ZZZZ395 - Checking ofS operators of reduction of model

Summary:

The objective of this test is of to check in an elementary way the operators of reduction of model DEFI_BASE_REDUITE, DEFI_DOMAINE_REDUIT and REST_REDUIT_COMPLET.
One testE in thermics non-linear (operator HTER_NON_LINE) and in mechanics non-linear (operator STAT_NON_LINE).

1 Problem of reference

1.1 Geometry

One considers a cube of with dimensions $3\,mm$.

1.2 Properties of material

The material is élastO-plastic with work hardening isotropic linear (VMIS_ISOT_LINE) whose properties are:

- Modulus of elasticity: $E=210\,000\,MPa$
- Poisson's ratio: $\nu=0.3$
- Linear module of work hardening: $H=100\,MPa$
- Yield stress: $\sigma_y=100\,MPa$
- Thermal conductivity: function of the temperature on the figure 1.2-a
- Voluminal heat: function of the temperature on the figure

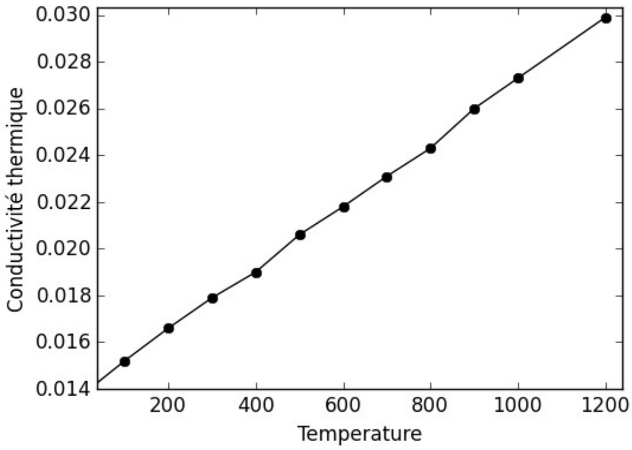

Figure 1.2-a: Thermal conductivity

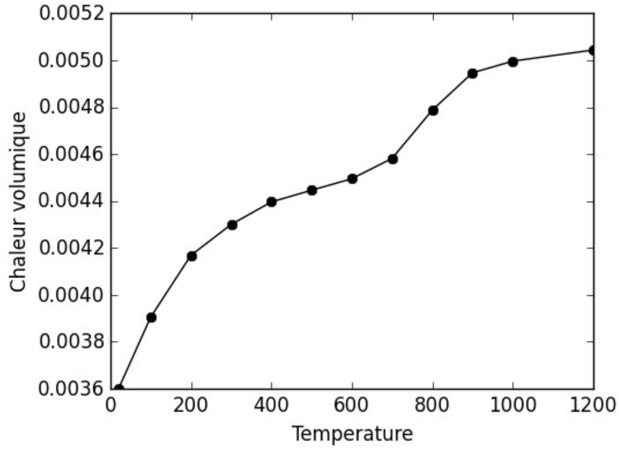

Figure 1.2-b: Voluminal heat

1.3 Boundary conditions and loadings

1.3.1 Thermal calculation

One imposes a condition of radiation on five faces of the cube (see figure 1.3.1-a) with:

- Boltzmann constant: $5,67\times 10^{-14} J.mm^{-2}.K^{4}$;
- emissivity: $0,75$
- outside temperature: $20°C$

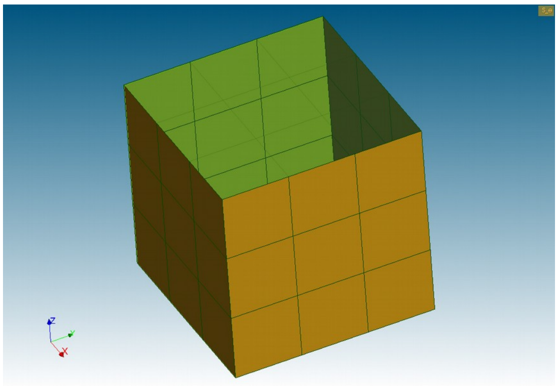

Figure 1.3.1-a: Surface for the condition of radiation

A condition of exchange on the face top (see figure 1.3.1-c) with:

- Coefficient of exchange: $1,0\,W.mm^{-2}.K^{-1}$
- Outside temperature: function of time on the figure 1.3.1-b

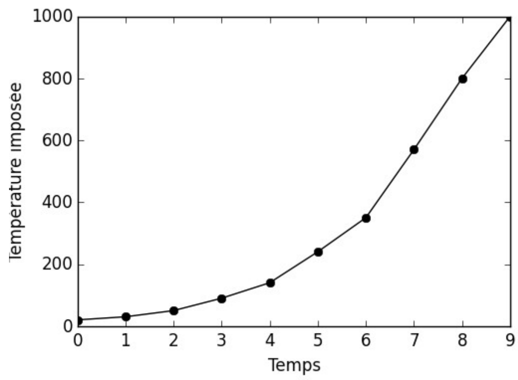

Figure 1.3.1-b: Outside temperature

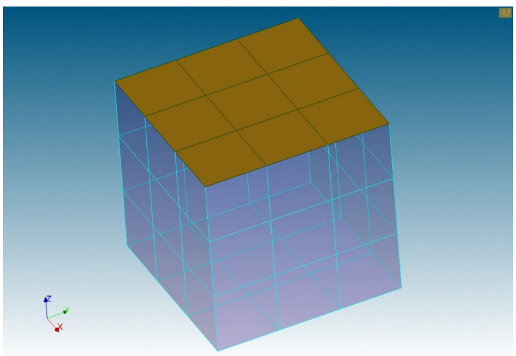

Figure 1.3.1-c: Surface for the condition of exchange

A condition of exchange on the others faces (see figure 1.3.1-a) with:

- Coefficient of exchange: $1{,}5 \times 10^{-5} W.mm^{-2}.K^{-1}$
- Outside temperature: $20°C$

1.3.2 Mechanical calculation

On Lhas lower surface (see figure 1.3.2-a), one imposes DX=DY=DZ=0.
On five faces of the cube (see figure 1.3.1-a), a pressure is imposed $p=1000\,MPa$

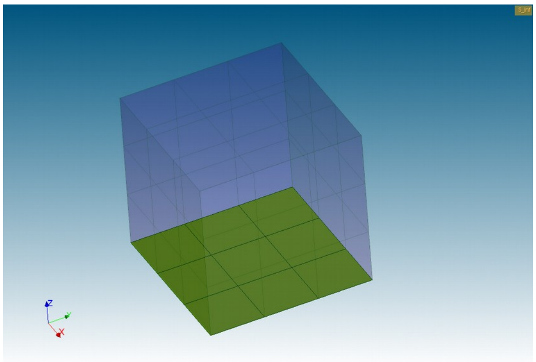

Figure 1.3.2-a: Surface for embedding

1.4 Initial conditions

Nothing.

2 Reference solution

2.1 Method of calculating

The results of reference are values of not-regression (values of the empirical modes, coefficients of reduction) that is to say values (displacements, temperatures, constraints and flow) calculated on one model ***complete***. The reduced coordinates are also tested. It is pointed out that the empirical modes $\Psi_m(x)$ are such as:

$$u(x,t)\approx\sum_{m=1}^{nbmode}\Psi_m(x)\times a_m(t) \quad (1)$$

For a field $u(x,t)$ given (temperature, displacement, heat flux or constraint) with a_m reduced coordinates.

2.2 Sizes and results of reference

For thermics, the results on the model ***complete*** :

Place	**Moment**	**Temperature (TEMP)**
Node With in $(1,0,3)$	$t=1s$	$29{,}9053048593\,°C$
Node With in $(1,0,3)$	$t=4s$	$139{,}462715634\,°C$
Node With in $(1,0,3)$	$t=7s$	$567{,}08693147\,°C$
Node With in $(1,0,3)$	$t=10s$	$999{,}349943608\,°C$
Node B in $(3,3,3)$	$t=1s$	$29{,}90499961\,°C$
Node B in $(3,3,3)$	$t=4s$	$139{,}458066818\,°C$
Node B in $(3,3,3)$	$t=7s$	$567{,}040457129\,°C$
Node B in $(3,3,3)$	$t=10s$	$999{,}12502482\,°C$

For mechanics, the results on the model ***complete*** :

