which contains exclusively elements which LOBSTER can treat: segments, triangles, quadrangles and tetrahedrons. The presence hexahedrons or pentahedrons will cause a stop in error. It is the default option.*

### **3.4 Word**

**key**

**ANALYZE**

**ANALYZE = \_F (**

*Allows to specify the type of analysis wished for the grid.*

#### **3.4.1 Operand**

**QUALITY**

**/**  
**QUALITY**

**=**

**/**  
**“YES”**

**,**

**[DEFECT]**

**/**  
**“NOT”**

**,**

*So “YES”, a summary of the quality of the elements of the grid will be published.*

*So “NOT”, nothing is done.*

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### **3.4.2 Operand**

#### **INTERPENETRATION**

/  
*INTERPENETRATION*

=

/  
"YES"

,

[DEFECT]

/

"NOT"

,

So "YES", *LOBSTER* tests if the elements of the grid do not overlap.

So "NOT", nothing is done.

### **3.4.3 Operand**

#### **NUMBERS**

/  
*NUMBERS*

=

/  
"YES"

,

[DEFECT]

“NOT”

,  
*So “YES”, a summary of the numbers of nodes and elements are printed.  
So “NOT”, nothing is done.*

### **3.4.4 Operand CONNEXITY**

/  
CONNEXITY  
=  
/  
“YES”

,  
[DEFECT]  
“NOT”

,  
*So “YES”, information on the connexity of the elements of the grid is printed.  
So “NOT”, nothing is done.*

### **3.4.5 Operand CUT**

/  
CUT  
=  
/  
“YES”

,  
[DEFECT]  
“NOT”

,  
*So “YES”, the sizes of the various under-fields are printed.  
So “NOT”, nothing is done.*

### **3.5 Operand LANGUAGE**

LANGUAGE  
=

“FRENCH”

,  
[DEFECT]

“FRENCH”

,  
“ENGLISH”

,  
“ENGLISH”

,

*The operand defines the language used for the messages resulting from LOBSTER.*

### **3.6 Operand**

#### **FICHIER\_CONF**

*FICHIER\_CONF = f\_conf*

*Reference symbol of the file of configuration for LOBSTER which will be written by this procedure.*

### **3.7 Operand**

#### **FICHIER\_DONN**

*FICHIER\_DONN = f\_donn*

*Reference symbol of the data file for LOBSTER which will be written by this procedure.*

### **3.8 Operand**

#### **INFORMATION**

*INFORMATION =*

*/ 1 ,*

*/*

*2*

*,*

*If INFORMATION is worth 2, some impressions of débogage take place.*

*If not, nothing takes place.*

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*Version*

8.2

*Titrate:*

*Procedure IMPR\_FICO\_HOMA*

*Date:*

31/01/06

*Author (S):*

**G. Key NICOLAS**

:

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#### **4 Example**

***IMPR\_FICO\_HOMA (TREATMENT = \_F (NOM\_MED\_MAIILLAGE\_N=' MZERO',  
INFORMATION=' OUI'),***

***ANALYZE = \_F (QUALITY = "YES",  
INTERPENETRATION***

***=***

***"YES"),***

***REFERENCE MARK***

***=***

***"MZERO\_INFO")***

***This order will involve the writing of a file of configuration requiring of LOBSTER to analyze a grid. This file will reside in sub-directory MZERO\_INFO of the current directory.***

***Instruction manual***

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***Code\_Aster ®***

***Version***

**7.4**

***Titrate:***

***Procedure IMPR\_MISS\_3D***

**Date:**  
**08/02/05**  
**Author (S):**  
**G. DEVESA Key**  
**:**  
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**Organization (S): EDF-R & D /AMA**

**Instruction manual**  
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**Document: U7.04.11**

**Procedure IMPR\_MISS\_3D**

**1 Goal**

**To write on a file the data input for a seismic study with MISS3D.**

**The data transmitted by procedure IMPR\_MISS\_3D are:**

**.**  
**the contribution of the loads intern with a superstructure in the form of a second member projected on a modal basis made up of clean or constrained modes,**



.  
*signals of harmonic excitation or transient associated with these loads,*

.  
*signals of seismic excitation,*

.  
*parameters of calculation of the harmonic or transitory evolution.*

*The ground or the fluid is modelled by code MISS3D and the superstructures by Code\_Aster which provides for them a dynamic macronutrient printed on the file of interface by IMPR\_MACR\_ELEM [U7.04.33] with format "MISS\_3D".*

*The call to this procedure is répetable. With each call an evolution calculated corresponds by MISS3D whose launching is ensured by MACRO\_MISS\_3D [U7.03.11].*

*Instruction manual*

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**Code\_Aster** ®

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Titrate:

Procedure IMPR\_MISS\_3D

Date:

08/02/05

Author (S):

**G. DEVESA** Key

:

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## **2 Syntax**

**IMPR\_MISS\_3D (**

**MACR\_ELEM\_DYNA = macro\_dyna,**  
**[macr\_elem\_dyna]**

/  
**EXCIT = \_F**  
(  
**VECT\_ASSE = vecas,**  
**[cham\_no\_DEPL\_R]**

**/FONC\_MULT = fonc, [function]**

/  
**COEF\_MULT**  
=  
**coef**  
**, [R]**

)

/  
**EXCIT\_SOL = \_F**  
**(DIRECTION = (d1, d2, d3), [l\_R]**

**FONC\_SIGNAL = fonc,**

**[function]**

**NOM\_CHAM**  
=/"DEPL", [DEFECT]  
/  
"QUICKLY",  
/  
"ACCE",  
/  
"FORC",  
  
)

**/INST\_INIT**  
=  
**tini**  
,  
[R]  
**INST\_FIN**  
=  
**tfin**  
,  
[R]  
/  
**FREQ\_INIT**  
=  
**finished**  
,  
[R]  
**FREQ\_FIN**

=  
***ffin***  
,

***NOT***  
=  
***not***

,

***[R]***

***UNIT***  
= /  
***links***

,

***[I]***  
/  
26

,

***[DEFECT]***

***INFORMATION***

=  
/  
1,  
***[DEFECT]***

/ 2,

## **TITRATE**

= *title*,

[*l\_Kn*]

)

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**Date:**

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**Author (S):**

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### **3 Operands**

#### **3.1 Operands**

**MACR\_ELEM\_DYNA**

**MACR\_ELEM\_DYNA = macro\_dyn**

**Name of the concept *macr\_elem\_dyn* produces by projection on the basis of modal clean mode and static modes of a superstructure modelled by Code\_Aster.**

#### **3.2 Word**

**key**

**EXCIT**

/  
**EXCIT**

**Key word factor defining the loads intern with this structure. Can be repeated for to summon several loads associated with different signals.**

**3.2.1 Operand**  
**VECT\_ASSE**

**VECT\_ASSE = vecas**

**Vector assembled correspondent with a loading applied to this structure (concept of the type cham\_no\_DEPL\_R).**

**3.2.2 Operands**  
**FONC\_MULT/COEF\_MULT**

**Allow respectively to define the signal or the multiplying coefficient of the definite loading in key word EXCIT.**

**/FONC\_MULT = fonc**

**Evolution defined point by point by a concept of the function type having for parameter frequency  $F$  or time  $T$  according to the type (harmonic or transitory) of the dynamic evolution calculated by MISS3D.**

**/COEF\_MULT = coef**

**Multiplying coefficient of the loading independent of the loading.**

**3.3 Word**  
**key**  
**EXCIT\_SOL**

/  
**EXCIT\_SOL**

**Key word factor defining the loads resulting from the ground, given by their direction, their type and it signal in associated time or frequency. Can be repeated to summon several loads resulting from ground. It is compatible with key word EXCIT to combine in the same evolution calculated by MISS3D of the loads applied directly to the structure or resulting from the ground.**

### **3.3.1 Operand**

#### **DIRECTION**

**DIRECTION = (d1, d2, d3)**

**Components of the vector direction of load, renormé to 1. , according to which one recombines the effects**

**of an incidental wave P vertical with those of transverse waves SV and HS.**

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**Date:**

**08/02/05**

**Author (S):**

**G. DEVESA Key**

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### **3.3.2 Operand**

#### **FONC\_SIGNAL**

**Allows to define the multiplying signal of the loading resulting from the ground defined in key word EXCIT\_SOL.**

**FONC\_SIGNAL = fonc**

**Evolution defined point by point by a concept of the function type having for parameter frequency F or time T according to the type (harmonic or transitory) of the dynamic evolution calculated by MISS3D.**

### **3.3.3 Operand**

#### **NOM\_CHAM**

**Allows to define the type of imposition of a request resulting from the ground.**

### ***NOM\_CHAM***

***=/“DEPL”***

***/***

***“QUICKLY”***

***/***

***“ACCE”***

***/***

***“FORC”***

***The request is respectively in displacement, speed, acceleration or imposed force.***

### ***3.4 Operands***

***INST\_INIT/INST\_FIN***

***Present in the case of a transitory calculation by MISS3D.***

***/INST\_INIT = tini***

***Moment of beginning of transitory calculation.***

***INST\_FIN = tfin***

***Moment of end of transitory calculation.***

### ***3.5 Operands***

***FREQ\_INIT/FREQ\_FIN***

***Present in the case of a harmonic calculation by MISS3D.***

***/FREQ\_INIT = finished***

***Frequency of beginning of harmonic calculation.***

***FREQ\_FIN = ffin***

***Frequency of end of harmonic calculation.***

### ***3.6 Operand***

***NOT***

***NOT = not***



***Step value of time or frequency according to the nature (transitory or harmonic) of calculation.***

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***Date:***

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***G. DEVESA Key***

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***3.7 Operand***

***UNIT***

***UNIT = links***

***Logical number of unit for the impression with the format of code MISS3D.***

***3.8 Operand***

***TITRATE***

***TITRATE = title***

***Allows the user to define the evolution calculated by MISS3D. Appears in the file written with format of code MISS3D.***

***3.9 Operand***

***INFORMATION***

## **INFORMATION**

***Indicate a level of impression for information in the file "MESSAGE".***

***/1***

***Impression of the title (if there exists) and of the number of modes of the modal base of projection of dynamic macronutrient.***

***/2***

***Impression of the characteristics of loadings and the associated signals.***

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***Procedure IMPR\_MISS\_3D***

***Date:***

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***Author (S):***

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*Code\_Aster ®  
Version  
7.4*

*Titrate:  
Procedure IMPR\_CLASSI*

*Date:  
01/02/05  
Author (S):  
G. DEVESA, Key P. LATRUBESSE  
:  
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*Organization (S): EDF/R & D /AMA, SAMTECH*

*Instruction manual  
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Document: U7.04.21*

## ***Procedure IMPR\_CLASSI***

### ***1 Goal***

***To write the result of a modal analysis to the format of code CLASSI.***

***This written procedure:***

- .  
the description of the nodes (coordinated, ddl free = 0, ddl blocked = 1),***
- .  
the diagonal of the matrix of mass to the free ddl,***
- .  
the mode (frequency, reduced damping, modal deformation for the components of the ddl free),***
- .  
Selective writing of active numbers of ddl in the file result.***

***Code CLASSI (interaction ground-structure) acquired by the SEPTEN (at the UCLA) is maintained by him. It makes it possible starting from the modal analysis of one or more buildings to carry out the calculation of response to a seismic excitation with interaction ground-structure for homogeneous grounds or laminates. This procedure results from the resorption of the code LICE.***

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***7.4***

***Titrate:***

***Procedure IMPR\_CLASSI***

***Date:***

**01/02/05**

**Author (S):**

**G. DEVESA, Key P. LATRUBESSE**

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**2 Syntax**

**IMPR\_CLASSI**

**(**

**UNITE\_CLASSI**

**=**

**links**

**,**

**[I]**

**MODE\_MECA = mode, [mode\_meca]**

**/**

**TOUT\_ORDRE**

**=**

**“YES”,**

**[DEFECT]**

**/**

**NUME\_ORDRE**

**=**

**l\_nuor, [l\_I]**

/  
**NUME\_MODE**

=  
**l\_numo, [l\_I]**

/  
**FREQ**

=  
**freq**  
**[l\_R]**

**I PRECISION**

=  
/  
**prec,**  
**[l\_R]**

/  
**1.0D-3**

,  
**[DEFECT]**

**I CRITERION =**  
**/"RELATIVE",**

**[DEFECT]**  
/  
**"ABSOLUTE"**

,  
/  
**LIST\_FREQ**

=

*l\_freq,*  
*[listr8]*

***I PRECISION***

=  
/  
*prec,*  
*[l\_R]*  
/  
***1.0D-3***  
,  
***[DEFECT]***

***I CRITERION =***  
***/"RELATIVE",***

***[DEFECT]***  
/  
***"ABSOLUTE"***  
,

***AMOR = l\_amor [l\_R]***

***IMPRESSION***

**=\_F (/**  
**NODE =**  
**lno**  
**, [l\_noeud]**

**/**  
**GROUP\_NO =lgno, [l\_gr\_noeud]**

**NOM\_CMP**  
**=**  
**I `DX',**

**I `DY',**



***I `DZ',***

***I `DRX',***

***I `DRY',***

*I `DRZ',*

)

);

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**Code\_Aster** ®

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Titrate:

Procedure *IMPR\_CLASSI*

Date:

01/02/05

Author (S):

**G. DEVESA, Key P. LATRUBESSE**

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### **3 Operands**

#### **3.1 Operand**

***UNITE\_CLASSI***

***UNITE\_CLASSI = links***

***Logical number of unit on which one prints the results.***

#### **3.2 Operand**

***MODE\_MECA***

***MODE\_MECA = mode***

***Name of the concept of the mode\_meca type.***

### **3.3**

***Extraction in the concept mode\_meca***

#### **3.3.1 Operand**

***TOUT\_ORDRE***

***/TOUT\_ORDRE = "YES" (default value)***

***This key word indicates that one wants to print all the already calculated modes.***

#### **3.3.2 Operand**

***NUME\_ORDRE***

/

***NUME\_ORDRE = l\_nuor***

*The extraction will be done for the values of sequence number l\_nuor provided.*

**3.3.3 Operand**  
***NUME\_MODE***

/

***NUME\_MODE = l\_numo***

*The extraction will be done for the values of number of l\_numo mode provided.*

**3.3.4 Operand**  
***FREQ***

/

***FREQ = freq***

*The extraction will be done at the provided frequencies freq.*

***PRECISION = prec***

*This key word makes it possible to indicate that one seeks the field whose frequency is in an interval defined by the absolute or relative position:*

