DIRECTION DE L'ÉNERGIE NUCLÉAIRE
DIRECTION DÉLÉGUÉE AUX ACTIVITÉS NUCLÉAIRES DE SACLAY
DÉPARTEMENT DE MODÉLISATION DES SYSTÈMES ET STRUCTURES
SERVICE DE THERMO-HYDRAULIQUE ET DE MÉCANIQUE DES FLUIDES

LABORATOIRE DE MODELISATION ET SIMULATION A L'ECHELLE SYSTEME

CATHARE

CATHARE 2 V2.5_3mod2.1 : DICTIONARY OF POST-PROCESSING

CSSI

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	Document technique DEN	Page 1/108

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Rapport technique DEN

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MOTS CLEFS

CATHARE V2.5_3, DICTIONARY, POST-PROCESSING

RESUME / CONCLUSIONS

Ce document décrit les commandes et variables disponibles dans le code CATHARE V2.5_3 permettant le traitement à postériori des calculs CATHARE du fichier résultats des calculs vers un fichier texte de grandeurs extraites de ce fichier résultats.
Plus précisément, on trouvera dans ce rapport :

- La définition, la syntaxe et le champ d'application de chaque commande et opérateur,
- La liste des grandeurs accessibles pour chaque réacteur, circuit, module et sous module,
- Des informations simples sur le format du fichier résultats
- Des exemples de jeu de données graphique et de fichier texte de grandeurs extraites.

ABSTRACT :
This document presents the commands and variables available in the CATHARE 2 V2.5_3 code to post process the CATHARE calculations from the result file to the selected variable text file.
More precisely, the document describes :

- The definition, syntax and field of application of each operator
- The list of available variables for each reactor, circuit, module and sub-module,
- Informations about the format of the result file
- Selected input deck used to extract selected variables and txt file.

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CONTENTS

Contents

DICTIONARY INDEX

LIST OF FIGURES

1 ORGANISATION OF PROCESSING

This chapter describes the overall processing of results.

A basic EVOLUTION is an object in respect with the **CATHARE** definition. Each evolution contains a variable dependent on time or on the x-axis.
The number maximum of evolutions is 500. The maximum of points per evolution is 5000 (See example in A.2).
The graphical input data deck can be processed in two stages (See example in appendix A).

1. Creation of evolutions : each containing a variable dependent on time or on the x-axis,
2. Operations on these evolutions.

For stage (1), the use of the post-processing part of **CATHARE** is necessary since it is the only software that knows the structure of the result file. On the contrary for stage (2), any graphic software can be used instead of **CATHARE**, thanks to the simplicity of the evolutions.

1.1 Saving results

The storage in the result file is initialized when the computation is performed using RESULT [1] directive.
The RESULT [1] directive must be placed in the command block (for more details refer to the dictionary of operators and directives).

1.2 Creation of evolutions

To read the result file created by the **CATHARE** computation, the READ directive is used. This directive will indicate the file to be used. Using the read information, the user creates EVOLUTION objects that will contain the evolution of one of the variables stored or recalculated as a function of time (CHRONO) or the space coordinate (PHOTO).

The CEXPER and PEXPER operators are used to create and fill evolutions from experimental results.

It is also possible to combine evolutions (AND, CONCAT, VERSUS), compute the integral of the variable represented (INTEVOL), shift the x-axis of an evolution (SHIFT), carry out simple operations on evolutions (ADD, SUB, MULT, DIV), or between an evolution and a constant.

The result files of a transient calculation performed in several successive runs can be compressed into a single file by the COMPRESS directive.

1.3 Files used by processing of results

The processing of results uses the following files, each of which has a FORTRAN default number. This number can be changed.

- RESULT : FORT21 result storage file. The default logical unit is 21 (unformatted storage).
- EXPERIM : FORT11 file containing results of experiments to be used by the CEXPER or PEXPER directives. The default logical unit is 11.

The processing of results creates a file (FORT07) in which evolutions are stored. The default logical unit is 7 and can not be changed.

All the results are given in the International System SI [2, 3].