Place	**Moment**	**Component**	**Displacement (DEPL)**
Node With in $(1,0,3)$	$t=10s$	DX	$0{,}0696319525128\,mm$
Node With in $(1,0,3)$	$t=10s$	DY	$0{,}199062276741\,mm$
Node With in $(1,0,3)$	$t=10s$	DZ	$0{,}529606351907\,mm$
Node B in $(3,3,3)$	$t=10s$	DX	$-0{,}208992921588\,mm$
Node B in $(3,3,3)$	$t=10s$	DY	$-0{,}208992921588\,mm$
Node B in $(3,3,3)$	$t=10s$	DZ	$0{,}547254495773\,mm$

Place	**Moment**	**Component**	**Constraint (SIEF_NOEU)**
Node With in $(1,0,3)$	$t=10s$	SIXX	$-2739{,}13961277\,MPa$
Node With in $(1,0,3)$	$t=10s$	SIYY	$-2737{,}51235419\,MPa$
Node With in $(1,0,3)$	$t=10s$	SIZZ	$-2612{,}22311229\,MPa$

Node C in $(0,0,0)$	$t=10s$	SIXX	$13992,3974341\,MPa$
Node C in $(0,0,0)$	$t=10s$	SIYY	$13992,3974341\,MPa$
Node C in $(0,0,0)$	$t=10s$	SIZZ	$14047,6477194\,MPa$
Node D in $(3,1,0)$	$t=10s$	SIXX	$13300,4780377\,MPa$
Node D in $(3,1,0)$	$t=10s$	SIYY	$13300,3220671\,MPa$
Node D in $(3,1,0)$	$t=10s$	SIZZ	$13368,1442621\,MPa$

2.3 Uncertainties on the solution

The error on the solution depends on the degree of reduction (many modes empiricalS and cuts reduced field).

3 Modeling A

3.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics.
This modeling tests the creation of the empirical modes in thermics. One takes for the primal base and the dual base TOLE_SVD = 1.E-3.

3.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

3.3 Sizes tested and results

One tests some values of the primal base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not A – TEMP – Mode 1	NON_REGRESSION
Not A – TEMP – Mode 2	NON_REGRESSION
Not A – TEMP – Mode 3	NON_REGRESSION

One tests some values of the dual base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not A – FLUX_NOEU/FLUX – Mode 1	NON_REGRESSION
Not A – FLUX_NOEU/FLUY – Mode 1	NON_REGRESSION
Not A – FLUX_NOEU/FLUX – Mode 2	NON_REGRESSION
Not A – FLUX_NOEU/FLUY – Mode 2	NON_REGRESSION
Not A – FLUX_NOEU/FLUX – Mode 3	NON_REGRESSION
Not A – FLUX_NOEU/FLUY – Mode 3	NON_REGRESSION

One tests the values of the reduced coordinates (table COOR_REDUIT) a_m^T calculated during the extraction of the empirical modes. For the primal base (temperature) :

Identification	Moment	Mode	Type of reference
$a_{m=1,t=10s}^T$	$t=10s$	1	NON_REGRESSION
$a_{m=1,t=4s}^T$	$t=4s$	1	NON_REGRESSION
$a_{m=3,t=10s}^T$	$t=10s$	3	NON_REGRESSION
$a_{m=3,t=4s}^T$	$t=4s$	3	NON_REGRESSION

For the dual base (heat flux Φ):

Identification	Moment	Mode	Type of reference
$a^{\Phi}_{m=1,t=10s}$	$t=10s$	1	NON_REGRESSION
$a^{\Phi}_{m=1,t=4s}$	$t=4s$	1	NON_REGRESSION
$a^{\Phi}_{m=4,t=10s}$	$t=10s$	4	NON_REGRESSION
$a^{\Phi}_{m=4,t=4s}$	$t=4s$	4	NON_REGRESSION

3.4 Remarks

One cannot say anything in the absolute on the precision of these values because ON tests values of not-regression, but the two bases produced (in temperature and flow) will be tested in other modelings to compare compared to complete calculation.

4 Modeling B

4.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics.
This modeling tests creation DU reduced field (RID).
One uses the bases produced in modeling A.