***“freq ± freq” (cf CRITERION).***

***By defect prec = 1.0D-3.***

***CRITERION =***

***“RELATIVE”: the interval of research is: [freq (1-prec), freq (1+prec)]***

***“ABSOLUTE”: the interval of research is: [freq-prec, freq+prec]***

***By defect, the criterion is relative.***

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**Titrate:**

**Procedure IMPR\_CLASSI**

**Date:**

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**Author (S):**

**G. DEVESA, Key P. LATRUBESSE**

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**3.3.5 Operand**

**LIST\_FREQ**

**/**

**LIST\_FREQ = l\_freq**

*The extraction will be done at the frequencies described in the concept l\_freq of the listr8 type.*

**PRECISION = prec, by defect prec = 1.0D-3.**

*This key word makes it possible to indicate that one seeks the field whose frequency is in an interval defined by the absolute or relative position:*

**“freq ± freq” (cf CRITERION).**

**CRITERION =**

**.**

**“RELATIVE”: the interval of research is: [freq (1-prec), freq (1+prec)]**

**.**

**“ABSOLUTE”: the interval of research is: [freq-prec, freq+prec]**

*By defect, the criterion is relative.*

### **3.4 Operand**

**AMOR**

*AMOR = l\_amor*

*List of type [l\_R] values of reduced modal damping.*

### **3.5 Word**

*key*

**IMPRESSION**

*Selective writing of the active numbers of ddl in the file result.*

#### **3.5.1 Operands**

**NODE and GROUP\_NO**

*One can specify either a list of nodes, or a list of groups of nodes. It will be posted for each node of the selection a list of ddl active (a line by node).*

#### **3.5.2 Operand**

**NOM\_CMP**

*Allows to limit the impression to some components. If NOM\_CMP does not appear, they will be posted*

*active numbers of ddl of all the components (6 maximum).*

*Example:*

```
=_F IMPRESSION (NODE = ("NO1", "NO10", "NO20")),  
=_F IMPRESSION (NODE = ("NO1", "NO17", "NO18", "NO19"),  
NOM_CMP = ("DY", "DX", "DRX", "DRZ")  
)  
=_F IMPRESSION (GROUP_NO = ("AXIS", "NEW"),  
NOM_CMP = ("DX", "DZ")  
)
```

*will give the following impression on the file result:*

**IMPR\_CLASSI: WRITING OF THE NUMBERS OF ACTIVE DDL**

**NODE**

**NO1 1 2 3 4 5 0**

**NO10 0 0 0 0 0 0**

***NO20 31 32 33 34 35 0***

***NODE DY DX DRX DRZ***

***NO1 2 1 4 0***

***NO17 0 0 0 0***

***NO18 0 0 0 0***

***NO19 27 26 29 0***

***NODE DX DZ***

***NO1 1 3***

***NO14 11 13***

***NO19 26 28***

***NO20 31 33***

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***Procedure IMPR\_CLASSI***

***Date:***

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***Author (S):***

***G. DEVESA, Key P. LATRUBESSE***

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***4***

***Vertical Post example, embedded free, defined in 3 nodes***

***After having defined material, the model, the loads, the matrices of rigidity and mass, us let us calculate the modes of the structure:***

***mode\_mec = MODE\_ITER\_SIMULT (MATR\_A = rigidity, MATR\_B = mass,***

**CALC\_FREQ =\_F (OPTION = "PLUS\_PETITE", NMAX\_FREQ = 5));**

**The order below prints the modes with format CLASSI:**

**IMPR\_CLASSI (UNIT CLASSI = 8, MODE\_MECA = mode\_meca, AMOR = 0.03  
)  
;**

**The file unit 8 contains:**

**0.00000 0.00000 0.00000 1 1 1 1 1  
0.50000 0.00000 0.00000 0 0 0 0 0  
10.00000 0.00000 0.00000 0 0 0 0 0  
5.000E+04 5.000E+04 5.000E+04 0.000E+00 0.000E+00 0.000E+00 5.000E+03 5.000E+03  
5.000E+03 0.000E+00 0.000E+00 0.000E+00  
1.550E+00 3.000E- 02% mode 1  
-7.353E-20 5.220E-05 1.177E-18 0.000E+00-2.689E-18 2.070E-04-2.101E-19 1.414E-02  
-4.034E-17 0.000E+00 8.068E-18 2.121E-03  
2.614E+00 3.000E- 02% mode 2  
-4.761E-20-2.657E-19 5.220E-05 0.000E+00-2.070E-04-7.086E-19-9.965E-20 1.814E-17  
1.414E-02 0.000E+00-2.121E-03 3.401E-18  
4.645E+01 3.000E- 02% mode 3  
-1.586E-15 4.472E-03-6.711E-15 0.000E+00 1.742E-14 1.289E-02-3.425E-15-1.651E-04  
-2.518E-16 0.000E+00-1.469E-14-7.176E-03  
7.834E+01 3.000E- 02% mode 4  
9.895E-16-1.894E-14-4.472E-03 0.000E+00 1.289E-02 9.750E-15 4.695E-15 1.087E-15  
1.651E-04 0.000E+00-7.176E-03-8.466E-14  
1.728E+02 3.000E- 02% mode 5  
1.244E-03 1.966E-14 8.601E-15 0.000E+00-5.927E-13-1.765E-12 1.358E-02 5.697E-15  
-2.567E-15 0.000E+00-1.149E-12 3.227E-12**

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**7.4**

**Titrate:**

**Procedure IMPR\_CLASSI**

**Date:**

**01/02/05**



**Author (S):**

**G. DEVESA, Key P. LATRUBESSE**

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***Version***

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***Titrate:***

***Procedure IMPR\_MATRICE***

***Date:***

**31/01/06**

**Author (S):**

**J. Key PELLET**

**:**

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**Organization (S): EDF-R & D /AMA**

**Instruction manual**

**U7.0- booklet: Data exchanges**

**Document: U7.04.32**

**Procedure IMPR\_MATRICE**

**1 Goal**

**To print on a file with format IDEAS or RESULT of the elementary matrices and assemblies.**

**The impressions with the format RESULT are especially useful for the developers of the code at ends of “débuggage”.**

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**Titrate:**

**Procedure IMPR\_MATRICE**

**Date:**

**31/01/06**

**Author (S):**

**J. Key PELLET**

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**2 Syntax**

**IMPR\_MATRICE**

**(**

**/**  
**MATR\_ELEM = \_F (**

**#**  
**impressions in the form of a universal file IDEAS.**

**/**  
**FORMAT**  
**=**  
**“IDEAS”**  
**,**  
**[DEFECT]**

***STAMP = mel***

,  
***[matr\_elem\_DEPL\_R]***

***UNIT***

=  
/  
30,  
***[DEFECT]***

/  
***iunit,***  
***[I]***

***VERSION =***

5,  
***[DEFECT]***

*# impressions in a listing (debuggage):*

/

*FORMAT*

=  
“*RESULT*”,

*STAMP = mel*

,  
/  
*[matr\_elem\_\*]*  
/  
*[vect\_elem\_\*]*

*UNIT*

=  
/  
8,  
*[DEFECT]*  
/  
*iunit,*  
*[I]*

#

*choice*

*meshs*

:

*/ALL = “YES”,*

/|  
*NODE* =  
*l\_no*,

[*l\_noeud*]

/ *GROUP\_NO*  
= *l\_gno*,  
[*l\_group\_no*]

/  
*NET* =  
*l\_ma*,

[*l\_maille*]

/ *GROUP\_MA*  
= *l\_gma*,  
[*l\_group\_ma*]

*NOM\_CMP*  
=

*l\_cmp,*  
*[l\_Kn]*

*GRAIN*  
*= /*  
*“VALUE”,*  
*[DEFECT]*  
*/*  
*“NODE”*  
*,*  
*/*  
*“MESH”,*

*NB\_CHIFFRE =/4*  
*,*  
*[DEFECT]*  
*/*  
*nchif,*  
*[I]*  
*/*  
*999*  
*,*  
*#*  
*precision*  
*max.*

)

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***Code\_Aster*** ®

*Version*

8.2

*Titrate:*

*Procedure IMPR\_MATRICE*

*Date:*

31/01/06

*Author (S):*

**J. Key PELLET**

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/  
*MATR\_ASSE =\_F (*

*# impressions in the form of a universal file IDEAS.*

/  
*FORMAT*  
*=*  
*“IDEAS”*  
*,*  
*[DEFECT]*

*STAMP = chechmate*

*,*  
*[matr\_asse\_DEPL\_R]*



*UNIT*  
=  
/  
30,  
[DEFECT]

/  
*iunit*,  
[I]

*VERSION* =  
5,  
[DEFECT]

*# impressions in a listing (debuggage):*

/  
*FORMAT*  
=  
"RESULT"  
,

*STAMP = mel*

,  
*[matr\_asse\_\*]*

*UNIT*

=

/

8,

*[DEFECT]*

/

*iunit,*

*[I]*

#

*choice*

*nodes*

:

*/ALL = "YES",*

/|  
*NODE* =  
*l\_no*,  
  
[*l\_noeud*]

| *GROUP\_NO*  
= *l\_gno*,  
[*l\_group\_no*]

|  
*NET* =  
*l\_ma*,  
  
[*l\_maille*]

| *GROUP\_MA*  
= *l\_gma*,  
[*l\_group\_ma*]

*OPTION*=/  
“*SOUS\_MATRICE*”  
, [*DEFECT*]  
/

*“LINE”*

,

/

*“COLUMN”*

,

*NOM\_CMP=*

*l\_cmp,*

*[l\_Kn]*

*GRAIN =*

*/“VALUE”,*

*[DEFECT]*

/

*“NODE”*

,

*NB\_CHIFFRE =/4*

,

*[DEFECT]*

/

*nchif,*

*[I]*

/

*999*

,  
#  
*precision*  
*max.*

*VALE\_ZERO*

=  
/  
0.

,  
*[DEFECT]*

/  
*eps,*  
*[R]*

)

)

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### ***3 Operands***

#### ***3.1***

***Impressions in the form of a universal file IDEAS***

##### ***3.1.1 Key word factor MATR\_ELEM***

***Allows to specify to it (S) concept (S) of matr\_elem type to be printed as well as the format of impression.***

###### ***3.1.1.1 Operand***

***FILE***

***FILE =***

***nom\_fich***

***[KN]***

***Name of the file in which one wishes to see printing the data to be transferred. This name of file must be defined beforehand by the procedures BEGINNING [U4.11.01], CONTINUATION [U4.11.03] or DEFI\_FICHER [U4.12.03].***

###### ***3.1.1.2 Operand***

***FORMAT***

***Format under which one wishes to print the data.***

###### ***3.1.1.3 Operand***

***VERSION***

***VERSION =***

5

**[DEFECT]**

*Number of the version of IDEAS corresponding to the format of the file used to print them data. Only version 5 (default value) is supported for the moment.*

#### **3.1.1.4 Operand STAMP**

*STAMP = mel*

*Name of the elementary matrices (standard matr\_elem\_DEPL\_R) that one wishes to print on one file.*

#### **3.1.2 Key word factor MATR\_ASSE**

*Allows to specify to it (S) concept (S) of type matr\_asse to print as well as the format of impression.*

#### **3.1.2.1 Operand FILE**

*FILE =  
nom\_fich*

**[KN]**

*Name of the file in which one wishes to see printing the data to be transferred. This name of file must be defined beforehand by the procedures BEGINNING, CONTINUATION or DEFI\_FICHER.*

#### **3.1.2.2 Operand FORMAT**

*FORMAT*

*=*

*“IDEAS” [DEFECT]*

*Format under which one wishes to print the data. Only the format by defect “IDEAS” is supported for the moment.*

#### **3.1.2.3 Operand**

## **VERSION**

*VERSION =*  
*5*  
*[DEFECT]*

*Number of the version of IDEAS corresponding to the format of the file used to print them data. Only version 5 (default value) is supported for the moment.*

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### **Code\_Aster** ®

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### **3.1.2.4 Operand** **STAMP**

*STAMP = mel*

*Name of the assembled matrix (standard matr\_asse\_DEPL\_R) that one wishes to print on one file.*

## **3.2** **Impressions on listing**

### **3.2.1 Operand** **FORMAT = "RESULT"**



*It is the choice of the format RESULT which makes it possible to print in “light” (on listing) the contents of matrices (or elementary vectors).*

### **3.2.2 What can one print?**

*A priori all concepts of the type MATR\_ASSE\_\* except the MATR\_ASSE\_GENE or MATR\_ELEM\_\* or VECT\_ELEM\_\**

*For the MATR\_ASSE\_\*, one will use the key word factor MATR\_ASSE, for the MATR\_ELEM\_\* (or VECT\_ELEM\_\*), one will use the key word factor MATR\_ELEM.*

### **3.2.3 Operand**

**FILE**

**FILE =**  
*nom\_fich*

**[KN]**

*Name of the file in which one wishes to see printing the treated data. By defect, it acts file “RESULT”.*

### **3.2.4 Operand**

**STAMP**

**STAMP =** *chechmate*

*Name of the assembled or elementary matrix which one wishes to print on a file.*

**Note:**

*One cannot print the matr\_asse\_gene but they are simple objects (full matrices) for which order IMPR\_CO is sufficient.*

### **3.2.5 To select the meshes or the nodes which one wants to print**

#### **3.2.5.1 Case**

**RESUELEM** *(matrix or vector)*

***Choice of the elements which one wants to print:***

***has)***

***/list of meshes: lma***

***only meshes of lma***

***b)/***

***TOUT=' OUI'***

***all meshes***

***c)***

***/list of nodes: lno***

***all meshes resting on at least***

***a node of the list of nodes lno***

***Note:***

***The possibility c) makes it possible to print the matrices (or the vectors) elementary of “Lagrange” which***

***force a physical node which one connait the name.***

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***3.2.5.2 Case***

***MATR\_ASSE***

***Choice of the nodes which one wants to print:***

***has)***

*/list of meshes: lma*

*nodes of the meshes of lma*

*b)/*

*TOUT=' OUI'*

*all "physical " nodes carrying ddls*

*c)*

*/list of nodes: lno*

*only nodes of lno.*

### **3.2.5.3 Word**

*key*

**OPTION**

*By defect (OPTION = "MATRIX"), one prints only the terms of the MATR\_ASSE defined by "under" matrix corresponding to the choice of the nodes which one has just made. If the user asks (OPTION = "LINE"), one will print all the contents of the lines corresponding to the nodes chosen, (in the same way for OPTION = "COLUMN").*

### **3.2.6 To select**

*CMPS to be printed*

*NOM\_CMP = l\_kn list of the components which one wants to print (by defect: all).*

### **3.2.7 Format**

*of impression*

#### **3.2.7.1 General information**

*The matrices, even if they are symmetrical, will be entirely printed: they are "rectangles" full.*

*NB\_CHIFFRE = nchif*

*nchif is the number of decimals to be written for each floating number.*

*VALE\_ZERO = eps*

*One will print only the values whose absolute value is higher than eps. This key word is not valid that for the MATR\_ASSE, to limit the impressions.*

#### **3.2.7.2 Case**

*RESUELEM (matr\_elem or vect\_elem)*

*GRAIN = "VALUE"*

*one prints a value by line of listing.*

*Example: RESUELEM (matrix) = mel NETS = (“M1”, “m2”), NOM\_CMP= “TEMP”*

*M1/NO1/“TEMP”*

*M1/NO1/“TEMP”*

*12.*

*M1/NO1/“TEMP”*

*M1/NO4/“TEMP”*

*12.*

*M1/NO1/“TEMP”*

*M1/NO7/“TEMP”*

*12.*

*M1/NO4/“TEMP”*

*M1/NO4/“TEMP”*

*12.*

*M1/NO4/“TEMP”*

*M1/NO7/“TEMP”*

*12.*

*...*

*M2/NO4/“TEMP”*

*M2/NO4/“TEMP”*

*7.*

*...*

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**J. Key PELLET**

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Example: *RESUELEM* (vector) = mel, *MESH* = "M1", *NOM\_CMP*= "TEMP"

*M1/NO1*/"TEMP"

12.