2 CATHARE 2 COMMANDS

The commands recognized by **CATHARE** 2 postprocessor are the followings :

- The CEXPER and PEXPER operators, which create and fill evolutions from experimental results.
- The CHRONO and PHOTO operators, which create and fill evolutions which are used to receive computation results.
- The CONCAT operator, which creates an evolution that is the concatenation (by the X-axis coordinates) of two other evolutions. The result of the operation is a single evolution.
- The AND operator, which creates an evolution from two other evolutions. The result of the operation is composed by the set of all the evolutions belonging already to the first two.
- The VERSUS operator, which creates an evolution combining the y-axis values of two other evolutions and thus shows one variable as a function of another.
- The ADD and SUB operators, which create an evolution for which the y-axis values are either the sum of or the difference between the y-axis values of the corresponding points of the initial evolutions, or the sum of or the difference between the initial evolution and a constant.
- The SHIFT operator, which creates an evolution whose x-axis values are shifted by a constant in relation to the initial evolution.
- The INTEVOL operator, which creates an evolution whose y-axis value is the integral of the function represented by the initial evolution.
- The MULT operator, which creates an evolution whose y-axis values are the product of those of the corresponding points of the initial evolutions, or of the initial evolution and a constant.
- The DIV operator, which creates an evolution whose y-axis values are either the quotient of those of the corresponding points of the initial evolutions, or the quotient of the initial evolution and a constant.
- The COMPRESS directive, which compresses several result files (chronologically ordered) into a single file.
- The XMGROP directive, which creates xmgr files from the evolutions (one file per evolution).

2.1 ADD operator

2.1.1 Purpose

Creates an evolution whose y-axis values are the sum either of two other evolutions, or of one evolution and a constant.

2.1.2 Syntax

evol3 = evol1 ADD evol2;
or
evol3 = evol1 ADD coef;

The evolution "evol3" contains the labels and x-axis values of "evol1", and y-axis values which are the sum of those of the corresponding points of "evol1" and "evol2", or of "evol1" and "coef".

The evolutions "evol1" and "evol2" must be simple, in other words they must not be the result of an AND.

coef is a real or integer constant. It should imperatively be placed as second operand.

2.1.3 Field of application

X-axis (PHOTO) or Time-axis (CHRONO) points must be identical for both "evol1" and "evol2".

Warning : Not more than two evolutions can be added in the same command line.

2.2 AND operator

2.2.1 Purpose

Creates an evolution by joining together two others.

2.2.2 Syntax

evol3 = evol1 AND evol2 ;

The "evol3" evolution combines the evolutions "evol1" and "evol2" in the FORT07 file. The curves contained in "evol1" and "evol2" will be plotted together in one graph.

X-axis on "evol1" and "evol2" must be the same.

2.3 CEXPER operator

2.3.1 Purpose

Creates and fills a time-dependent evolution from a file containing experimental results in **CATHARE** or BETHSY format.

2.3.2 Syntax

evol1 = CEXPER ident MULT mult ADD add TSUB tsub TMIN tmin TMAX tmax ;

The terms in capital letters are keywords.

"evol1"	is the name of the evolution created	
Ident	is the identifier of the variable. It contains a maximum of 8 characters.	
MULT	optional keyword followed by the real number :	
	mult	coefficient which must be used to multiply the results of the measurement. Its default value is 1.
ADD	optional keyword followed by the real number :	
	add	coefficient which will then be added to the results. Its default value is 0.
TSUB	optional keyword followed by the real number :	
	tsub	value to be subtracted from experimental time to obtain zero time of the **CATHARE** computation.Its default value is 0.
TMIN	optional keyword followed by :	
	tmin	minimum time to be included in the post-treatment.
TMAX	optional keyword followed by :	
	tmax	maximum time to be included in the post-treatment.

TMIN and TMAX are **CATHARE** times, that is after correction by TSUB.

If TMIN and TMAX are missing, the evolution will cover the total time interval of the measurements. If TMIN is present and TMAX is missing, the evolution will go from the TMIN time to the last time measured.

2.3.3 Examples

A = CEXPER TEMP3 MULT 3. ADD 5. TSUB 1. TMIN 50. TMAX 100.;

B = CEXPER TEMP3 MULT 3. TMAX 100. ;

2.4 CHRONO operator

2.4.1 Purpose

Creates and fills a time-dependent evolution from the results contained in a **CATHARE** 2 computation result file.

2.4.2 Syntax

evol1 = CHRONO object var index1 index2 tmin tmax ;
or
evol1 = CHRONO object var ELEV elev tmin tmax ;

object	is the name of the object being observed (ELEMENT, JUNCTION, WALL or CIRCUIT ...). It is not indicated if the variable requested is the time step or a USER variable.
var	is the name of the variable to be extracted. The list of variables can be found in the chapter entitled ACCESSIBLE VARIABLES.
index1	is the first index indicating a node number, or an axial location (optional).
index2	is the second index indicating a radial node number (optional).
tmin	is the minimum time to be included in the treatment (optional). The default setting is the time at the beginning of the file.
tmax	is the maximum time to be included in the treatment (optional). The default setting is the time at the end of the file.
elev	is a real number following keyword ELEV and indicating the coordinate along x-axis. The variable is extracted at the nearest scalar or vector point.