4.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

4.3 Sizes tested and results

It is checked that the meshs and the groups are well created by the operator DEFI_DOMAINE_REDUIT.
Creation of a group of meshs named 'RID' for the RID (keyword NOM_DOMAINE) and of a group of nodes 'INF' (keyword NOM_INTERFACE) for the interface between the RID and the rest of the field.

Identification	Type of reference
NR shade of GROUP_MA	NON_REGRESSION
Number of GROUP_ NO	NON_REGRESSION
Many nodes in the group INF	NON_REGRESSION
Many meshs in the group RID	NON_REGRESSION

4.4 Remarks

One cannot say anything in the absolute on the precision of these values because ON tests values of not-regression, but the reduced field will be tested in other modelings.

5 Modeling C

5.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics with reduction of model.
This modeling tests Lprecision of the empirical modes obtained in modeling A has
One uses thus bases produced in modeling A.

5.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

5.3 Sizes tested and results

One tests the value of the temperatures obtained with a scale model compared to those obtained in the complete model (§2.2):

Place	Moment	VALE_REFE (TEMP)	PRECISION
Node With in $(1,0,3)$	$t=1s$	$29{,}9053048593°C$	6.0E-5
Node With in $(1,0,3)$	$t=4s$	$139{,}462715634°C$	2.0E-5
Node With in $(1,0,3)$	$t=7s$	$567{,}08693147°C$	7.0E-6
Node With in $(1,0,3)$	$t=10s$	$999{,}349943608°C$	6.0E-6

5.4 Remarks

It is seen that the base produced in modeling A makes it possible to obtain very good performances (error lower than 0.01%) compared to complete calculation.

6 Modeling D

6.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics with very-reduction of model. This modeling tests the precision of the empirical modes obtained in modeling A on the reduced field created in modeling B.
One uses thus bases produced in modeling A and the reduced field created in modeling B. One also tests the operator of reconstruction REST_REDUIT_COMPLET by gappy-POD.

6.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

6.3 Sizes tested and results

One tests the value of the temperatures obtained with a model hyper-tiny room compared to those obtained in the complete model (§2.2):

Place	**Moment**	**VALE_REFE (TEMP)**	**PRECISION**
Node With in $(1,0,3)$	$t=1s$	$29,9053048593°C$	5.0E-5
Node With in $(1,0,3)$	$t=4s$	$139,462715634°C$	1.5E-5
Node With in $(1,0,3)$	$t=7s$	$567,08693147°C$	5.0E-6
Node With in $(1,0,3)$	$t=10s$	$999,349943608°C$	5.0E-6

The node B does not belong to the field reduces RID. One cannot thus reach his value at the conclusion of thermal calculation very-tiny room. The operator is used REST_REDUIT_COMPLET :

Place	**Moment**	**VALE_REFE (TEMP)**	**PRECISION**
Node B in $(3,3,3)$	$t=10s$	$999,12502482°C$	0,3 %

6.4 Remarks

It is seen that the base produced in modeling A on the reduced field of modeling B allows to obtain very good performances (error lower than 0.01%) compared to complete calculation. But they are inevitably slightly less less good than in the simply reduced case (modeling C).
Moreover, the operator of reconstruction REST_REDUIT_COMPLET also give a good solution to 0.3 % near on the temperature evaluated outside the RID.

7 Modeling E

7.1 Characteristics of modeling

A modeling is used 3D in mechanics non-linear.
This modeling tests the creation of the empirical modes in mechanics. One takes for the primal base and the dual base TOLE_SVD = 1.E-3.

7.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

7.3 Sizes tested and results

One tests some values of the primal base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not A – DEPL/DX – Mode 1	NON_REGRESSION
Not A – DEPL/DY – Mode 1	NON_REGRESSION
Not A – DEPL/DZ – Mode 1	NON_REGRESSION
Not A – DEPL/DX – Mode 2	NON_REGRESSION
Not A – DEPL/DY – Mode 2	NON_REGRESSION
Not A – DEPL/DZ – Mode 2	NON_REGRESSION

One tests some values of the primal base obtained by the method POD_INCR with SHEET = 1.E-10. One obtains the same modes as previously:

Identification	Type of reference
Not A – DEPL/DX – Mode 1	NON_REGRESSION
Not A – DEPL/DY – Mode 1	NON_REGRESSION
Not A – DEPL/DZ – Mode 1	NON_REGRESSION
Not A – DEPL/DX – Mode 2	NON_REGRESSION
Not A – DEPL/DY – Mode 2	NON_REGRESSION
Not A – DEPL/DZ – Mode 2	NON_REGRESSION

One tests some values of the dual base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not A – SIEF_NOEU/SIXX – Mode 1	NON_REGRESSION
Not A – SIEF_ NOEU/ SIYY – Mode 1	NON_REGRESSION
Not A – SIEF_ NOEU/ SIZZ – Mode 1	NON_REGRESSION
Not A – SIEF_ NOEU/ SIXY – Mode 1	NON_REGRESSION
Not A – SIEF_ NOEU/ SIXZ – Mode 1	NON_REGRESSION

Not A – SIEF_ NOEU/ SIYZ – Mode 1	NON_REGRESSION
Not A – SIEF_NOEU/SIXX – Mode 3	NON_REGRESSION
Not A – SIEF_ NOEU/ SIYY – Mode 3	NON_REGRESSION
Not A – SIEF_ NOEU/ SIZZ – Mode 3	NON_REGRESSION
Not A – SIEF_ NOEU/ SIXY – Mode 3	NON_REGRESSION
Not A – SIEF_ NOEU/ SIXZ – Mode 3	NON_REGRESSION
Not A – SIEF_ NOEU/ SIYZ – Mode 3	NON_REGRESSION

7.4 Remarks

One cannot say anything in the absolute on the precision of these values because ON tests values of not-regression, but the two bases produced (in displacement and in constraints) will be tested in other modelings to compare compared to complete calculation.

8 Modeling F

8.1 Characteristics of modeling

A modeling is used 3D in mechanics non-linear.
This modeling tests creation DU reduced field (RID).
One uses the bases produced in modeling E.

8.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

8.3 Sizes tested and results

It is checked that the meshs and the groups are well created by the operator DEFI_DOMAINE_REDUIT.
Creation of a group of meshs named 'RID' for the RID (keyword NOM_DOMAINE) and of a group of nodes 'INF' (keyword NOM_INTERFACE) for the interface between the RID and the rest of the field.

Identification	**Type of reference**
Nombre of GROUP_MA	NON_REGRESSION
Number of GROUP_ NO	NON_REGRESSION
Many nodes in the group INF	NON_REGRESSION
Many meshs in the group RID	NON_REGRESSION

8.4 Remarks

One cannot say anything in the absolute on the precision of these values because ON tests values of not-regression, but the reduced field will be tested in other modelings.

9 Modeling G

9.1 Characteristics of modeling

A modeling is used 3D in mechanics non-linear with reduction of model.
This modeling tests Lprecision of the empirical modes obtained in modeling E has.
One uses thus bases produced in modeling E.

9.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

9.3 Sizes tested and results

One tests the value of displacements obtained with a scale model compared to those obtained in the complete model (§2.2):

Place	Moment	Component	Displacement (**DEPL**)	Précision
Node With in $(1,0,3)$	$t=10s$	DX	$0{,}0696319525128\,mm$	0.0015
Node With in $(1,0,3)$	$t=10s$	DY	$0{,}199062276741\,mm$	<1,0E-6 %
Node With in $(1,0,3)$	$t=10s$	DZ	$0{,}529606351907\,mm$	<1,0E-6 %

And constraints:

Place	Moment	Component	Constraint (**SIEF_NOEU**)	Précision
Node With in $(1,0,3)$	$t=10s$	SIXX	$-2739{,}13961277\,MPa$	0.2 %
Node With in $(1,0,3)$	$t=10s$	SIYY	$-2737{,}51235419\,MPa$	0.2 %
Node With in $(1,0,3)$	$t=10s$	SIZZ	$-2612{,}22311229\,MPa$	0.2 %

One tests the values of the reduced coordinates (table COOR_REDUIT) a_m^u calculated at the time of calculation reduced in STAT_NON_LINE. For the primal base (displacements) :

Identification	Moment	Mode	Type of reference
$a^u_{m=1,t=1s}$	$t=1s$	1	NON_REGRESSION
$a^u_{m=2,t=10s}$	$t=10s$	2	NON_REGRESSION