*M1/NO4*/"TEMP"

12.

*M1/NO7*/"TEMP"

12.

*GRAIN* = "NODE"

In this case, the "grain" of impression is the node.

Example: *RESUELEM* (matrix) = mel, *MESH* = "M1", *NOM\_CMP*= ("DX", "DZ")

*M1/NO1 X NO1*

*DX*

*DZ*

*DX* 12.

13.

*DX* 13.

15.

*M1/NO1 X NO4*

*DX*

*DZ*

*DX* 12.

13.

*DX 13.*

*15.*

...

*GRAIN = "MESH"*

*In this case, the "grain" of impression is the mesh.*

*Example: RESUELEM = mel, MESH = "M1", NOM\_CMP= ("DX", "DZ")*

*M1*

*N1/DX N1/DZ N3/DX N3/DZ...*

*N1/DX 12. 13. 14. 15. ...*

*N1/DZ 13. 13. 14. 15. ...*

*N3/DX 14. 14. 14. 15. ...*

...

### **3.2.7.3 MATR\_ASSE**

*For a MATR\_ASSE, one will print only the "grains" for which at least a value is nonnull (see key word VALE\_ZERO in the 3.2.7.1 paragraph).*

*GRAIN = "VALUE"*

*one prints a value by line of listing.*

*Example: MATR\_ASSE=matass, NOEUD= ("NO1", "NO3", "NO7"), NOM\_CMP= ("DX", "DZ"),*

**OPTION**

=

**"SOUS\_MATRICE"**

**NO1/"DX"**

**NO1/"DX"**

**12.**

**NO1/"DX"**

**NO1/"DZ"**

**12.**

**NO1/"DX"**

**NO3 "DX"**

**12.**

**NO1/"DX"**

**NO3 "DZ"**

**12.**

**NO1/“DX”**

**NO7/“DX”**

**12.**

**NO1/“DX”**

**NO7/“DZ”**

**12.**

**NO3 “DX”**

**NO3 “DX”**

**12.**

**NO3 “DX”**

**NO3 “DZ”**

**12.**

**...**

**NO7/“DZ”**

**NO7/“DZ”**

**12.**

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***Example: MATR\_ASSE = matass, NODE = (“NO1”), NOM\_CMP= (“DX”, “DZ”),***

***OPTION***

***=***

***“COLUMN”***

***NO1***

**/“DX”**  
**NO1/“DX”**  
**12.**  
**NO1**  
**/“DX”**  
**NO1/“DZ”**  
**12.**  
**NO1**  
**/“DZ”**  
**NO1/“DX”**  
**12.**  
**NO1**  
**/“DZ”**  
**NO1/“DZ”**  
**12.**  
**NO2**  
**/“DX”**  
**NO1/“DX”**  
**12.**  
**NO2**  
**/“DX”**  
**NO1/“DZ”**  
**12.**  
**NO2**  
**/“DZ”**  
**NO1/“DX”**  
**12.**  
**NO2**  
**/“DZ”**  
**NO1/“DZ”**  
**12.**  
**NO3**  
**/“DX”**  
**NO1/“DX”**  
**12.**  
**NO3**  
**/“DX”**  
**NO1/“DZ”**  
**12.**  
**...**



**NO999**  
**/“DZ”**  
**NO1/“DX”**  
**12.**  
**NO999**  
**/“DZ”**  
**NO1/“DZ”**  
**12.**

*Example: MATR\_ASSE = matass, NODE = (“NO1”), NOM\_CMP= (“DX”, “DZ”),*

**OPTION**  
**=**  
**“LINE”**  
**NO1/“DX”**  
**NO1**  
**/“DX”**  
**12.**  
**NO1/“DZ”**  
**NO1**  
**/“DX”**  
**12.**  
**NO1/“DX”**  
**NO1**  
**/“DZ”**  
**12.**  
**...**

**NO1/“DX”**  
**NO999/“DZ”**  
**12.**  
**NO1/“DZ”**  
**NO999/“DZ”**  
**12.**

**GRAIN = “NODE”**

*In this case, the “grain” of impression is the node.*

*Example: MATR\_ASSE= matass, NODE = (“NO1”, “NO3”), NOM\_CMP= (“DX”, “DZ”)*

***NO1 X NO1***

***DX***

***DZ***

***DX 12.***

***13.***

***DX 13.***

***15.***

***NO1 X NO3***

***DX***

***DZ***

***DX 12.***

***13.***

***DX 13.***

***15.***

***NO3 X NO3***

***DX***

***DZ***

***DX 12.***

***13.***

***DX 13.***

***15.***

***...***

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**4 Examples****One wants:**

- 1) elementary matrices corresponding to the meshes S1 and S2,
- 2) 1 table by mesh,
- 3) 2 significant figures for the floating numbers,
- 4) one is interested only in the components DY and DRZ.

```

matel = CALC_MATR_ELEM (...)
IMPR_MATRICE (
MATR_ELEM = _F (
STAMP
=
matel,
FORMAT = "RESULT",
FILE = "RESULT",
NET = ("S1", "S2"),
GRAIN = "MESH",
NOM_CMP = ("DY", "DRX"),
NB_CHIFFRE = 2))

```

**One obtains in the file RESULT:**


---

**! LIGREL = MO .MODELE OPTION = RIGI\_MECA\_GE!**

---



---

**! S1! N1/DY! N1/DRX! N2/DY! N2/DRX!**

---

**! N1/DY! -5.3E-03! 5.8E-02! 5.3E-03! 5.8E-02!**

---

**! N1/DRX! 5.8E-02! -2.1E+01! -5.8E-02! 1.1E+01!**

---

**! N2/DY! 5.3E-03! -5.8E-02! -5.3E-03! -5.8E-02!**

---

**! N2/DRX! 5.8E-02! 1.1E+01! -5.8E-02! -2.1E+01!**

---



---

**! S2! N2/DY! N2/DRX! N3/DY! N3/DRX!**

---

***! N2/DY! -5.3E-03! 5.8E-02! 5.3E-03! 5.8E-02!***

---

***! N2/DRX! 5.8E-02! -2.1E+01! -5.8E-02! 1.1E+01!***

---

***! N3/DY! 5.3E-03! -5.8E-02! -5.3E-03! -5.8E-02!***

---

***! N3/DRX! 5.8E-02! 1.1E+01! -5.8E-02! -2.1E+01!***

---

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*Version*

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*Titrate:*

*Procedure IMPR\_MACR\_ELEM*

*Date:*

*31/01/05*

*Author (S):*

*O. NICOLAS, G. DEVESA Key*

*:*

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*Organization (S): EDF-R & D /AMA*

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*Document: U7.04.33*

## ***Procedure IMPR\_MACR\_ELEM***

### ***1 Goal***

***To print with formats IDEAS, MISS\_3D, PLEXUS and CADYRO a structure of data macr\_elem\_dyna.***

### ***One prints:***

***.  
the definition of an interface of connection between a macrostructure and its environment outside,  
.***

***a modal base (dynamic modes of the macrostructure and static modes resulting is the unit displacements imposed on the interface, is unit efforts imposed on the interface),  
.***

***matrices of mass and rigidity of the macrostructure projected on the modal basis the preceding one.***

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### ***Titrate:***

***Procedure IMPR\_MACR\_ELEM***

### ***Date:***

***31/01/05***

### ***Author (S):***

***O. NICOLAS, G. DEVESA Key***

***:***

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## ***2 Syntax***

***IMPR\_MACR\_ELEM (***

***MACR\_ELEM\_DYNA=melem,  
[macr\_elem\_dyna]***

***FORMAT=/  
“IDEAS”,  
[DEFECT]***

***UNITE=  
/  
30, [DEFECT]  
/  
links,  
[I]***

***VERSION:  
5,  
[DEFECT]***

***/"PLEXUS",***

*UNITE=*  
*/*  
*30, [DEFECT]*  
*/*  
*links,*  
*[I]*

*VERSION:*  
*5,*  
*[DEFECT]*

*/*  
*“MISS\_3D”,*

*UNITE=*  
*/*  
*26, [DEFECT]*



/  
*links,*  
*[1]*

*SOUS\_TITRE =*  
*l\_st,*  
*[l\_Kn]*

/  
*AMOR\_REDUIT*  
*=*  
*lam,*  
*[l\_R]*  
/  
*LIST\_AMOR =*  
*l\_amor*  
,  
*[litr8]*

*GROUP\_MA\_INTERF= gr\_inter, [l\_group\_ma]*

*GROUP\_MA\_FLU\_STR= gr\_flustr,  
[l\_group\_ma]*

*GROUP\_MA\_FLU\_SOL= gr\_flusol,  
[l\_group\_ma]*

*GROUP\_MA\_SOL\_SOL= gr\_flusol,  
[l\_group\_ma]*

*IMPR\_MODE\_STAT=  
/  
“YES”,  
[DEFECT]  
/  
“NOT”,*

*IMPR\_MODE\_MECA=*

*/*

*“YES”,*

*[DEFECT]*

*/*

*“NOT”,*

*/*

*“CADYRO”,*

*SKELETON*

*=*

*squel,*

*[skeleton]*

*UNITE\_MODE\_MECA=/26,*

*[DEFECT]*

*/*

*n\_mode\_meca,*

*[1]*

*UNITE\_MODE\_STAT*=/27,  
[DEFECT]  
/  
*n\_mode\_stat*,  
[I]

*UNITE\_MAILLAGE*=/28,  
[DEFECT]  
/  
*n\_maillage*,  
[I]

*IMPR\_MODE\_MECA*=  
/  
"YES",  
[DEFECT]  
/  
"NOT",

*IMPR\_MODE\_STAT*=  
/  
"YES",  
[DEFECT]  
/  
/

“NOT”,

);  
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*Titrate:*

*Procedure IMPR\_MACR\_ELEM*

*Date:*

31/01/05

*Author (S):*

**O. NICOLAS, G. DEVESA** *Key*

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### **3 Operands**

#### **3.1 Operand**

**MACR\_ELEM\_DYNA**

**MACR\_ELEM\_DYNA**

=

**melem**

**[macr\_elem\_dyna]**

*Name of the concept of the macr\_elem\_dyna type which one wishes to print in the file.*

#### **3.2**

**FORMAT = “IDEAS”**

**FORMAT**

=

/

**“IDEAS” [DEFECT]**

*Allows to specify the format of impression. Format “IDEAS” is taken by defect. Currently only the impression is carried out according to the specifications of version 5. Compatibility ascending with the versions of IDEAS is thus assured.*

**3.2.1 Operand  
UNIT**

**UNIT**  
= / 30,  
**[DEFECT]**  
/  
**links**  
**[I]**

*This key word makes it possible to define the logical unit of impression in format “IDEAS” (30 per defect).*

**3.2.2 Operand  
VERSION**

**VERSION =**  
/  
5,  
**[DEFECT]**

*This key word makes it possible to define the version of impression in format “IDEAS” (5 per defect).*

**3.3  
FORMAT = “PLEXUS”**

**FORMAT**  
=  
/  
**“PLEXUS”**  
**[DEFECT]**

*Impression of the modal base of type “DIAG\_MASS” to format IDEAS poured 5:*

.  
*matrices of mass and rigidity generalized per block (left static, left dynamics and coupling STAT/DYNA),*

.  
*dynamic clean modes,*

.  
*static modes of the modal base.*

### **3.3.1 Operand UNIT**

**UNIT**  
= / 30,  
[DEFECT]  
/  
*links*  
[I]

*This key word makes it possible to define the logical unit of impression in the format “PLEXUS” (30 per defect).*

### **3.3.2 Operand VERSION**

**VERSION =**  
/  
5,  
[DEFECT]

*This key word makes it possible to define the version of impression in the format “PLEXUS” (5 per defect).*

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**Version**  
**7.4**

**Titrate:**  
**Procedure IMPR\_MACR\_ELEM**

**Date:**

**31/01/05**

**Author (S):**

**O. NICOLAS, G. DEVESA Key**

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**3.4**

**FORMAT = "MISS\_3D"**

**FORMAT**

**=/"MISS\_3D"**

*The format `MISS\_3D' is used by the code of dynamics of grounds MISS3D to import structural data coming from Code\_Aster (contained dynamic macronutrient which corresponds under the terms of contribution of the structure to the impedance of the total problem of interaction ground-structure). One also prints the grid of the interface ground-structure in its local classification and possibly dynamic modes and statics reduced to this interface.*

*For this format one will have to provide operand GROUP\_MA\_INTERF and five operands are optional*

*UNIT, SOUS\_TITRE, AMOR\_REDUIT, IMPR\_MODE\_STAT and IMPR\_MODE\_MECA.*

**3.4.1 Operand**

**UNIT**

**UNIT**

**= / 26,**

**[DEFECT]**

**/**

**links**

**[I]**

*This key word makes it possible to define the logical unit of impression in format "MISS\_3D" (26 per defect).*