2.4.3 Examples

A = CHRONO CANAL LIQTEMP ELEV 0.4563 0. 25. ;
A will contain the time-dependent liquid temperature at point 0.4563 meter of the CANAL element, between time zero and time 25 seconds.

B = CHRONO CANAL LIQTEMP 4 0. 25. ;
B will contain the time-dependent liquid temperature at the scalar mesh number 4 of the CANAL element, between time zero and time 25 seconds.

2.5 COMPRESS directive

2.5.1 Purpose

Compress several computation result files (successive transient phases on a given plant geometry) into a single file.

2.5.2 Syntax

COMPRESS ifilex ifiley .... IN ifilez ;

ifilex ifiley .... are the logical numbers of the results files of a chronologically ordered.
Possible numbers are 21, 31 or between 62 and 80.
IN ifilez Optional keyword.
If it exists, it is followed by an integer indicating the logical number of the compressed file.
The default number is 61.

NB : The reference file is the first file (ifilex) called by the directive ; only results for times greater than last time in the reference file (txn) are added to create the resulting file (ifilez) (see below : results associated with tyi-1 will not be saved in ifilez, only those after tyi).

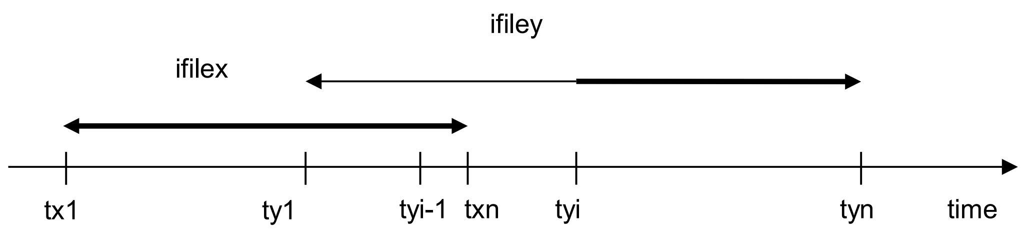

Figure 2.5.1: Time scheme of the COMPRESS directive

2.5.3 Examples

COMPRESS 62 63 64 ;

The files with the logical numbers 62 63 64 will be compressed in the file with the Fortran logical number 61.

COMPRESS 62 63 64 IN 80 ;

The files with the logical numbers 62 63 64 will be compressed in the file with the Fortran logical number 80.

2.6 CONCAT operator

2.6.1 Purpose

Creates an evolution which is the concatenation of two others.

2.6.2 Syntax

evol3 = evol1 CONCAT evol2 ;

The evolution "evol3" contains the evolution "evol1" then the points of "evol2" for which x-axis values are greater than that of the last point of "evol1".

The evolutions "evol1" and "evol2" must be simple, in other words they must not be the result of an AND.

2.7 DIV operator

2.7.1 Purpose

2.7.2 Syntax

evol3 = evol1 DIV evol2 ;
or
evol3 = evol1 DIV coef ;

The "evol3" evolution contains the labels and the x-axis values of "evol1", and y-axis values that are the quotient of the corresponding points of "evol1" and "evol2", or of "evol1" and "coef".

The evolutions "evol1" and "evol2" must be simple, in other words they must not be the result of an AND.

coef is an integer or real constant. It should imperatively be placed as second operand.

2.7.3 Field of application

X-axis (PHOTO) or Time–axis (CHRONO) points must be identical for both "evol1" and "evol2".

2.8 GNUPLOT directive

Creates file(s) in the gnuplot format from the evolution(s) variable. The name of each gnuplot file is automatically defined by the evolution variable name completed with the suffix ".evol".

For example : Evolution variable name: "XXXX" and gnuplot file name:"XXXX.evol"

2.8.1 Syntax

GNUPLOT ALL ;
or
GNUPLOT evol1 evol2 evol3 . . . ;

ALL : Keyword to be used to create one gnuplot file from each evolution variable.
The evolutions "evol*" must be simple (CHRONO, PHOTO).

NB : Only one GNUPLOT directive may be used in graphic input data deck

2.8.2 Examples

GNUPLOT ALL ;

One gnuplot file will be created for each existing evolution.

GNUPLOT evol1 evol2 ;

Two gnuplot files will be created from the two variables ("evol1.evol" and "evol2.evol").

2.9 HIDE / SHOW option

2.9.1 Purpose

These options, specific to the postprocessing step, allow to display or hide evolutions of temporary variables defined in graphic file. These evolutions appear or not in the FORT07 file. Furthermore, it's possible to specify a group of variables with only short prefix followed by the "wild" character "?", provided that all those given variables name begin with the same prefix.