One also tests PREDICTION=' EXTRAPOLE' :

Place	Moment	Component	Displacement (**DEPL**)	Précision
Node With in $(1,0,3)$	$t=10s$	DX	$0{,}0696319525128\,mm$	0.0015

Node With in $(1,0,3)$	$t=10s$	DY	$0{,}199062276741\,mm$	<1,0E-6 %
Node With in $(1,0,3)$	$t=10s$	DZ	$0{,}529606351907\,mm$	<1,0E-6 %

One tests the values of the reduced coordinates (table COOR_REDUIT) a_m^u calculated at the time of calculation reduced in STAT_NON_LINE. For the primal base (displacements) :

Identification	Moment	Mode	Type of reference
$a_{m=1,t=1s}^u$	$t=1s$	1	NON_REGRESSION
$a_{m=2,t=10s}^u$	$t=10s$	2	NON_REGRESSION

9.4 Remarks

It is seen that the base produced in modeling E allows to obtain very good performances (error lower than 0.2%) compared to complete calculation except for the three last constraints. But for these last, it is not significant because the constraints are very low.

10 Modeling H

10.1 Characteristics of modeling

A modeling is used 3D in mechanics non-linear with very-reduction of model. This modeling tests the precision of the empirical modes obtained in modeling E on the reduced field created in modeling F.
One uses thus bases produced in modeling D and the reduced field created in modeling F. One also tests the operator of reconstruction REST_REDUIT_COMPLET by gappy-POD.

10.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

10.3 Sizes tested and results

One tests the value of displacements obtained with a model Hyper-tiny room compared to those obtained in the complete model (§2.2):

Place	Moment	Component	Displacement (DEPL)	Précision
Node With in $(1,0,3)$	$t=10s$	DX	$0{,}0696319525128\,mm$	0.0015
Node With in $(1,0,3)$	$t=10s$	DY	$0{,}199062276741\,mm$	0.0035
Node With in $(1,0,3)$	$t=10s$	DZ	$0{,}529606351907\,mm$ 0.0015	0.0025

And constraints:

Place	Moment	Component	Constraint (SIEF_NOEU)	Précision
Node With in $(1,0,3)$	$t=10s$	SIXX	$-2739{,}13961277\,MPa$	0,34 %
Node With in $(1,0,3)$	$t=10s$	SIYY	$-2737{,}51235419\,MPa$	0,36 %
Node With in $(1,0,3)$	$t=10s$	SIZZ	$-2612{,}22311229\,MPa$	0,37 %

10.4 Remarks

It is seen that the base produced in modeling E on the reduced field of modeling F allows to obtain very good performances compared to complete calculation. But they are inevitably slightly less less good than in the simply reduced case (modeling G).
On the other hand, just like in modeling G, the error remains important on the three last constraints, but it is not significant (low value of the constraints).

11 Modeling I

11.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics.
This modeling tests the creation of the empirical modes ***linear*** in thermics. One takes 3 maximum modes for the primal base and TOLE_SVD = 1.E-3 for the dual base.

11.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

11.3 Sizes tested and results

One tests some values of the primal base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not $(0,0,3)$ – TEMP – Mode 1	NON_REGRESSION
Not $(0,0,3)$ – TEMP – Mode 2	NON_REGRESSION
Not $(0,0,3)$ – TEMP – Mode 3	NON_REGRESSION

One tests some values of the dual base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not $(0,0,3)$ – FLUX_NOEU/FLUY – Mode 1	NON_REGRESSION
Not $(0,0,3)$ – FLUX_NOEU/FLUY – Mode 2	NON_REGRESSION
Not $(0,0,3)$ – FLUX_NOEU/FLUX – Mode 3	NON_REGRESSION

11.4 Remarks

One cannot say anything in the absolute on the precision of these values because ON tests values of not-regression.