**3.4.2 Operand**



**SOUS\_TITRE**

**SOUS\_TITRE = l\_st [l\_Kn]**

*Allows the user to give a name to the data transferred in code MISS3D.*

**3.4.3 Operand****AMOR\_REDUIT**

**/AMOR\_REDUIT = lam**

**[l\_R]**

**/**

**LIST\_AMOR**

**=**

**l\_amor**

**[listr8]**

*These key words make it possible to enter a list of depreciation for the dynamic modes. One can thus supplement the terms of the dynamic macronutrient.*

**3.4.4 Operand****GROUP\_MA\_INTERF**

**GROUP\_MA\_INTERF**

**=**

**gr\_inter**

**[l\_group\_ma]**

*This key word, makes it possible to define the list of the groups of surface meshes constitutive of the interface ground-structure. One prints the co-ordinates of the “Nb\_noeuds” nodes of the unit interfaces, then the “Nb\_elem” elements with their connectivities in classification local of the whole of the interfaces (1 in “Nb\_noeuds”).*

**3.4.5 Operand****IMPR\_MODE\_STAT**

**IMPR\_MODE\_STAT =/“YES”**

**[DEFECT]**

**/**

**“NOT”**

*This key word possibly makes it possible (so “YES”) to print the static modes reduced to the interface. That proves to be necessary for the 6 modes of rigid bodies. In this case, it macronutrient is based on a dynamic interface of type CRAIGB reduced to a point with a rigid connection of the interface (key word LIAISON\_SOLIDE of AFFE\_CHAR\_MECA [U4.44.01]).*

### **3.4.6 Operand IMPR\_MODE\_MECA**

*IMPR\_MODE\_MECA =/“YES”  
[DEFECT]  
/  
“NOT”*

*This key word possibly makes it possible (so “YES”) to print the dynamic modes reduced to the interface.*

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### **3.4.7 Operands GROUP\_MA\_FLU\_STR/GROUP\_MA\_FLU\_SOL/GROUP-MA-SOL/SOL**

*GROUP\_MA\_FLU\_STR= gr\_flustr  
[l\_group\_ma]*

**GROUP\_MA\_FLU\_SOL= gr\_flusol**  
**[l\_group\_ma]**

**GROUP\_MA\_SOL\_SOL= gr\_flusol**  
**[l\_group\_ma]**

*In the case of an interaction ground-fluid-structure, these key words make it possible to supplement list groups of surface meshes respectively made up of the interfaces fluid structure, fluid-ground and free ground.*

*In this case, one supplements the impression of their elements with their connectivities in local classification of the whole of the interfaces (1 with “Nb-nodes”) (including the interface ground-structure).*

### 3.5

**FORMAT = “CADYRO”**

**FORMAT**  
**=/“CADYRO”**

*Format “CADYRO” is used by the dynamic code of analysis of the lines of trees of machines revolving CADYRO to import structural data coming from Code\_Aster describing the bodies of self-supporting quality of the turbine (table of group, bodies internal and/or external...). One also prints a file of visualization of the grid of calculation used by Code\_Aster (resulting from a concept of the skeleton type) on which results of code CADYRO could be restored later on.*

*For this format, six optional operands can be indicated*

**: SKELETON,**  
**UNITE\_MODE\_MECA,**  
**UNITE\_MODE\_STAT,**  
**UNITE\_MALLAGE,**  
**IMPR\_MODE\_MECA and**  
**IMPR\_MODE\_STAT.**

#### 3.5.1 Operand

**SKELETON**

**SKELETON**

**=**

**squel [skeleton]**

*Name of the concept of the skeleton type which one wishes to print in the file grid and who will be used later on for visualization of the results resulting from code CADYRO.*

*Note:*

*When one wishes to print the skeleton with format CADYRO, only triplettes of angles nautical (0 0 0), (0 90 0) or (0 90.180), defined in order DEFI\_SQUELETTE, are accepted.*

### **3.5.2 Operand**

**UNITE\_MODE\_MECA**

**UNITE\_MODE\_MECA**

=

/

**26**

**[DEFECT]**

/

*u\_mode\_meca*

**[I]**

*This key word makes it possible to define the logical unit of impression of the file of the modes suitable for format “CADYRO” (26 per defect).*

### **3.5.3 Operand**

**UNITE\_MODE\_STAT**

**UNITE\_MODE\_STAT**

=

/

**27**

**[DEFECT]**

/

*u\_mode\_stat*

**[I]**

*This key word makes it possible to define the logical unit of impression of the file of the static deformations with format “CADYRO” (27 per defect).*

### **3.5.4 Operand**

**UNITE\_MALLAGE**

**UNITE\_MAILLAGE =/28**  
**[DEFECT]**  
**/**  
**u\_maillage [I]**

*This key word makes it possible to define the logical unit of impression of the file grid in the format “CADYRO” (28 per defect).*

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**3.5.5 Operand**  
**IMPR\_MODE\_MECA**

**IMPR\_MODE\_MECA =/“YES”**  
**[DEFECT]**  
**/**  
**“NOT”**

*This key word determines if the writing of the file of the modes suitable for format “CADYRO” is effective (“YES”) or not (“NOT”).*

**3.5.6 Operand**  
**IMPR\_MODE\_STAT**

***IMPR\_MODE\_STAT =/"YES"  
[DEFECT]  
/  
"NOT"***

***This key word determines if the writing of the file of the static deformations to format "CADYRO" is effective ("YES") or not ("NOT"). If the file is written, code CADYRO can take account of the static deformations of the bodies of self-supporting quality by their flexibility residual, which improves much the precision of calculations.***

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## **4 Example**

### **4.1**

#### ***Impression of data to format MISS3D***

***One gives in the example below the principal orders which allow the chaining between Code\_Aster and the code MISS3D, and which illustrate the use of order IMPR\_MACR\_ELEM in this context.***

#

# *calculation of the modes*

#

***mode = MODE\_ITER\_SIMULT (***

***MATR\_A= rigidity, MATR\_B= mass,***

***CALC\_FREQ=\_F***

***(NMAX\_FREQ= 30***

***)***

***);***

#  
# *calculation of the dynamic macronutrient*  
#

*interdyn = DEFI\_INTERF\_DYNA*  
*(NUME\_DDL= nume\_ddl,*

*INTERFACE= (*  
*NAME*

=  
*“RIGHT”,*

*TYPE*

=  
*“CRAIGB”,*

*NOEUD=*  
*“N98”*

)

);

*bamo = DEFI\_BASE\_MODALE*



(  
**CLASSIQUE=\_F**

(  
**INTERF\_DYNA**

=  
**interdyn,**

**MODE\_MECA**

=  
**mode,**

**NMAX\_MODE**

=  
**30**

)

);

**mael = MACR\_ELEM\_DYNA (BASE\_MODALE= bamo, OPTION=  
"TRADITIONAL");**

**fo1 = DEFI\_FONCTION (**  
**NOM\_PARA=**  
**“FREQ”,**

**VALE=**  
**(0.,**  
**1.,**  
**100., 1. ) );**  
**#**

**# reading of the accélérogramme of ground acce**  
**#**

**ACCE = DEFI\_FONCTION**  
**(NOM\_PARA = “INST”,**

**VALE**  
**=**  
**(**  
**0.00000E+00,**  
**1.1940E-03,**

-----

**));**  
**#**  
**#**  
**preprocessing of MISS3D**  
**#**  
**#**  
**(grid and impedances of interface)**

**IMPR\_MACR\_ELEM (MACR\_ELEM\_DYNA = mael,**

***FORMAT***

=  
"MISS\_3D",

***SOUS\_TITRE =***  
***`CIVAUX***  
***RIGIDE'***,

***IMPR\_MODE\_STAT***  
=  
"YES",

***IMPR\_MODE\_MECA***  
=  
"NOT",

***AMOR\_REDUIT***  
=  
(  
0.07  
),

***GROUP\_MA\_INTERF***  
=  
("SRADIER")

);  
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**#**

**# forces harmonic horizontal at the top of the structure**

**#**

**IMPR\_MISS\_3D**

**(MACR\_ELEM\_DYNA= mael,**

**FREQ\_INIT= 0. ,**

**FREQ\_FIN=**

**10. , PAS= 0.1,**

**EXCIT=\_F**

**(VECT\_ASSE=**

**vecas1, FONC\_MULT= fo1)**

**);**

**#**

**# horizontal transitory acceleration in the ground**

**#**

**IMPR\_MISS\_3D**

**(MACR\_ELEM\_DYNA: mael,**

**INST\_INIT= 0. ,**

**INST\_FIN=**

**10. , PAS= 0.01,**

**EXCIT\_SOL=\_F**

**(**

**DIRECTION= (1. ,**

**0.,**

**0.),**

***NOM\_CHAM=***  
***“ACCE”***,

***FONC\_SIGNAL***  
***=***  
***ACCE***  
***)***

***);***

## ***4.2*** ***Impression of data to format CADYRO***

***# Calculation of the modes***  
***#***

***modes***  
***= MODE\_ITER\_SIMULT***  
***(MATR\_A = K\_asse,***  
***MATR\_B = M\_asse,***  
***CALC\_FREQ***  
***=\_F***  
***(NMAX\_FREQ = 10));***

***#***  
***# Calculation of the dynamic macronutrient***  
***#***

***interf***  
***=***  
***DEFI\_INTERF\_DYNA***  
***(NUME\_DDL = num,***  
***INTERFACE***  
***=\_F (NOM=***  
***“PALIERI”***,

***TYPE=***  
***“MNEAL”***,

***MASQUE= (“DZ”, “DRX”, “DRY”, “DRZ”),***  
***GROUP\_NO***  
***=***  
***“PALIERI”***),  
***INTERFACE***  
***=\_F (NOM=***

```
“PALIER2”,  
TYPE=  
“MNEAL”,  
MASQUE= (“DZ”, “DRX”, “DRY”, “DRZ”),  
GROUP_NO  
=  
“PALIER2”)  
)  
;
```

```
bamo  
=  
DEFI_BASE_MODAL
```

```
(TRADITIONAL =_F (INTERF_DYNA = interf,  
MODE_MECA
```

```
=  
modes,  
NMAX_MODE
```

```
=  
10  
)  
)  
;
```

```
macr =  
MACR_ELEM_DYNA  
(BASE_MODAL = bamo,  
OPTION =  
“TRADITIONAL”);  
#  
# Calculation of the grid skeleton
```

```
sq_m = DEFI_SQUELETTE (  
GRID = my,  
GROUP_MA = “SQUEL”,
```

***TRANS = (0. , 0. , 0. ),***

***ANGL\_NAUT = (0. , 0. , 0. );***  
***#***  
***# Impressions with format CADYRO***  
***#***  
***IMPR\_MACR\_ELEM***  
***(***  
***FORMAT***  
***=***  
***“CADYRO”,***  
***MACR\_ELEM\_DYNA***  
***=***  
***macr,***  
***IMPR\_MODE\_MECA***  
***=***  
***“YES”,***  
***IMPR\_MODE\_STAT***  
***=***  
***“YES”,***  
***UNITE\_MODE\_MECA***  
***=***  
***26,***  
***UNITE\_MODE\_STAT***  
***=***  
***27,***  
***UNITE\_MALLAGE***  
***=***  
***28,***  
***SKELETON***  
***=***  
***sq\_m***  
***)***  
***;***

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***O. Key NICOLAS***

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***Procedure IMPR\_RESU with format “IDEAS”***



## ***1 Goal***

***To write a grid and/or results of a calculation on a file with format “IDEAS”.***

***Currently this procedure makes it possible to write with the choice:***

- .  
a grid,  
.***
- fields with the nodes (of displacements, temperatures, clean modes, modes statics,...),  
.***
- fields by elements with the nodes or the points of GAUSS (of constraints, efforts generalized, of variables intern...), if these fields by elements do not have under points.***

***For the concepts of the result type, one can print only part of information, in selecting the fields and the sequence numbers which one wishes to exploit.***

***It is possible to select the entities topological (nodes, meshes, groups of nodes and groups meshes) on which one wants to print the results. The selection is not possible for impression of the grid.***

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## ***2 Syntax***

**IMPR\_RESU**

(

**MODELE= MO,**  
**[model]**

**FORMAT**  
**=/"IDEAS",**

**VERSION =/**  
**4,**  
**/**  
**5,**  
**[DEFECT]**

**UNIT**  
**= 30,**  
**[DEFECT]**

**RESU =\_F (**

**/ GRID**  
**=**  
**MA,**  
**/**  
**[grid]**  
**/**  
**[skeleton]**

**//CHAM\_GD = CH\_GD,**

**/**  
**RESULT**  
**=**  
**RESU,**

**# Extraction of a field of size of resu**

/  
**TOUT\_CHAM**  
=  
/“YES”, [DEFECT]

/“NOT”,

/

**NOM\_CHAM**  
=  
**L\_NOMSYMB, [L\_K16]**

/

**TOUT\_ORDRE =**  
**“YES”,**  
**[DEFECT]**

/

**NUME\_ORDRE =**  
**LORDRE, [L\_I]**

/

**LIST\_ORDRE =**  
**LENTI,**  
**[listis]**

/

**NUME\_MODE**  
=  
**LMODE,**  
**[L\_I]**

/

**NOEUD\_CMP**

=

**LNOECMP,**

**[l\_K16]**

/

**NOM\_CAS =**

**NCAS,**

**[l\_K16]**

/

**ENG**

=

**LANGL,**

**[l\_K16]**

/

/

**FREQ**

=

**LFREQ,**

**[l\_R]**

/

**LIST\_FREQ**

=

**LREEL,**

**[listr8]**

/

**INST**

=

**LINST,**

**[l\_R]**

/

**LIST\_INST**

=

**LREEL,**

**[listr8]**

**/PRECISION**

=

/

**PREC, [R]**

/

**1.0D-3,**  
**[DEFECT]**

/  
**CRITERION =/"RELATIVE",**

**[DEFECT]**  
/  
**"ABSOLUTE"**  
,

**# Selection of the components**

**/TOUT\_CMP**  
**=**  
**"YES",**  
**[DEFECT]**

**/NOM\_CMP =**  
**L\_NOMCMP,**  
**[I\_K8]**

**# Selection of the topological entities**

/  
**ALL**  
**=**  
**"YES",**  
**[DEFECT]**

//  
**NODE**  
=  
**L\_NOEU, [l\_noeud]**

/  
**GROUP\_NO**  
=  
**L\_GRNO,**  
**[l\_gr\_noeud]**

/  
**NET**  
=  
**L\_MAILLE,**  
**[l\_maille]**

/  
**GROUP\_MA**  
=  
**L\_GRMA, [l\_gr\_maille]**

**SOUS\_TITRE = L\_ST,**  
**[l\_Kn]**

)