WARNING : only one OPTION HIDE/ SHOW is recognized. If two such options are specified in the graphic file, only the last one is taken into account.

2.9.2 Syntax

OPTION HIDE EVOL1 EVOL2 EVOL3 .... ; **or** **SHOW EVOL? ;**

2.9.3 Example

If evolutions have been defined like :

ML = CHRONO CANAL LIQMASS ;
MV = CHRONO CANAL STEAMASS ;
DUM0 = CHRONO CANAL PRESSURE ELEV 0. ;
DUM8 = CHRONO CANAL LIQH ELEV 4.579;
DUM50 = ML ADD MV ;
MASS = DUM50 DIV 1000.0 ;

OPTION SHOW ML MV DUM?

Then "DUM?" is sufficient to consider all variables with name beginning with "DUM", and corresponding evolutions will be shown in FORT07 file.

OPTION HIDE DUM?

ML, MV, MASS will be output to FORT07, DUM0, DUM8, DUM50 are generated internally but are not output to FORT07.

2.10 INTEVOL operator

2.10.1 Purpose

Creates an evolution for which the y-axis is the integral of the initial evolution from the origin to the current x-axis value.

2.10.2 Syntax

evol2 = INTEVOL evol1 IMPLICIT ;

The "evol2" evolution contains the integrated value of "evol1" in the same range of time.
The keyword IMPLICIT is optional. When it is present, instead of integrating by the trapezium method, the following formula is used : $SUM(I) = SUM(I-1) + Y(I) * (X(I) - X(I-1))$.

The "evol1" evolution must be simple, in other words not the result of an AND.

2.11 MULT operator

2.11.1 Purpose

Creates an evolution whose y-axis values are the product, either of those of two other evolutions, or of an evolution and a constant.

2.11.2 Syntax

evol3 = evol1 MULT evol2;
or
evol3 = evol1 MULT coef ;

The "evol3" evolution contains the labels and the x-axis values of "evol1", and the y-axis values which are the product of the corresponding points of "evol1" and "evol2", or of "evol1" and "coef". The evolutions "evol1" and "evol2" must be

simple, in other words not the result of an AND.

coef is a real or integer constant. It should imperatively be placed as second operand.

2.11.3 Field of application

X-axis (PHOTO) or Time–axis (CHRONO) points must be identical for both "evol1" and "evol2".

2.12 PEXPER operator

2.12.1 Purpose

Creates and fills an evolution as a function of the curvilinear x-axis from results contained in the experimental result file in **CATHARE** or BETHSY format.

2.12.2 Syntax

evol = PEXPER ident MULT mult ADD add ;

The terms in capital letters are the keywords.

"evol"	is the name of the evolution created	
ident	is the identifier of the variable. It contains a maximum of 16 characters.	
MULT	optional keyword followed by the real number :	
	mult	coefficient by which the results of the measurement will have to be multiplied. Its default value is 1.
ADD	optional keyword followed by the real number :	
	add	add coefficient which will then be added to the results. Its default value is 0.
TSUB	optional keyword followed by the real number :	
	tsub	value to be subtracted from experimental time to obtain zero time of the **CATHARE** computation.Its default value is 0.
TMIN	optional keyword followed by :	
	tmin	minimum time to be included in the post-treatment.
TMAX	optional keyword followed by :	
	tmax	maximum time to be included in the post-treatment.

2.12.3 Examples

A = PEXPER ALZ MULT 3. ADD 5.;

B = PEXPER ALZ;

2.13 PHOTO operator

2.13.1 Purpose

Creates and fills an evolution as a function of the curvilinear space coordinate from a result file created by **CATHARE** 2.

2.13.2 Syntax

- For an **1-D** element :

  evol = PHOTO object var index2 time ;

- For a **3-D** element :

  evol = PHOTO object var orient index1 index2 time ;

"object" is the name of the element which must be of the **1-D** sub-type, of a wall corresponding to an **1-D** element, or of a **3-D** element.
"var" is the name of the variable to be extracted. The list of these variables is given in the chapter 3 entitled ACCESSIBLE VARIABLES.
"orient" is equal to X, Y or Z corresponding to the direction of the photo, to be used only in the case of a **3-D** element.
"index1" is the first index indicating a node number, to be used only in the case of a **3-D** element.
"index2" is the second index indicating a radial node number, to be used only in the case of [WALLTEMP] variable.
"time" is the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

2.13.3 Example

A = PHOTO BYPASS LIQV 2.5 ;

"A" will contain the velocity of the liquid as a function of the x-axis for the BYPASS **1-D** element at the first time available since 2.5 seconds.