12 Modeling J

12.1 Characteristics of modeling

A modeling is used 3D in mechanics non-linear with very-reduction of model. This modeling tests the precision of the empirical modes obtained in modeling E on the reduced field created in modeling F.
One uses thus bases produced in modeling D and the reduced field created in modeling F. This modeling tests the manner of rebuilding the fields on the complete field

12.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

12.3 Sizes tested and results

12.3.1 Values in the RID

One tests the value of displacements obtained with a model Hyper-tiny room compared to those obtained in the complete model (§2.2):

Place	Moment	Component	Displacement (**DEPL**)	Précision
Node With in $(1{,}0{,}3)$	$t=10s$	DX	$0{,}0696319525128\,mm$	0.0015
Node With in $(1{,}0{,}3)$	$t=10s$	DY	$0{,}199062276741\,mm$	0.0035
Node With in $(1{,}0{,}3)$	$t=10s$	DZ	$0{,}529606351907\,mm$ 0.0015	0.0025

And constraints:

Place	Moment	Component	Constraint (**SIEF_NOEU**)	Précision
Node D in $(3{,}1{,}0)$	$t=10s$	SIXX	$13300{,}4780377\,MPa$	0,20 %
Node D in $(3{,}1{,}0)$	$t=10s$	SIYY	$13300{,}3220671\,MPa$	0,20 %
Node D in $(3{,}1{,}0)$	$t=10s$	SIZZ	$13368{,}1442621\,MPa$	0,20 %

12.3.2 Values out of RID

The values out of RID cannot be obtained directly calculation very-tiny room with STAT_NON_LINE. It is necessary to rebuild the fields. One tests the reconstruction of the fields “to the hand” by recovering the reduced coordinates and by applying the formula (1) with CREA_CHAMP :

Place	Moment	Component	Displacement (**DEPL**)	Précision
Node B in $(3{,}3{,}3)$	$t=10s$	DX	$-0{,}208992921588\,mm$	0.0015
Node B in $(3{,}3{,}3)$	$t=10s$	DY	$-0{,}208992921588\,mm$	0.003
Node B in $(3{,}3{,}3)$	$t=10s$	DZ	$0{,}547254495773\,mm$	0.0025

Place	Moment	Component	Constraint (**SIEF_NOEU**)	Précision
Node C in $(0{,}0{,}0)$	$t=10s$	SIXX	$13300{,}4780377\,MPa$	0,7 %
Node C in $(0{,}0{,}0)$	$t=10s$	SIYY	$13300{,}3220671\,MPa$	0,7 %

Node C in $(0,0,0)$	$t=10s$	SIZZ	$13368,1442621\,MPa$	9.7 %

The reconstruction of the fields is tested by gappy-POD by using the operator REST_REDUIT_COMPLET :

Place	Moment	Component	Displacement (DEPL)	Précision
Node B in $(3,3,3)$	$t=10s$	DX	$-0,208992921588\,mm$	0.0015
Node B in $(3,3,3)$	$t=10s$	DY	$-0,208992921588\,mm$	0.003
Node B in $(3,3,3)$	$t=10s$	DZ	$0,547254495773\,mm$	0.002

Place	Moment	Component	Constraint (SIEF_NOEU)	Précision
Node C in $(0,0,0)$	$t=10s$	SIXX	$13300,4780377\,MPa$	0.002
Node C in $(0,0,0)$	$t=10s$	SIYY	$13300,3220671\,MPa$	0.002
Node C in $(0,0,0)$	$t=10s$	SIZZ	$13368,1442621\,MPa$	0.002

One also tests PREDICTION=' EXTRAPOLE' :

Place	Moment	Component	Displacement (DEPL)	Précision
Node With in $(1,0,3)$	$t=10s$	DX	$0,0696319525128\,mm$	0.0015
Node With in $(1,0,3)$	$t=10s$	DY	$0,199062276741\,mm$	0.0015
Node With in $(1,0,3)$	$t=10s$	DZ	$0,529606351907\,mm$	0.033

12.4 Remarks

Lreconstruction of the fields has, in particular apart from the RID give excellent results in terms of precision.

13 Modeling K

13.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics.
This modeling tests the creation of the empirical modes in thermics by incremental POD. One takes parameters so as to find the same modes as in modeling A.