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### **3 Formats of writing**

*Procedure IMPR\_RESU makes it possible to write values in a file with the format I-DEASTM, software marketed by company SDRC, for a graphic visualization.*

#### **3.1 Operands**

##### **FORMAT/VERSION**

*The operand FORMAT makes it possible to specify the format of impression and is obligatory in the case of one impression with format I-DEASTM.*

*The operand FORMAT makes it possible to ask for the creation of a file ASCII, known as “universal file”, which could be read again by I-DEASTM.*

*The universal file used by software I-DEASTM, has a different data-processing structure according to version of software I-DEASTM. The operand VERSION makes it possible to specify the version of I-DEASTM that one wishes to use. This operand is thus licit only when the operand FORMAT is worth “IDEAS”. poured authorized are version 4 and version 5 of I-DEASTM.*

*By defect, the impression is done in version 5.*

*Example: IMPR\_RESU (RESU= (\_F (FORMAT= “IDEAS”, VERSION= 4, .....)))*

*The upward compatibility of the versions of I-DEASTM is ensured starting from version 5. One can thus to use the versions higher than version 5 of I-DEASTM with files written in version 5*

*(because any version NR of I-DEASTM can read again the files created by the NI version).*

### **3.2 Operand UNIT**

*Logical unit (30 per defect) of the written file.*

#### **4 Word key RESU**

*This key word factor makes it possible to specify the results to print and the format according to which one wants them to print.*

#### **5 Impression of the grid: operands GRID/MODEL**

*The operand “GRID” makes it possible to print the grid with format I-DEASTM. Impression of the grid can be asked only once and before any other result. By defect one prints all it grid.*

*One can however reduce the impression of the grid to the only meshes of the grid supporting one finite element by defining the MODEL operand. So concept of the model type is optional in the majority of the impressions. However, it can be used to print only the part of grid whose meshes are affected in the model.*

*In addition, to format “IDEAS” when the key word MODELS is provided one seeks the type of finite element I-DEASTM nearest to that of Code\_Aster, if not a type of finite element by defect is affected in universal file I-DEASTM.*

*With format “IDEAS”, the classification of the nodes is that of Code\_Aster except when the grid is resulting from software I-DEASTM (one checks the presence of the character string AUTEUR=INTERFACE\_IDEAS in the first line of the title of the grid and starting from the tenth position); in this case one restores classification I-DEASTM.*

#### **Note:**

*1) The meshes 3D of the type PYRAM5 and PYRAM13 are not available under I-DEAS. These meshes are thus not written in the universal file created by order IMPR\_RESU with format IDEAS.*

*2) The mesh 3D of the type HEXA27 is not available under I-DEAS. The meshes Aster of this type are converted into meshes of the type HEXA20 in the universal file created by the order IMPR\_RESU with format IDEAS.*



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## **6 Operands**

### **CHAM\_GD and RESULT**

*The values of the computed fields are stored in structures of data called fields of size. These fields of size can be directly accessible (concept CHAM\_GD) where to find in a structure of data gathering several fields of size (concept result).*

*A field of size is a structure of data which makes it possible to store fields defined in the nodes (*cham\_no\_\**) or of the fields defined by elements (*cham\_elem\_\**). For the fields by elements, one distinguishes the fields defined in the nodes from the elements and them fields defined in the points of GAUSS of the elements.*

*A concept result is composed of one or more fields of size. For example, with each step of calculation one stores in the structure of data result, the field of size displacement. This structure is thus a matric structure of order 2, including one index is, for example, the list of the moments of calculation and the other the whole of the fields calculated (displacements, constraints, deformations,...).*

*One reaches in this case a field of size by specifying a value of a variable access (sequence number, moment, frequency, number of mode,...) and a field name (“DEPL”, “SIGM\_ELNO\_DEPL”,...). There are several types of concept result: *evol\_elas*, *evol\_noli*, *mode\_meca*,.... With each one corresponds a list of fields and a list of*

*licit variables of access (cf [U5]).*

*Taking into account the structure of data result, one understands easily that them possibilities of impression which one lays out are those of the fields of size, supplemented by specific possibilities.*

**Note:**

*1) The meshes 3D of the type PYRAM5 and PYRAM13 are not available under I-DEAS. values of the Aster fields associated with these meshes are thus not written in universal file created by order IMPR\_RESU with format IDEAS.*

*2) The mesh 3D of the type HEXA27 is not available under I-DEAS. Values of aster fields calculated on this type of mesh are written on meshes of the type HEXA20; i.e. one transfers only the values from the Aster fields on the 20 first nodes.*

**6.1 Operand  
CHAM\_GD**

*The values of the fields of size are written in one or more datasets universal file:*

*.  
dataset 55  
for the fields with the nodes,*

*.  
dataset 57  
for the fields by element with the nodes,*

*.  
dataset 56  
for the fields by elements at the points of GAUSS (in fact, one writes constant fields by element while realising on the points of GAUSS).*

*In I-DEASTM, some datasets is typified: displacements, constraints, deformations, temperature, pressure. One thus gathers the components in order to write the typified datasets, then they are written other components in datasets of the type “UNKNOWN”.*

*The datasets of the type “UNKNOWN” contain to the maximum six components; for a field of size of N components one thus writes n/6 datasets.*

**6.2 Operand  
RESULT**

*The operand RESULT makes it possible to print the fields contained in a concept result. One can for example to choose to print only certain fields (cf the key word: NOM\_CHAM).*

*The concept result is written field of size per field of size in datasets 55, 56*

or 57.

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**7**

***Extraction of a field of size***

***7.1 Operands***

***TOUT\_CHAM/NOM\_CHAM***

*Cf document [U4.71.00].*

***7.2 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/***

***NUME\_MODE/INST/LIST\_INST/FREQ/LIST\_FREQ/***

***NOEUD\_CMP/NOM\_CAS/ENG/PRECISION/CRITERION***

*Cf document [U4.71.00].*

**8**

***Selection on the components***

*In order to reduce the volume of the impressions and the size of “universal” file I-DEASTM, the user can*

*to print only the values of certain components (for example that displacement following the axis X: component DX or that constraint XX: component SIXX).*

## **8.1 Operand** **TOUT\_CMP**

*This key word makes it possible to indicate that one wishes to print all the components of the field. It is default value.*

## **8.2 Operand** **NOM\_CMP**

*This key word makes it possible to choose the list of the components of the CHAM\_GD or all the fields of concept result which one wishes to print.*

*Key words TOUT\_CMP and NOM\_CMP cannot be used simultaneously.*

*When the user specifies key word NOM\_CMP, the datasets create in the universal file are typified UNKNOWN, which will forbid the user to trace deformed (even if the dataset contains them components DX, DY, DZ, DRX, DRY, DRZ) and of the calculation of the criteria of Von Mises and/or Tresca (even if the dataset contains components SIXX, SIYY,... SIXZ).*

*This functionality makes it possible to choose the components, as well for cham\_no of cham\_elem with actual values.*

*Operand NOM\_CMP is not programmed for the cham\_no and cham\_elem with complex values.*

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HT-66/05/004/A*

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**Code\_Aster** ®

Version  
7.4

Titrate:  
Procedure IMPR\_RESU format "IDEAS"

Date:  
05/04/05  
Author (S):  
**O. Key NICOLAS**  
:  
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## **9**

### ***Selection of the topological entities***

*In order to reduce the volume of the impressions and the size of “universal” file I-DEASTM, it is sometimes necessary to print only part of the result. With this intention one can wish not to print a field with the nodes that in certain nodes, or a field by element that in certain elements.*

*This selection which one will note “selection on topological entities” is possible with the format “IDEAS”.*

#### **9.1 Operand**

##### **ALL**

*This key word indicates that one wishes to print the field on all the structure (all the nodes for one field with the nodes, all the elements for a field by element).*

#### **9.2 Operand**

##### **NODE**

*This key word makes it possible to indicate the list of the nodes on which one wishes to print a cham\_no. If it key word is used in the case of the impression of a cham\_elem, it is ignored, and the cham\_elem is printed in all the meshes specified in addition.*

#### **9.3 Operand**

##### **GROUP\_NO**

*This key word makes it possible to indicate the list of the groups of nodes on which one wishes to print one cham\_no. If this key word is used in the case of the impression of a cham\_elem, it is ignored, and it cham\_elem is printed in all the meshes, specified by ailleurs.*

#### **9.4 Operand**

##### **NET**

*This key word makes it possible to indicate the list of the meshes on which one wishes to print a cham\_elem.*

*For a cham\_no, it makes it possible to indicate the list of the nodes, tops of the meshes to which one wishes to print the cham\_no.*

#### **9.5 Operand**

## **GROUP\_MA**

*This key word makes it possible to indicate the list of the groups of meshes on which one wishes to print one*

*cham\_elem. For a cham\_no, it makes it possible to indicate the list of the nodes, tops of the meshes to which*

*one wishes to print the cham\_no.*

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*HT-66/05/004/A*

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## **Code\_Aster** ®

*Version*

*7.4*

*Titrate:*

*Procedure IMPR\_RESU format "IDEAS"*

*Date:*

*05/04/05*

*Author (S):*

**O. Key NICOLAS**

*:*

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## **10 Operand**

### **SOUS\_TITRE**

*This argument makes it possible to print under title of comment, for more details to consult it document [U4.03.01].*

*The SOUS\_TITRE by defect is:*

*.*

*for a cham\_gd*

*- for*

*one*

*cham\_no*

**SOUS\_TITRE**

*:*

**('FIELD**

*WITH  
NOEUDS'  
)  
- for  
one  
cham\_elem*

*SOUS\_TITRE:  
("FIELD BY ELEMENT &LOC (cham\_elem)")*

*Example: `FIELD BY ELEMENT WITH THE POINTSDE GAUSS "*

*.  
for a result*

*- for  
one  
cham\_no*

*SOUS\_TITRE: ("FIELD WITH THE NODES",*

*'OF  
NAME  
SYMBOLIC SYSTEM  
&NOM\_SYMB (Result  
cham\_no) &RL',*

*'NUMBER  
D " ORDER  
&NUM\_ORDRE (Result  
cham\_no) ',*

*'&ACCES (Result  
cham\_no)  
'*

*Example of impression:*

*FIELD  
WITH  
NODES  
OF  
NAME  
SYMBOLIC SYSTEM*

*DEPL  
NUMBER  
Of ORDER:  
2  
NUME\_MODE:  
3  
FREQ  
:  
5.52739E+00*

*- for  
one  
cham\_elem  
SOUS\_TITRE  
:  
(FIELD  
BY  
ELEMENT  
&LOC (Result  
cham\_elem) ',*

*'OF  
NAME  
SYMBOLIC SYSTEM  
&NOM\_SYMB (Result  
cham\_elem) &RL',*

*'NUMBER  
D " ORDER  
&NUM\_ORDRE (Result  
cham\_elem)  
,*

*'&ACCES (Result  
cham\_elem)  
'*

*Example of impression:*



*FIELD BY ELEMENT WITH THE NODES OF REFERENCE SYMBOL*

*EPSI\_ELNO\_DEPL*

*NUMBER*

*Of ORDER:*

*1*

*INST*

*:*

*0.00000E+00*

***11 Remark***

***In Aster, there are fields by elements with under points (as well for fields by elements with the nodes that for fields by elements at the points of Gauss).***

***Format “IDEAS”, IMPR\_RESU does not allow the impression of these fields by elements with under points.***

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***Code\_Aster*** ®

***Version***

***7.4***

***Titrate:***

***Procedure IMPR\_RESU format “IDEAS”***

***Date:***

***05/04/05***

***Author (S):***

***O. Key NICOLAS***

***:***

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**Code\_Aster** ®

Version

8.2

Titrate:

*Procedure IMPR\_RESU with format "CASTEM"*

Date:

22/02/06

Author (S):

Key **COURTEOUS Mr.**

:  
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*Organization (S): EDF-R & D /AMA*

***Instruction manual***

***U7.0- booklet: Data exchanges***

***Document: U7.05.11***

***Procedure IMPR\_RESU with format "CASTEM"***

***1 Goal***

***To write a grid and/or results of a calculation on a file with format "CASTEM".***

***Currently this procedure makes it possible to write with the choice:***

.  
*a grid,*

.  
*fields with the nodes (of displacements, temperatures, clean modes, modes statics,...),*

.  
*fields by elements with the nodes (of constraints, generalized efforts, variables interns...), if these fields by elements do not have under points.*

*For the concepts of the result type, one can print only part of information, in selecting the fields and the sequence numbers which one wishes to exploit.*

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*Code\_Aster* ®

*Version*

*8.2*

*Titrate:*

*Procedure IMPR\_RESU with format “CASTEM”*

*Date:*

*22/02/06*

*Author (S):*

*Key COURTEOUS Mr.*

*:*

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*2 Syntax*

*IMPR\_RESU*

*(*

*MODELE= MO,*

*[model]*

*FORMAT*

*=/“CASTEM”,*

**UNIT**  
= *links*,  
**[I]**

**NIVE\_GIBI**  
= / 3,  
/  
10,  
**[DEFECT]**

**RESU = (\_F (**

**/ GRID**  
=  
**MA,**  
/  
**[grid]**  
/  
**[skeleton]**

**//CHAM\_GD = CH\_GD,**

/  
**RESULT**  
=  
**RESU,**

**# Extraction of a field of size of resu**

/  
**TOUT\_CHAM**  
=  
/“YES”, [DEFECT]

/“NOT”,

/

**NOM\_CHAM**  
= *l\_nomsymb*, [l\_K16]

/

**TOUT\_ORDRE =**  
“YES”,  
[DEFECT]

/

**NUME\_ORDRE =**  
*lordre*, [l\_I]

/

**LIST\_ORDRE =**

***lenti,***

***[listis]***

**/**

**NUME\_MODE**

**=**

***lmode,***

***[l\_I]***

**/**

**NOEUD\_CMP**

**=**

***lnoecmp,***

***[l\_K16]***

**/**

**NOM\_CAS =**

***ncas,***

***[l\_K16]***

**/**

**ENG**

**=**

***langl,***

***[l\_K16]***

**/**

**/**

**FREQ**

**=**

***lfreq,***

***[l\_R]***

**/**

**LIST\_FREQ**

**=**

***lreel,***

***[listr8]***

**/**

**INST**

**=**

**linst,**  
**[l\_R]**  
**/**  
**LIST\_INST**  
**=**  
**lreel,**  
**[listr8]**

**/ PRECISION =/prec,**  
**[R]**  
**/**  
**1.0D-3,**  
**[DEFECT]**

**/**  
**CRITERION =/"RELATIVE", [DEFECT]**  
**/**  
**"ABSOLUTE"**  
**,**

**/ PART**  
**=/"REAL",**  
**/**  
**"IMAG",**

**# Selection of the components**



/  
**TOUT\_CMP**  
=  
"YES",  
[DEFECT]