B = PHOTO PAROI WALLWET Z 12 10. ;

"B" will contain the wet wall temperature as a function of z-axis and starting from the mesh number "12" for the PAROI **3-D** element at the first time available since 10 seconds.

C = PHOTO PAROI WALLTEMP Z 12 3 10. ;

"C" will contain the internal wall temperature as a function of z-axis and starting from the mesh number "12" at the third wall radial temperature node ("3") for the PAROI **3-D** element at the first time available since 10 seconds.

2.14 READ directive

2.14.1 Purpose

Initializes the read operation of the **CATHARE** 2 result file.

2.14.2 Syntax

READ RESULT n1 EXPERIM n2 ;

RESULT	: Keyword to be used for the post-treatment of a calculation.
EXPERIM	: Keyword to be used for the post-treatment of an experimental data set.
"n1"	: Optional Fortran number for result storage file. The default value is 31 (unformatted storage).
"n2"	: Optional Fortran number for experimental data file. The default value is 11.

Other admissible values for "n1" and "n2" are 21 or in the range [60-80].

2.14.3 Examples

READ RESULT 60 ;

Result file will be read on Fortran logical unit 60.

READ EXPERIM ;

Experimental data file will be read on the default logical unit 11.

READ RESULT 60 EXPERIM 61 ;

In this example, the logical units of both result file and experimental data file are set to 60 and 61.

2.15 SHIFT operator

2.15.1 Purpose

Creates an evolution whose x-axis values are equal to those of the initial evolution shifted by a constant, with all other data (y-axis values, titles) remaining unchanged.

2.15.2 Syntax

evol2 = evol1 SHIFT coef ;

The evolution "evol2" contains the labels and the y-axis values of "evol1", and x-axis values that are the sum of those of the corresponding points of "evol1" and "coef".

The evolution "evol1" must be simple, in other words it must not be the result of an AND.

coef is a real constant that can be negative.

2.16 SUB operator

2.16.1 Purpose

Creates an evolution whose y-axis values are the difference, either between two other evolutions, or between an evolution and a constant.

2.16.2 Syntax

evol3 = evol1 SUB evol2;
or
evol3 = evol1 SUB coef ;

The "evol3" evolution contains the labels and x-axis values of "evol1", and y-axis values that are the difference between those of the corresponding points of "evol1" and "evol2", or of "evol1" and "coef".

The "evol1" and "evol2" evolutions must be simple, in other words not the result of an AND.

coef is a real or integer constant. It should imperatively be placed as second operand.

2.16.3 Field of application

X-axis (PHOTO) or Time–axis (CHRONO) points must be identical for both "evol1" and "evol2".

2.17 VERSUS operator

Creates an evolution composed of the y-axis values of two others.

2.17.1 Syntax

evol3 = evol1 VERSUS evol2 ;

The "evol3" evolution contains the y-axis values of "evol2" on the x-axis and the y-axis values of "evol1" on the y-axis. It is thus possible to represent the variation of one variable as a function of another.

The "evol1" and "evol2" evolutions must be simple, in other words not the result of an AND, and they must have the same x-axis values.

2.18 XMGROP directive

2.18.1 Purpose

Creates file(s) in the xmgr format from the evolution(s) variable. The names of each xmgr file is automatically defined by the evolution variable name completed with the suffix ".evol".
For example : Evolution variable name:"XXXX" and xmgr file name: "XXXX.evol"

2.18.2 Syntax

XMGROP ALL ;
or
XMGROP evol1 evol2 evol3 . . . ;

ALL : Keyword to be used to create one xmgr file from each evolution variable.

The evolutions "evol*" can be simple (CHRONO, PHOTO), or the result of the AND operator.

NB : Only one XMGROP directive may be used in graphic input data deck

2.18.3 Examples

XMGROP ALL ;

One xmgr file will be created for each existing evolution.

XMGROP evol1 evol2 ;

Two xmgr files will be created from the two variables ("evol1.evol" and "evol2.evol").

3 ACCESSIBLE VARIABLES

This chapter presents the variables that can be used for each type of element.

In addition, the appendix B presents the structure of the result file as well as the geometric data which are stored for each object.

The code writes the variables listed below in the result file. This file is built in such a way that supplementary variables can be added without creating any incompatibility with the results previously written.

3.1 Reactor and user variables

The following reactor variables are available :

DTGEN	Time step
CPUTRA	Cumulated CPU Time of transient
HATGREL	Relative gravity
GRAVEXT	Absolute gravity (m/s^2)
TGEN	Time
NGOTRA	Number of time step for the reactor
NBPROCS	Number of threads

Call :

```
ev =    CHRONO reac          VARIABLE tmin tmax ;
```

ev : Name of the evolution
reac : Name of the reactor
VARIABLE : Name of the variable
tmin tmax : (optional) Real numbers defining the time interval of interest for the post-treatment.