13.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

13.3 Sizes tested and results

One tests some values of the primal base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not A – TEMP – Mode 1	NON_REGRESSION
Not A – TEMP – Mode 2	NON_REGRESSION
Not A – TEMP – Mode 3	NON_REGRESSION

One tests some values of the dual base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not A – FLUX_NOEU/FLUX – Mode 1	NON_REGRESSION
Not A – FLUX_NOEU/FLUY – Mode 1	NON_REGRESSION
Not A – FLUX_NOEU/FLUX – Mode 2	NON_REGRESSION
Not A – FLUX_NOEU/FLUY – Mode 2	NON_REGRESSION
Not A – FLUX_NOEU/FLUX – Mode 3	NON_REGRESSION
Not A – FLUX_NOEU/FLUY – Mode 3	NON_REGRESSION

One tests the values of the reduced coordinates (table COOR_REDUIT) a_m^T calculated during the extraction of the empirical modes. For the primal base (temperature) :

Identification	Moment	Mode	Type of reference
$a_{m=1,t=10s}^T$	$t=10s$	1	NON_REGRESSION
$a_{m=1,t=4s}^T$	$t=4s$	1	NON_REGRESSION
$a_{m=3,t=10s}^T$	$t=10s$	3	NON_REGRESSION
$a_{m=3,t=4s}^T$	$t=4s$	3	NON_REGRESSION

For the dual base (heat flux Φ):

Identification	Moment	Mode	Type of reference
$a^{\Phi}_{m=1,t=10s}$	$t=10s$	1	NON_REGRESSION
$a^{\Phi}_{m=1,t=4s}$	$t=4s$	1	NON_REGRESSION
$a^{\Phi}_{m=4,t=10s}$	$t=10s$	4	NON_REGRESSION
$a^{\Phi}_{m=4,t=4s}$	$t=4s$	4	NON_REGRESSION

13.4 Remarks

The calculated modes are strictly identical between POD and incremental POD.

14 Modeling L

14.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics.
This modeling tests the creation of the empirical modes in thermics by incremental POD in mode recovery. One takes parameters so as to find the same modes as in modeling A. I.e. that the following sequence is carried out:

- Calculation of a first empirical base on a non-linear calculation of thermics with the same assumptions as modeling K;
- Enrichment of this base by a calculation of incremental POD on ***even*** non-linear calculation of thermics.

This sequence makes it possible to find the same modes exactly as modelings K and L.

14.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

14.3 Sizes tested and results

One tests some values of the primal base (as they are empirical modes, the tests are made with the sign near):

Identification	Type of reference
Not A – TEMP – Mode 1	NON_REGRESSION
Not A – TEMP – Mode 2	NON_REGRESSION
Not A – TEMP – Mode 3	NON_REGRESSION

One tests the values of the reduced coordinates (table COOR_REDUIT) a_m^T calculated during the extraction of the empirical modes. For the primal base (temperature) :

Identification	Moment	Mode	Type of reference
$a_{m=1,t=10s}^T$	$t=10s$	1	NON_REGRESSION
$a_{m=1,t=4s}^T$	$t=4s$	1	NON_REGRESSION
$a_{m=3,t=10s}^T$	$t=10s$	3	NON_REGRESSION
$a_{m=3,t=4s}^T$	$t=4s$	3	NON_REGRESSION

14.4 Remarks

The calculated modes are strictly identical between POD (modeling A), Incremental POD (modeling K) and incremental POD in mode recovery (modeling L).

15 Modeling M

15.1 Characteristics of modeling

A modeling is used 3D in non-linear thermics.
This modeling tests various keywords in DEFI_DOMAINE_REDUIT. This test is purely data-processing.

15.2 Characteristics of the grid

The grid contains 27 elements of the type HEXA8.

15.3 Sizes tested and results

It is checked that the meshs and the groups are well created by the operator DEFI_DOMAINE_REDUIT.
Creation of a group of meshs named 'RID' for the RID (keyword NOM_DOMAINE) and of a group of nodes 'INF' (keyword NOM_INTERFACE) for the interface between the RID and the rest of the field.

Identification	Type of reference
Nombre of GROUP_MA	NON_REGRESSION
Number of GROUP_ NO	NON_REGRESSION
Many nodes in the group INF	NON_REGRESSION
Many meshs in the group RID	NON_REGRESSION

15.3.1 Test of **NB_COUCHE_SUPPL**

While taking NB_COUCHE_SUPPL=4, the RID becomes the whole field.

15.3.2 Test of **CORR_COMPLET**

Tests of data-processing not-regression.

15.3.3 Test of **DOMAINE_INCLUS**

Tests of data-processing not-regression.