/  
**NOM\_CMP =**  
**l\_nomcmp,**  
[l\_K8]

))

)  
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**Version**  
**8.2**

**Titrate:**  
**Procedure IMPR\_RESU with format "CASTEM"**

**Date:**  
**22/02/06**  
**Author (S):**  
**Key COURTEOUS Mr.**  
**:**  
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## ***Formats of writing and logical unit***

***Procedure IMPR\_RESU makes it possible to write a grid and/or values of results to the format of software CASTEM 2000 developed by the ECA for a graphic visualization by GIBI. Software GIBI (operators of postprocessing of CASTEM 2000) is usable free with Code\_Aster.***

***One asks for the creation of an ASCII file, which could be read again by GIBI. In GIBI, the second reading of file is made by orders OPTI REST FORM “\*\*\* .cast”; and REST FORM; (them \*\*\* replace it name of the file of the cast type given by the user in astk). UNIT is worth by defect 37 and corresponds to the cast type in astk.***

***NIVE\_GIBI***  
***= / 3,***  
***/***  
***10,***  
***[DEFECT]***

***Operand NIVE\_GIBI makes it possible to choose level GIBI of impression of the grid and/or of results. Level 10 (by defect) corresponds to version GIBI-98, but the files thus generated can be read again by the more recent versions of GIBI. Version GIBI installed in the Aster environment is version GIBI-2000.***

***4 Word***  
***key***  
***RESU***

***This key word factor makes it possible to specify the results to print and the format according to which one wants them to print.***

***5***  
***Impression of the grid: operands GRID/MODEL***

***This argument makes it possible to print the grid with format “CASTEM”. The impression of the grid cannot to be asked that only once and before any other result.***

***Concept of the model type is optional in the majority of the impressions. It is however obligatory, with format “CASTEM”, during the impression of a field per element (it is transferred as an object CASTEM of the grid type).***

***With format “CASTEM”, one prints:***

***for each group of meshes Aster an object CASTEM of the grid type and of the same name,***

***an object CASTEM of the grid type containing all the meshes of the grid and accessible by the name of the grid Aster,***

***and, if the MODEL operand were specified, an object CASTEM of the grid type containing all meshes affected in the model Aster and accessible by the name from the model Aster.***

***Note:***

***If the grid were generated with Ideas or GMSH, Ideas classification or GMSH is not retranscribed with format CASTEM. The classification of the nodes in CASTEM is identical to the classification of the nodes in Aster.***

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***Procedure IMPR\_RESU with format “CASTEM”***

***Date:***

***22/02/06***

***Author (S):***

***Key COURTEOUS Mr.***

***:***

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***6 Operands***

***CHAM\_GD and RESULT***

***The values of the computed fields are stored in structures of data called fields of size. These fields of size can be directly accessible (concept CHAM\_GD) where to find in a structure of data gathering several fields of size (concept result).***

•  
*a field of size is a structure of data which makes it possible to store definite fields with the nodes (cham\_no\_\*) or fields defined by elements (cham\_elem\_\*). For the fields by elements, one distinguishes the fields defined in the nodes from the elements and the fields defined in*

*points of GAUSS of the elements (the latter are not displayable with GIBI). For to visualize fields by elements at the points of GAUSS, the user can however use MACR\_ECLA\_PG which makes it possible to build a new grid by bursting each mesh of old grid out of N smaller meshes and a field with the nodes with identical values in each node top of the mesh. That functions only for elements 2D isoparametric and HEXA8 in 3D and for constraints and variables internal,*

•  
*a concept result is composed of one or more fields of size. For example, with each step of calculation one stores in the structure of data result, the field of size displacement. This structure is indexed by a matrix structure of order 2, of which an index is, for example, the list of the moments of calculation and the other the whole of the computed fields (displacements, constraints, deformations,...).*

*One reaches in this case a field of size by specifying a value of a variable of access (sequence number, moment, frequency, number of mode...) and a field name (“DEPL”, “SIGM\_ELNO\_DEPL”,...). There are several types of concept result: evol\_elas, evol\_noli, mode\_meca,.... With each one corresponds a list of fields and a list of variables licit accesses (cf [U5]).*

*Taking into account the structure of data result, one understands easily that the possibilities of impression which one lays out are those of the fields of size, supplemented by specific possibilities.*

*Note:*

*With format “CASTEM” one can treat only the fields with the nodes or the fields by element defined in the nodes (in this case one must obligatorily specify the name of a model Aster by the MODEL operand).*

## **6.1 Operand CHAM\_GD**

*A field with the Aster nodes of name U is retranscribed with format “CASTEM” in a champoint in the same way name. In CASTEM 2000, one can thus reach this field by the name U and one can carry out on it field all operations allowed on champoints. It will be noted however that them components of the fields of size DEPL which are in Aster DX, DY, DZ, DRX, DRY, DRZ will be in CASTEM UX, UY, UZ, X-ray, RY, RZ. For all the other components the name of the component*

*in CASTEM will be defined by the first four characters of the name of the component in Aster.  
All the champoints are defined compared to the Aster grid.*

*Some possible operations in GIBI on an object of the champoint type and named U:*

.

*Creation and visualization of an object of the type deformed*

**DEF1**  
**=**  
**DEFORM**  
**GRID**  
**U**  
**AMPLIFIER**  
**COLOR;**  
**TRAC**  
**DEF1**

;

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**Version**  
**8.2**

**Titrate:**  
**Procedure IMPR\_RESU with format "CASTEM"**

**Date:**  
**22/02/06**  
**Author (S):**  
**Key COURTEOUS Mr.**  
**:**  
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.

*Creation of an object of the vector type*

**VECI**  
**=**  
**VECTOR**  
**U**

**UX**  
**UY**  
**UZ**  
**AMPLIFIER**  
**COLOR;**  
**TRAC**  
**VECI**  
**GRID**  
**;**

*Creation of an object of the champoint type by extraction on a champoint*

**DEPX**  
**=**  
**EXCO**  
**UX**  
**U**  
**;**  
**TRAC**  
**DEPX**  
**GRID**  
**;**

*A field by element with the nodes of name CHAM in Aster is written with format "CASTEM" in one chamelem of the same name. In CASTEM 2000, one can thus reach this field by the name cham and one can carry out on this field all the operations allowed on chamelem the nodes. One will note however that components of the fields of size SIGM which are in Aster SIXX, SIYY, SIZZ, SIXY, SIYZ, SIXZ will be in CASTEM SMXX, SMYY, SMZZ, SMXY, SMYZ, SMXZ. components of size VARI will be named V1, V2,... For all the other components it name of the component in CASTEM will be obtained by concatenation of the two first and two last letters of the name of the component in Aster. All the chamelem with the nodes are defined compared to the model Aster.*

*Some possible operations in GIBI on an object of the cham\_elem type and named CHAM:*

*All the treatments on chamelem require the preliminary creation of an object CASTEM of type models (nothing to see with the Aster model) what can be made by the order:*

**MODCAST**  
**=**  
**MODE**  
**MODEL**  
**MECHANICS**

## **RUBBER BAND**

;

.

*Creation of an object of the chamelem type by extraction on a chamelem*

**SIGXX**

=

**EXCO**

**SMXX**

**CHAM**

;

**TRAC**

**EYE**

**SIGXX**

**MODCAST GRID**

;

.

*Creation of an object of the chamelem type by operation on a chamelem*

**TRE1**

=

**TRESCA**

**CHAM**

**MODCAST;**

*(constraints*

*of*

*Tresca)*

## **6.2 Operand**

### **RESULT**

*The operand RESULT makes it possible to print the fields contained in a concept result. One can for example to choose to print only certain fields (cf the following key word: NOM\_CHAM).*

*With format "CASTEM", the concept result of name TITI is written in the form of an object CASTEM of type counts (table) of the same name than the concept Aster result.*

*The first index of the table is an entirety I which can take the value of the sequence numbers Aster (TITI. 1 is also a table).*

*The second table is subscripted by a chain made up of the reference symbol Aster U = TITI. 1.*

***DEPL*** (field of displacements to the sequence number 1), ***SIG = TITI. 2. SIGM\_ELNO\_DEPL***  
(stress field to the sequence number 2).

***Example:***

***In Aster:***

***IMPR\_RESU*** (***RESU = (\_F (RESULT = TITI, NUME\_ORDRE = (1,2),***  
***NOM\_CHAM=***  
***(“DEPL”, “SIGM\_ELNO\_DEPL”))***))

***In CASTEM:***

***U = TITI. 1. DEPL;***  
(object ***CASTEM*** of the champoint type)

***SIG = TITI. 2. SIGM\_ELNO\_DEPL;***

(object ***CASTEM*** of the type  
***chamelem***)

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***Code\_Aster*** ®

***Version***

***8.2***

***Titrate:***

***Procedure IMPR\_RESU with format “CASTEM”***

***Date:***

***22/02/06***

***Author (S):***

***Key COURTEOUS Mr.***

***:***



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**7**

***Extraction of a field of size***

### **7.1 Operands**

***TOUT\_CHAM/NOM\_CHAM***

***Cf document [U4.71.00].***

***7.2 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/  
NUME\_MODE/INST/LIST\_INST/FREQ/LIST\_FREQ/  
NOEUD\_CMP/NOM\_CAS/ENG/PRECISION/CRITERION***

***Cf document [U4.71.00].***

**8**

***Selection on the components***

***Another manner of reducing the volume of the impressions is to print only the values of certain components (for example that displacement following axis X: component DX).***

***One cannot print complex fields with format CASTEM, it is thus necessary, for such fields, to select the Real or Imaginary PART to print.***

### **8.1 Operand**

***TOUT\_CMP***

***This key word makes it possible to indicate that one wishes to print all the components of the field. It is default value.***

### **8.2 Operand**

***NOM\_CMP***

***This key word makes it possible to choose the list of the components of the CHAM\_GD (cham\_no and/or cham\_elem) or of all the fields of the concept result which one wishes to print.***

***Key words TOUT\_CMP and NOM\_CMP cannot be used simultaneously.***

***These components are described in the specific documentation of the elements.***

## **9 Remark**

*In Aster, there are fields by elements with under points (as well for fields by elements with the nodes that for fields by elements at the points of Gauss).*

*Format "CASTEM", IMPR\_RESU does not allow the impression of these fields by elements with under points.*

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*Code\_Aster ®*

*Version*

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*Titrate:*

*Procedure IMPR\_RESU (FORMAT "MED")*

*Date:*

*22/02/06*

*Author (S):*

*COURTEOUS Mr., C. Key DURAND*

*:*

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*Organization (S): EDF-R & D /AMA*

***Instruction manual  
U7.0- booklet: Data exchanges  
Document: U7.05.21***

***Procedure IMPR\_RESU (FORMAT "MED")***

***1 Goal***

***To write the result of a calculation in a file with format MED. One describes the whole of the key words of only order IMPR\_RESU [U4.91.01] concerning this format of exit.***

***One can write with the choice in a file with format MED:***

- .  
a grid,***
- .  
fields with the nodes,***
- .  
fields with the elements.***

***In this version of Code\_Aster, one does not write the definition of the elements of reference in file MED. If one thus reads again fields by elements at the points of Gauss with another software, this one must have the same elements of reference to ensure coherence.***

***MED (Modeling and Data exchanges) is a neutral format of data developed by EDF R & D and the ECA for the data exchanges between computer codes. The data which one can to exchange according to this format are the grids and the fields of results to the constant nodes and by elements. Files MED are binary and portable files (being pressed on the library HDF5, Hierarchical Dated Format). The writing of results in a file MED allows any other code of calculation, interfaced with MED, of reading the results produced by Code\_Aster via the order IMPR\_RESU.***

***Version 2.2.3 of MED is used as well in reading as in writing of files MED for the version 8.2 of Aster.***

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**Code\_Aster** ®

**Version**

**8.2**

**Titrate:**

**Procedure IMPR\_RESU (FORMAT "MED")**

**Date:**

**22/02/06**

**Author (S):**

**COURTEOUS Mr., C. Key DURAND**

**:**

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**2 Syntax**

**IMPR\_RESU**

**(**

**# Syntax of procedure IMPR\_RESU to format "MED"**

**UNIT = links,**

**FORMAT**

**=**

**/**

**"MED",**

**RESU = \_F**

**(**

**/**

**GRID**

**=**

**my, [grid]**

/

***/RESULT = resu,***

***# Extraction of a field of size of resu***

/

***NOM\_CHAM***

***=***

***l\_nomsymb, [l\_K16]***

/

***NUME\_ORDRE =***

***lordre, [l\_I]***

/

***NUME\_MODE***

***=***

***lmode,***

***[l\_I]***

/  
**NOEUD\_CMP**  
=  
**lnoecmp,**  
**[l\_K16]**

/  
**NOM\_CAS =**  
**ncas,**  
**[l\_K16]**

/  
**ENG**  
=  
**langl,**  
**[l\_K16]**

//  
**FREQ**  
=  
**lfreq,**  
**[l\_R]**

/  
**INST**  
=  
**linst,**  
**[l\_R]**

/ **PRECISION**  
=  
/  
**prec, [R]**  
/  
**1.0D-3,**  
**[DEFECT]**

/ **CRITERION =/**  
**“RELATIVE”,**  
**[DEFECT]**  
/  
**“ABSOLUTE”,**

/  
**CHAM\_GD =**  
**chgd,**

[Co]

)

);  
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*Version*

8.2

*Titrate:*  
*Procedure IMPR\_RESU (FORMAT “MED”)*

*Date:*  
22/02/06

*Author (S):*  
*COURTEOUS Mr., C. Key DURAND*

:  
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*3 Operands*  
*FORMAT and UNIT*

*3.1 Operand*  
*FORMAT*

*The operand FORMAT makes it possible to specify the format of the file where to write the result.*

*Format “MED” means with procedure IMPR\_RESU that the result must be written in a file with format MED.*

*3.2 Operand*  
*UNIT*

*Defines in which unit one writes the file med. By defect, UNIT = 80 and corresponds to the unit by defect of the rmed type in astk.*



#### **4 Word**

**key**

**RESU**

*This key word factor makes it possible to specify the results to print and the format according to which one wants them to print.*

#### **5 Operands**

##### **5.1 Operand**

**GRID**

*If the result is a grid (operand grid [U4.91.01]), the data deferred in the file result with format MED are:*

*.  
the list of the nodes  
number, name, coordinated,*

*.  
the list of the meshes  
number, name, type, name of the nodes,*

*.  
the list of the groups of nodes  
number, name, a number of nodes, names of the nodes,*

*.  
the list of the groups of meshes  
number, name, a number of meshes, names of the meshes.*

**Foot-note:**

*In a file MED, there is partition of the nodes and the meshes according to the groups. One partition corresponds to a family MED. In a file MED, the groups are distributed with centre of the families: families of nodes and families of elements are thus found there.*

##### **5.2 Operand**

**RESULT**

*The operand RESULT makes it possible to print in a file MED, fields contained in a concept result. With format MED, one can print only fields with the nodes indicated by the key word NOM\_CHAM.*

*One writes in the file "MESSAGE" following information:*

operand "RESULT",

operand "NOM\_CHAM",

operand "NUME\_ORDRE",

name of the field stored in file MED: concatenation of the three preceding ones operands.