The XUSER and KUSER tables of the common USER are filled by the user during the calculation.	
XUSER	XUSER variables
KUSER	KUSER variables

Call :

```
ev =    CHRONO               VARIABLE integ1  tmin  tmax ;
```

ev : Name of the evolution
VARIABLE : Name of the variable (= XUSER or KUSER)
integ1 : Number of the Xuser or Kuser variable
tmin tmax : (optional) Real numbers defining the time interval of interest for the post-treatment.

3.2 Circuit variables

The following variables are available :

TIMESTEP	Time step
ITECIR	Number of iterations of the time steps
NPACIR	Number of cumulated time step
NSTOCK	Number of division of the time step
ICUCIR	Total cumulated number of iterations
ITERUTIL	Effective cumulated number of iterations
BLOCKELM	Number of the hydraulic element
TOTMASS	Total current mass of the circuit
LIQMASS	Current liquid mass of the zone
SOUMASS	Cumulated mass injected/extracted in AXIAL, VOLUME or THREED elements by their gadgets (convention : positive if extracted)
JONMASS	Cumulated mass injected/extracted in boundary conditions and ruptures of the circuit (convention : positive if extracted)
MASERROR	Mass error : TOTMASS – initial TOTMASS + JONMASS + SOUMASS
XiMASS	$(1 \leq i \leq 4)$ Total mass of noncondensable gas #i
XiMASERR	$(1 \leq i \leq 4)$ Mass error of noncondensable gas #i
XiSOUMAS	$(1 \leq i \leq 4)$ cumulated mass of noncondensable gas #i injected/extracted in AXIAL, VOLUME or THREED elements by their gadgets
XiJONMAS	$(1 \leq i \leq 4)$ Cumulated mass of noncondensable gas #i injected/extracted in boundary conditions and ruptures
TOTNRJ	Total current energy of the circuit
SOUNRJ	Cumulated energy injected/extracted in all AXIAL, VOLUME or THREED elements of the circuit by their gadgets (convention : positive if extracted)
JONNRJ	Cumulated energy injected/extracted in boundary conditions and ruptures (convention : positive if extracted)

Call :

```
ev =    CHRONO circ          VARIABLE tmin tmax ;
```

ev	: Name of the evolution
circ	: Name of the circuit
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.3 1-D module

The following variables are available :

3.3.1 1-D vector point

LIQV	Velocity of liquid
GASV	Velocity of gas mixture
LIQFLOW	Mass flow rate of liquid
GASFLOW	Mass flow rate of gas mixture
ITOVI	Zone index for interfacial friction
LIQCFR	Wall-liquid friction coefficient
GASCFR	Wall gas friction coefficient
LIQREYN	Reynolds number of liquid used in friction coefficientcalculation
GASREYN	Reynolds number of gas mixture used in friction coefficientcalculation

3.3.2 1-D scalar point

PRESSURE	Pressure
LIQH	Enthalpy of liquid
GASH	Enthalpy of gas mixture (steam + noncondensable gases)
ALFA	Void fraction
XiFRACT	$(1 \leq i \leq 4)$ Mass fraction of noncondensable gas #i
LIQTEMP	Temperature of liquid
GASTEMP	Temperature of gas mixture
SATTEMP	Saturation temperature of water at gas total pressure
TSATPV	Saturation temperature of water at partial steam pressure
SATLIQH	Saturation enthalpy of liquid
SATGASH	Saturation enthalpy of gas mixture
LIQDENS	Density of liquid
GASDENS	Density of gas mixture
AVGDENS	Density of two phase mixture
GS	Absolute gravity (m/s^2)
IQL	(q_{le}) index (liquid-interface heat transfer)
IQG	(q_{ge}) index (steam-interface heat transfer)
EQL	Rate of entrainment used in (q_{le}) calculation
QVEBCCOR	Multiplicative term of (q_{ge}) in bubble to churn flow in case of vaporisation
HCOEFPO	Multiplying heat exchange flux coefficient (COMETE application)
LIQCP	Calorific capacity for liquid (p/s/K)
GASCP	Calorific capacity for gas (p/s/K)
XiCP	$(1 \leq i \leq 4)$ Calorific capacity for noncondensable gas #i (p/s/K)
LIQCOND	Liquid conductivity (W/m/K)
GASCOND	Gas conductivity (W/m/K)
	continued on next page