### 5.3 Operands

NOM\_CHAM/NUME\_ORDRE/NUME\_MODE/NOEUD\_CMP/  
NOM\_CAS/ENG/FREQ/INST/PRECISION/CRITERION/FILE

Cf document [U4.91.01].

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### 6 Example

IMPR\_RESU =

(

FORMAT

=

"MED",

RESU

=  
***\_F***

(  
***RESULT***  
=  
***REMEZERO,***  
***NOM\_CHAM***  
=  
***“ERRE\_ELGA\_NORE”***,  
***NUM\_ORDRE***  
=  
***3,***  
  
)  
)

*The execution of order IMPR\_RESU will cause following posting in the file “MESSAGE”:*

***RESULT***  
  
:  
***REMEZERO***  
***FIELD***  
  
:  
***ERRE\_ELGA\_NORE***  
***NUM\_ORDRE***  
***: 3***

***==> NAME MED: REMEZEROERRE\_ELGA\_NORE\_\_\_\_\_3***

***7***  
*Interest of the writing of a result in a file with the format MED*

*MED is a format of file for the data exchanges between codes. Any computer code having an interface MED is able to exchange information with any other code having this same interface.*

***In fact a result (grid or field) written in a file with format MED by the order IMPR\_RESU can be read by any computer code having an interface of reading MED.***

***Fields by element at the points of Gauss:***

***Library MED 2.2 has the concept of element of reference, necessary to knowledge complete of a field defines in the points of Gauss (the element of reference provides the position and the weight of each point of Gauss). IMPR\_RESU does not print yet this information in file MED. This does not pose a problem when one reads again the file with Code\_Aster (or Lobster); but if one reads again the file with another computer code coherence is not ensured, this last not having necessarily same elements of reference.***

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Titrate:

Procedure *IMPR\_RESU* with format “*ENSIGHT*”

Date:

10/02/05

Author (S):

Key **COURTEOUS Mr.**

:

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Organization (S): *EDF-R & D /AMA*

**Instruction manual**

**U7.0- booklet: Data exchanges**

**Document: U7.05.31**

**Procedure *IMPR\_RESU* with format “*ENSIGHT*”**

**1 Goal**

**To write a grid and/or results of a calculation on files with format “*ENSIGHT*”.**

**Currently this procedure makes it possible to write with the choice:**

.  
*a grid,*

.  
*fields with the nodes (of displacements, temperatures, clean modes, modes statics,...),*

*For the concepts of the result type, one can print only part of information, in selecting the fields and the sequence numbers which one wishes to exploit.*

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*Procedure IMPR\_RESU with format “ENSIGHT”*

*Date:*

*10/02/05*

*Author (S):*

*Key COURTEOUS Mr.*

*:*

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*2 Syntax*

*IMPR\_RESU*

*(*

*MODELE= MO,  
[model]*

*FORMAT  
=/"ENSIGHT",*

*UNIT = links,*

***RESU =\_F (***

***/ GRID***

***=***

***MA,***

***/***

***[grid]***

***/***

***[skeleton]***

***//CHAM\_GD = CH\_GD,***

***/***

***RESULT***

***=***

***RESU,***

***# Extraction of a field of size of resu***

***/***

***TOUT\_CHAM***

***=***

***/“YES”, [DEFECT]***

***/“NOT”,***

/

***NOM\_CHAM***  
***= L\_NOMSYMB, [l\_K16]***

/

***TOUT\_ORDRE =***  
***“YES”,***  
***[DEFECT]***

/

***NUME\_ORDRE =***  
***LORDRE, [l\_I]***

/

***LIST\_ORDRE =***  
***LENTI,***  
***[listis]***

/

***NUME\_MODE***



=  
**LMODE,**  
**[l\_I]**  
/  
**NOEUD\_CMP**

=  
**LNOECMP,**  
**[l\_K16]**  
/  
**NOM\_CAS =**  
**NCAS,**  
**[l\_K16]**

/  
**ENG**

=  
**LANGL,**  
**[l\_K16]**  
/  
/  
**FREQ**

=  
**LFREQ,**  
**[l\_R]**  
/  
**LIST\_FREQ**

=  
**LREEL,**  
**[listr8]**  
/  
**INST**

=  
**LINST,**  
**[l\_R]**  
/  
**LIST\_INST**

=  
**LREEL,**  
**[listr8]**

*/ PRECISION =/PREC,  
[R]  
/  
1.0D-3  
[DEFECT]*

*/  
CRITERION =/"RELATIVE" [DEFECT]  
/  
"ABSOLUTE"*

*# Selection of the components*

*/  
TOUT\_CMP  
=  
"YES",  
[DEFECT]*

*/  
NOM\_CMP =  
L\_NOMCMP,  
[L\_K8]*

)

)

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**3 Formats**  
**of writing**

**Procedure IMPR\_RESU makes it possible to write a grid and/or values of results to the format “ENSIGHT” (EnSight™ marketed by company CEI) for a graphic visualization.**

**EnSight™ is an accessible software on workstation.**

**One asks for the creation of ASCII files, which could be read again by EnSight™.**

**In the interface astk, the user must indicate a name of repertory and choose the type of files ensi.**

**The files produced by IMPR\_RESU, FORMAT “ENSIGHT” will be deposited in this repertory at the end calculation.**

**The names of the files produced in this repertory are automatically defined in the procedure IMPR\_RESU starting from the names of the concepts handled by the user, the names of the fields that they contain and their components (see operand CHAM\_GD and operand RESULT).**

**4 Word**  
**key**

## **RESU**

*This key word factor makes it possible to specify the results to print and the format according to which one wants them to print.*

5

### **Impression of the grid: operands GRID/MODEL**

*The operand GRID makes it possible to print the grid with format “ENSIGHT”. Impression of the grid can be asked only once and before any other result.*

*Concept of the model type is optional in the majority of the impressions. It can also be used in the case of the impression of a grid, which can seem redundant with the operand GRID: it is not wanted, in this case, to print that the part of the grid whose meshes are affected in the model.*

*With format “ENSIGHT”, the classification of the nodes is that of Aster except when the grid results from software I-DEASTM (one checks the presence of the character string AUTEUR=INTERFACE\_IDEAS in the first line of the title of the grid and starting from the tenth position); in this case one restores classification IDEAS.*

*With format “ENSIGHT”, one writes a NOM\_MAILLAGE.geo file in the repertory defined by the user in the interface astk (NOM\_MAILLAGE indicates the name allotted to the grid by the user). One y print:*

*.  
a first “share” EnSightTM containing all the meshes of the grid and whose name is that of the grid Aster,  
.*

*then for each group of meshes Aster a “share” of the same name than the group.*

*The groups of nodes are not printed in the NOM\_MAILLAGE.geo file and the finite elements Aster QUAD9 and PENTA15 are respectively reduced in QUAD8 and PENTA6.*

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**6 Operands**

**CHAM\_GD and RESULT**

*The values of the computed fields are stored in structures of data called fields of size. These fields of size can be directly accessible (concept cham\_gd) where to find in a structure of data gathering several fields of size (concept result).*

.

*A field of size is a structure of data which makes it possible to store definite fields with the nodes (cham\_no\_\*) or fields defined by elements (cham\_elem\_\*). For the fields by elements, one distinguishes the fields defined in the nodes from the elements and the fields defined in points of GAUSS of the elements.*

.

*A concept result is composed of one or more fields of size. For example, with each step of calculation one stores in the structure of data result, the field of size displacement. This structure is thus a matrix structure of order 2, whose index is, by example, the list of the moments of calculation and the other the whole of the computed fields (displacements, constraints, deformations,...).*

*One reaches in this case a field of size by specifying a value of a variable of access (sequence number, moment, frequency, number of mode...) and a field name ("DEPL", "SIGM\_ELNO\_DEPL",...). There are several types of concept result: evol\_elas, evol\_noli, mode\_meca,.... With each one corresponds a list of fields and a list of variables licit accesses (cf [U5]).*

*Taking into account the structure of data result, one understands easily that the possibilities of impression which one lays out are those of the fields of size, supplemented by specific possibilities.*

*Note:*

*With format “ENSIGHT”, one can treat only the fields with the nodes: fields by elements with the nodes or the points of GAUSS must thus be transformed into fields with nodes via order CALC\_NO [U4.81.03] before the call to the procedure IMPR\_RESU.*

*Currently, EnSight™ handles only scalar real variables and variables vectorial (3 values per file).*

.

*Scalar variable*

*With each scalar component of an Aster size is associated a EnSight™ file which contains the values of this component in all the nodes of the grid.*

.

*Vectorial variable*

*One regards as vectorial variables, the components of a field of size which can be gathered in a vector quantity with three components (component FLOW, FLUY, FLUZ of the size flu\_, component DX, DY, DZ of the size depl\_).*

*For each vectorial variable one writes a “vectorial” file containing the three values of vector in all the nodes of the grid.*

*Note:*

*For the size depl (component DX, DY, DZ), one generates moreover three files scalars containing the values of each component of the vector in all the nodes of grid.*

.

*Tensorial variable*

*One treats the various terms of the tensor like scalar variables.*

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**Note:**

***The complex variables are described in two distinct scalar files of which one contains the value of the real part in all the nodes and the other the value of the imaginary part.***

## **6.1 Operand**

**CHAM\_GD**

***A field of Aster size named U.S. 'supports on a size defined by its components.***

***According to the type of the component (scalar real, scalar complex, vectorial real, vectorial complex), one produces 1 or several files as mentioned previously.***

***The name of the produced files follows the following rule:***

***.  
Real scalar variable***

***1 named file  
u.NOMCMP***

***.  
Complex scalar variable***

***2 named files  
u.NOMCMP.R***

***u.NOMCMP.I***

•  
***Real vectorial variable***

***1 named “vectorial” file***

***U***

•  
***Complex vectorial variable***

***2 named “vectorial” files***

***u.R***

***u.I***

***Note:***

***In all the cases, one generates in more one file u.res which describes the correspondence between name of the variables to be visualized and the name of the corresponding files of values.***

***Examples:***

***IMPR\_RESU (FORMAT = “ENSIGHT”  
RESU = (\_F (CHAM\_GD = CONT,  
))***

•  
***The field with the nodes of name CONT is a real stress field having for components SIXX, SIYY, SIZZ, SIXY, SIXZ, SIYZ.***

***Seven files are created in the repertory of the user.***

***CHAM\_GD.res***

***correspondence enters the name of the variables to visualize and the name of the files of values correspondents,***

***CONT.SIXX, CONT.SIYY, CONT.SIZZ, CONT.SIXY, CONT.SIXZ, CONT.SIYZ containing the value of each component in all the nodes of the grid.***

•  
***IMPR\_RESU (FORMAT = “ENSIGHT”  
RESU = (\_F (CHAM\_GD = DEPLA,)))***



*The field with the nodes of name DEPLA is a field of real displacements having for components DX, DY, DZ, DRX, DRY, DRZ.*

*Eight files are generated in the repertory result.*

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*Procedure IMPR\_RESU with format "ENSIGHT"*

*Date:*

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*Key COURTEOUS Mr.*

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*CHAM\_GD.res*

*correspondence enters the name of the variables to visualize and the name of the files of values,*

*DEPLA*

*file of vectorial variables gathering the value of components (DX, DY and DZ) in all them nodes,*

*DEPLA.DX DEPLA.DY DEPLA.DZ DEPLA.DRX DEPLA.DRY DEPLA.DRZ*

*scalar files of variables containing the value of each component.*

*Note:*

*The user can reduce the number of files generated by using operand NOM\_CMP.*

*In the case of a field of displacements, if the user specifies*

*NOM\_CMP = (DX, DY, DZ), one creates only the file containing the vectorial variable (components DX, DY and DZ).*

## 6.2 Operand

### **RESULT**

*The operand **RESULT** makes it possible to print the fields contained in a concept result. One can for example to choose to print only certain fields (cf the following key word: **NOM\_CHAM**).*

*With format “**ENSIGHT**”, the concept result is written sequence number per sequence number and field of size by field of size.*

*The treatment of the fields of size extracted the concept result is described in [§6.1].*

*However the name of the produced **EnSight**<sup>TM</sup> files must take account of the structure of the concept result (sequence number, reference symbol).*

*In a general way, a concept result of name **resu** defined by **N** sequence numbers and **m** names symbolic systems contains **n.m** fields of size.*

*These fields of size do not have a name user also **IMPR\_RESU** with format **ENSIGHT** them give a fictitious name which is used like the name user of the field of size in the case of them **CHAM\_GD**:*

**RESU.NOMSYM.CHNU01+CHIORD**

*if **NBORDR** > 1*

**RESU.NOMSYM.CHNU01**

*if **NBORDR** = 1*

*with:*

•

**NOMSYM**

*reference symbol of the field in Aster (**DEPL**, **SIGM\_NOEU\_DEPL**,...),*

•

**CHNU01**

*number of the first sequence number to be printed,*

•

**CHIORD**

*index of the sequence number in the course of impression (**CHIORD** makes it possible to respect formats **ENSIGHT**),*

•

**NBORDR**

*numbers total sequence numbers to be printed.*

*The name of the EnSight™ files produced by IMPR\_RESU follows then the rule exposed in [§6.1].*

*For example, for a field of size of N real components scalar, N files are produced.*

*Those are named resu.NOMSYM.CHNUO1+CHIORD.NOMCMP containing for each component of name NOMCMP the value of the component in all the nodes of the grid.*

*In addition to the files of values, one generates a file of description named RESU.resCHNUO1 which specify for the EnSight™ software the number of sequence numbers and the correspondence between the names*

*scalar and vectorial variables to visualize and names of the associated files of values.*

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*Key COURTEOUS Mr.*

*:*

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*Example:*

*IMPR\_RESU*

*(*

*FORMAT*

*=*

*“ENSIGHT”,*

*RESU*

*= (\_F (RESULT*

*=*

*WIRE,*

*NUME\_ORDRE*

*=*

**(1,2),  
NOM\_CHAM  
=  
("DEPL", "SIGM\_NOEU\_DEPL"),**

**)))**

***The field of displacements to the nodes has as components DX, DY, real DZ.  
The stress field to the nodes has as components SIXX, SIYY, SIZZ, SIXY, SIXZ, SIYZ  
real.***

***The example led to creation, inside the repertory result of the user of the following files:***

***Number order 1***

***FIL.DEPL.1+0***

***file of vectorial variable containing displacement (components DX, DY, DZ)***

***FIL.DEPL.1+0.DX, FIL.DEPL.1+0.DY, FIL.DEPL.1+0.DZ***

***scalar files of variables containing the value of each component (DX, DY, DZ) in all  
nodes of the grid.***

***FIL.SIGM\_NOEU\_DEPL.1+0.SIXX,***

***FIL.SIGM\_NOEU\_DEPL.1+0.SIYY***

***FIL.SIGM\_NOEU\_DEPL.1+0.SIZZ,***

***FIL.SIGM\_NOEU\_DEPL.1+0.SIXY***

***FIL.SIGM\_NOEU\_DEPL.1+0.SIXZ,***

***FIL.SIGM\_NOEU\_DEPL.1+0.SIYZ***

*scalar files of variables containing the value of each component (SIXX,...) in all the nodes of the grid.*

*Number order 2*

***FIL.DEPL.1+1***

*file containing displacement (components DX, DY, DZ)*

***FIL.DEPL.1+1.DX, FIL.DEPL.1+1.DY, FIL.DEPL.1+1.DZ***

*files containing components DX, DY and DZ in all the nodes of the grid.*

***FIL.SIGM\_NOEU\_DEPL.1+1.SIXX,  
FIL.SIGM\_NOEU\_DEPL.1+1.SIYY  
FIL.SIGM\_NOEU\_DEPL.1+1.SIZZ,  
FIL.SIGM\_NOEU\_DEPL.1+1.SIXY  
FIL.SIGM\_NOEU\_DEPL.1+1.SIXZ,  
FIL.SIGM\_NOEU\_DEPL.1+1.SIYZ***

*files containing components SIXX,... SIYZ in all the nodes of the grid.*

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***Procedure IMPR\_RESU with format "ENSIGHT"***

***Date:***

***10/02/05***

***Author (S):***

***Key COURTEOUS Mr.***

***:***

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## ***Extraction of a field of size***

### ***7.1 Operands***

***TOUT\_CHAM/NOM\_CHAM***

***Cf document [U7.71.00].***

***7.2 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/  
NUME\_MODE/INST/LIST\_INST/FREQ/LIST\_FREQ/  
NOEUD\_CMP/NOM\_CAS/ENG/PRECISION/CRITERION***

***Cf document [U7.71.00].***

## ***8***

### ***Selection on the components***

***Another manner of reducing the volume of the impressions is to print only the values of certain components (for example that displacement following axis X: component DX).***

***Format “ENSIGHT” this selection on the components makes it possible to reduce the number of files generated.***

#### ***8.1 Operand***

***TOUT\_CMP***

***This key word makes it possible to indicate that one wishes to print all the components of the field.***

#### ***8.2 Operand***

***NOM\_CMP***

***This key word makes it possible to choose the list of the components of the CHAM\_GD or all the fields of the concept result which one wishes to print.***

***Key words TOUT\_CMP and NOM\_CMP cannot be used simultaneously.***

***These components are described in the specific documentation of the elements.***

***Note:***

***With format “ENSIGHT”, and if the user specifies NOM\_CMP = (“DX, DY, DZ”), one does not***

**create**

**that the file containing the vectorial variable (corresponding to components DX, DY and DZ [§6.2]).**

**9 Operand**

**UNIT**

**With format “ENSIGHT” the results are written in several formatted files whose names are determined automatically starting from the names of the concepts, the fields of size and theirs components (cf operand CHAM\_GD and operand RESULT).**

**Consequently, the operand UNIT does not have any effect with the format of impression “ENSIGHT”.**

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**Titrate:**

**Procedure IMPR\_RESU format “GMSH”**

**Date:**

**22/02/06**

**Author (S):**

**COURTEOUS Mr., NR. TARDIEU Key**

**:**

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**Organization (S): EDF-R & D /AMA**

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Document: U7.05.32***

***Procedure IMPR\_RESU with format “GMSH”***

***1 Goal***

***To write a field of size or a concept result with format “GMSH”.***

***Currently this procedure makes it possible to write with the choice:***

- fields with the nodes (of displacements, temperatures, clean modes, modes statics,...),***
- fields by elements with the nodes (of constraints, generalized efforts, variables interns...).***

***For the concepts of the result type, one can print only part of information, in selecting the fields and the sequence numbers which one wishes to exploit.***

***It is possible to select the topological entities (meshes or groups of meshes) on which one wants to print the results.***

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***Titrate:  
Procedure IMPR\_RESU format “GMSH”***



**Date:**

**22/02/06**

**Author (S):**

**COURTEOUS Mr., NR. TARDIEU Key**

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**2 Syntax**

**IMPR\_RESU**

**(**

**MODELE= Mo,**

**[model]**

**UNIT = links,**

**FORMAT**

**=/"GMSH",**

**RESU**

**=**

**(**

**//GRID = my,**

**/**

**[grid]**

**/**

**[skeleton]**

**/**

**/**

**CHAM\_GD =**

**ch\_gd,**

**/**

**RESULT**

**=**

**resu,**

*# Extraction of a field of size of resu*

*/TOUT\_CHAM*

*=  
/“YES”, [DEFECT]  
/“NOT”,*

*/  
NOM\_CHAM  
=  
l\_nomsymb, [l\_K16]*

*/TOUT\_ORDRE = “YES”,  
[DEFECT]*

*/  
NUME\_ORDRE =  
lordre,*

*[l\_I]  
/  
LIST\_ORDRE =  
lenti,  
[listis]*

*/  
NUME\_MODE*

*=  
lmode,*

*[l\_I]  
/  
NOEUD\_CMP*

=  
**lnoecmp,**  
**[l\_K16]**  
**/**  
**NOM\_CAS =**  
**ncas,**  
**[l\_K16]**  
**/**  
**ENG =**  
**langl,**  
**[l\_K16]**  
**/**  
**/**  
**FREQ =**  
**lfreq,**  
**[l\_R]**  
**/**  
**LIST\_FREQ**  
**=**  
**lreel,**  
**[listr8]**  
**/**  
**INST =**  
**linst,**  
**[l\_R]**  
**/**  
**LIST\_INST**  
**=**  
**lreel,**  
**[listr8]**

**/ PRECISION =/prec,**  
**[R]**  
**/**  
**1.0D-3,**  
**[DEFECT]**  
**/**

**CRITERION**

=

/

**“RELATIVE”,**  
**[DEFECT]**

/

**“ABSOLUTE”,**

**/ PART**

**=/“REAL”,**

/

**“IMAG”,**

**# Selection of the topological entities**

**/ NET**

=

**l\_maille,**  
**[l\_maille]**

/

**GROUP\_MA**

=

**l\_grma, [l\_gr\_maille]**

/

**NOM\_CMP =**

**l\_cmp,**  
**[l\_K8]**

**VERSION =/**

**1.2,**  
**[DEFECT]**

/

**1.0,**  
**[R]**

)

)

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Version

8.2

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Procedure *IMPR\_RESU* format “GMSH”

Date:

22/02/06

Author (S):

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**3 Word**

**key**

**RESU**

*This key word factor makes it possible to specify the results to print and the format according to which one wants them to print.*

**4 Operands**

**CHAM\_GD and RESULT**

*The values of the computed fields are stored in structures of data called fields of size. These fields of size can be directly accessible (concept *CHAM\_GD*) or to find in a structure of data gathering several fields of size (concept *result*).*

*A field of size is a structure of data which makes it possible to store fields defined in the nodes (*cham\_no\_\**) or of the fields defined by elements (*cham\_elem\_\**). For the fields by elements, one distinguishes the fields defined in the nodes from the elements and them fields defined in the points of GAUSS of the elements.*

*A concept *result* is composed of one or more fields of size. For example, with each step of calculation one stores in the structure of data *result*, the field of size displacement. This structure is thus a matrix structure of order 2, including one index is, for example, the list of the moments of calculation and the other the whole of the fields calculated (displacements, constraints, deformations,...).*

*One reaches in this case a field of size by specifying a value of a variable access (sequence number, moment, frequency, number of mode,...) and a field name (“DEPL”, “SIGM\_ELNO\_DEPL”,...). There are several types of concept result: evol\_elas, evol\_noli, mode\_meca,.... With each one corresponds a list of fields and a list of licit variables of access (cf [U5]).*

*Taking into account the structure of data result, one understands easily that them possibilities of impression which one lays out are those of the fields of size, supplemented by specific possibilities.*

### **Caution**

*One cannot print in the same file the GRID and the RESULTAT/CHAM\_GD, GMSH cannot read such a file. The order thus stops if the two key words are present.*

#### **4.1 Operand CHAM\_GD**

*For the CHAM\_NO, the components of the field to the nodes are burst in a vector field gathering components DX, DY and DZ and in as many scalar fields there are others components.*

**Example:** *In the case of a field with the nodes of size DEPL and whose modeling is of type beam, one writes:*

*.  
1 vector field (gathering the whole of the components of translation)*

*.  
3 scalar fields (a field per degree of rotation).*

*For the CHAM\_ELEM, one prints only the fields by elements with the nodes (\_ELNO\_). One field by elements with the nodes is burst in as many scalar fields there are components.*

#### **4.2 Operand RESULT**

*The operand RESULT makes it possible to print the fields contained in a concept result. One can for example to choose to print only certain fields (cf the key word: NOM\_CHAM).*

*The concept result is written field of size per field of size as described in [§4.1].*

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**5**

***Extraction of a field of size***

**5.1 Operands**

**TOUT\_CHAM/NOM\_CHAM**

*Cf document [U4.71.00].*

**5.2 Operands TOUT\_ORDRE/NUME\_ORDRE/LIST\_ORDRE/**

**NUME\_MODE/INST/LIST\_INST/FREQ/LIST\_FREQ/**

**NOEUD\_CMP/NOM\_CAS/ENG/PRECISION/CRITERION**

*Cf document [U4.71.00].*

**6**

***Selection of the topological entities and the components***

*In order to reduce the volume of the impressions, it is sometimes necessary to print only part of result. With this intention one can wish not to print a field with the nodes or a field by element that in certain elements.*

*This selection which one will note “selection on topological entities” is possible with format “GMSH”.*

*One cannot print complex fields with format GMSH, it is thus necessary, for such fields, to select the Real or Imaginary PART to print.*

**6.1 Operand**



## **NET**

*This key word makes it possible to indicate the list of the meshes on which one wishes to print a cham\_elem.*

*For a cham\_no, it makes it possible to indicate the list of the nodes, tops of the meshes to which one wishes to print the cham\_no.*

## **6.2 Operand GROUP\_MA**

*This key word makes it possible to indicate the list of the groups of meshes on which one wishes to print one cham\_elem. For a cham\_no, it makes it possible to indicate the list of the nodes, tops of the meshes to which one wishes to print the cham\_no.*

## **6.3 Operand NOM\_CMP**

*This key word makes it possible to choose the list of the components which one wishes to print. If this key word is not indicated, one prints the field with the tensor format (9 components per node).*

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## **7 Operand**

## **UNIT**

*UNIT makes it possible to choose on which file the results will be written. By defect, UNIT = 37 with format "GMSH".*

*One can thus print results on different files with each order IMPR\_RESU.  
The natural suffix of the files of post treatment GMSH is .pos and the usual logical unit (by defect in astk) is 37.*

## **8 Operand VERSION**

*The meshes accepted by GMSH (in postprocessing) are, since the version 1.35, the meshes of the type POI1, SEG2, TRIA3, QUAD4, TETRA4, HEXA8, PENTA6, PYRAM5, which corresponds to:*

*VERSION = "1.2" which is the default value*

*If one requires to visualize the fields with an old version of GMSH or if one wishes to cut out all the meshes in POI1, SEG2, TRIA3 and TETRA4, one uses VERSION = "1.0".*

*To be able to visualize the sights with GMSH, the grid is modified to have only meshes GMSH. Currently, meshes PYRAM13 are not treated.*

*.  
The SEG3 is broken up into 2 SEG2,*

*.  
the SEG4 is broken up into 3 SEG2,*

*.  
the TRIA6 is broken up into 4 TRIA3,*

*.  
the TRIA7 is broken up into 4 TRIA3,*

*.  
the QUAD4 is broken up into 2 TRIA3 (cut out only if VERSION='1.0'),*

*.  
the QUAD8 is broken up into 6 TRIA3,*

*.  
the QUAD9 is broken up into 6 TRIA3,*

*.  
the TETRA10 is broken up into 8 TETRA4,*

*.  
the PENTA6 is broken up into 3 TETRA4 (cut out only if VERSION='1.0'),*

*.  
the PENTA15 is broken up into 16 TETRA4,*

.  
the PYRAM5 is broken up into 2 TETRA4 (cut out only if VERSION='1.0'),

.  
the HEXA8 is broken up into 6 TETRA4 (cut out only if VERSION='1.0'),

.  
the HEXA20 is broken up of 24 TETRA4,

.  
the HEXA27 is broken up into 48 TETRA4.

### **Notice**

TRIA7 (respectively QUAD9) is cut out like the TRIA6 (resp. QUAD8) because the node exchange does not carry a DDL of displacement in modeling COQUES\_3D.

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