XiCOND	($1 \leq i \leq 4$) conductivity of noncondensable gas #i (W/m/K)
MULIQ	Dynamic viscosity for liquid (kg/m/s)
MUVAP	Dynamic viscosity for vapour (kg/m/s)
MUGAS	Dynamic viscosity for gas (kg/m/s)
SIGMA	Surface tension (N/m)
DDROPLET	Droplet diameter (m)
BULKH	Average enthalpy for the two phases (aviable only with the fluid IAPWSWAT)
BULKDENS	Average density for the two phases (aviable only with the fluid IAPWSWAT)
BULKTEMP	Average temperature for the two phases (aviable only with the fluid IAPWSWAT)
LIQFRAi	($1 \leq i \leq 12$) Concentration of radio-chemical element #i in the liquid phase
GASFRAi	($1 \leq i \leq 12$) Concentration of radio-chemical element #i in the gas phase
XSOLIDi	($1 \leq i \leq 12$) Crystallized mass of radio-chemical element #i
XLMAXi	($1 \leq i \leq 12$) Maximum concentration of radio-chemical element #i
EVAPORi	($1 \leq i \leq 12$) Evaporation constant
CONDENi	($1 \leq i \leq 12$) Condensation constant
DEGASAi	($1 \leq i \leq 12$) Degassing constant
DISSOLi	($1 \leq i \leq 12$) Dissolution constant

Call :

ev =	CHRONO element		VARIABLE ELEV real	tmin tmax ;
		or	VARIABLE integ	tmin tmax ;
ev =	PHOTO element		VARIABLE	time ;

ev	: Name of the evolution
element	: Name of the axial element
VARIABLE	: Name of the variable
real	: Real (preceded by keyword ELEV) corresponding to a vector or scalar coordinate of the element. The variable is extracted at the nearest scalar or vector point.
integ	: Integer corresponding to a vector or scalar point of the meshing of the element.
Tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.
Time	: Real number corresponding to the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

3.3.3 1-D global variables

LIQMASS	Mass of liquid
STEAMASS	Mass of steam
XiMASS	($1 \leq i \leq 4$) Mass of noncondensable gas #i
XiMASERR	($1 \leq i \leq 4$) Mass error of noncondensable gas #i
MASERROR	Mass error (cumulated value)
LIQVOL	Total volume of liquid in the element
GASVOL	Total volume of gas in the element
FLUIDNRJ	Energy contained in the fluid

continued on next page

NRJERROR	Energy error of the fluid in the AXIAL element
WALLPOWR	Power generated by the walls of the AXIAL (instantaneous value)
TOTPOWER	Total power exchanged on wet side (including nuclear power Qneut without the fraction of kinetics power dissipated in the fluid) (ie < 0 if the fluid heats the walls) (instantaneous value)
PXNEUT	Fraction of kinetics power dissipated in the fluid (instantaneous value)
DRYPOWER	Power exchanged on dry side (instantaneous value)
CWALLNRJ	Energy contained in the walls of the AXIAL (cumulated value)
CWALLGEN	Energy generated by the walls of the AXIAL (cumulated value)
CTOTPOWR	Energy exchanged by the walls on the wet side, given to the fluid (cumulated value)
CTOTLOSS	Energy lost by the walls, exchanged on dry side (cumulated value)
CWENERR	Wall energy error : CWALLNRJ + CTOTLOSS + CTOTPOWR – CWALLGEN
COLAPLVL	Water collapsed level
GREL	Relative gravity
MASACTi	($1 \leq i \leq 12$) Total activity or total mass of radio-chemical element #i
MASDEPi	($1 \leq i \leq 12$) Total crystallized mass of radio-chemical element #i
REACTMOD	Moderator density on reactivity ($) : Case of a BYPASS axial sub type element
REACTBOR	Boron concentration effect on reactivity ($) : Case of a BYPASS axial sub type element
ROMOY	Average density of the coolant (Kg/m^3) : Case of a BYPASS axial sub type element

The following variables are used when a valve has been defined on the axial element using VALVE directive :

TIMVA	Time activation of the valve (see TVA in VALVE directive)
IVECT	Position of the valve (see VALVE directive)
IACTPOS	1 if the valve is using a law, else 0 (see VALVE directive in case of same direction as the meshing)
IACTNEG	1 if the valve is using a law, else 0 (see VALVE directive in case of opposite direction to the meshing)

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the axial element
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.4 0-D module

For this element, the following variables are available:

3.4.1 0-D scalar nodes of upper and lower sub-volume

PRESSURE	Pressure
LIQH	Enthalpy of liquid
GASH	Enthalpy of gas mixture
ALFA	Void fraction
XiFRACT	$(1 \leq i \leq 4)$ Mass fraction of non condensable gas #i
TOTMASS	Mass contained in the sub-volume
LIQTEMP	Temperature of liquid
GASTEMP	Temperature of gas mixture
SATTEMP	Saturation temperature of water at gas total pressure
TSATPV	Saturation temperature of water at partial steam pressure
LIQDENS	Density of liquid
GASDENS	Density of gas mixture
AVGDENS	Density of two phase mixture
PV	Partial steam pressure
IQL	(q_{le}) index (liquid-interface heat transfer)
IQG	(q_{ge}) index (steam-interface heat transfer)
VOLUME	Volume of the fluid
LIQIFLUX	Flux exchange from the interface to the liquid
GASIFLUX	Flux exchange from the interface to the gaz
LIQFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase
GASFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase
XSOLIDi	$(1 \leq i \leq 12)$ Plated out mass of radio-chemical element #i
XLMAXi	$(1 \leq i \leq 12)$ Maximum concentration of radio-chemical element #i in the liquid phase
DEGASAi	$(1 \leq i \leq 12)$ Degassing constant
DISSOLi	$(1 \leq i \leq 12)$ Dissolution constant
CONDENi	$(1 \leq i \leq 12)$ Condensation constant
EVAPORi	$(1 \leq i \leq 12)$ Evaporation constant
BULKH	Average enthalpy for the two phases
BULKTEMP	Average temperature for the two phases
BULKDENS	Average density for the two phases

Call :

ev = CHRONO element VARIABLE INF tmin tmax ;
or VARIABLE SUP

ev	: Name of the evolution
element	: Name of the volume element
VARIABLE	: Name of the variable
INF	: Keyword for the lower sub volume
SUP	: Keyword for the upper sub volume
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.4.2 0-D port vector points

LIQV	Velocity of liquid
GASV	Velocity of gas mixture
LIQFLOW	Mass flow rate of liquid
GASFLOW	Mass flow rate of gas mixture
BTA	Port distribution coefficient for void fraction
BTL	Port distribution coefficient for the liquid
BTG	Port distribution coefficient for the gas
GPAT	Absolute gravity (m/s^2)

3.4.3 0-D port scalar points

PRESPATI	Pressure at the internal scalar point of the volume port
LIQHPATI	Enthalpy of the liquid at the internal scalar point of the volume port
GASHPATI	Enthalpy of gas mixture at the internal scalar of the volume port
ALFAPATI	Void fraction at the internal scalar of the volume port
XiFRPATI	$(1 \leq i \leq 4)$ Mass fraction of noncondensable gas #i

Call :

ev = CHRONO element VARIABLE integ tmin tmax ;

ev	: Name of the evolution
element	: Name of the volume element
VARIABLE	: Name of the variable
integ	: Integer corresponding to the selected port number (in order of their definition in VOLUME operator)
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.4.4 0-D FLOMIXER ZOOM type port

MASERRM	Instantaneous mass error of the flow mixe port
MASERRMC	Cumulated mass error of the flow mixe port
ENERRM	Instantaneous energy error of the flow mixe port
ENERRMC	Cumulated energy error of the flow mixe port

continued on next page

XERRMi	($1 \leq i \leq 4$) Instantaneous noncondensable gas mass error #i
XERRMCi	($1 \leq i \leq 4$) Cumulated noncondensable gas mass error #i
B1ERMi	($1 \leq i \leq 12$) Instantaneous Concentration of radio-chemical element error #i in the liquid phase
B1ERMCi	($1 \leq i \leq 12$) Cumulated Concentration of radio-chemical element error #i in the liquid phase
B2ERMi	($1 \leq i \leq 12$) Instantaneous Concentration of radio-chemical element error #i in the gas phase
B2ERMCi	($1 \leq i \leq 12$) Cumulated Concentration of radio-chemical element error #i in the gas phase

Call :

ev = CHRONO element VARIABLE integ tmin tmax ;

ev	: Name of the evolution
element	: Name of the volume element
VARIABLE	: Name of the variable
integ	: Integer corresponding to the selected flomixer port number (in order of their definition in FLOMIXER ZOOM operator)
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.4.5 0-D global variables

LEVEL	Separation level between upper and lower sub-volumes
LIQMASS	Mass of liquid
STEAMASS	Mass of steam
GASMASS	Mass of gas
XiMASS	($1 \leq i \leq 4$) Mass of noncondensable gas #i
XiMASERR	($1 \leq i \leq 4$) Mass error of noncondensable gas #i
MASERROR	Mass error (cumulated value)
GML	Liquid mass transfer between sub-volumes
GMG	Gas mass transfer between sub-volumes
GTT	Mass transfer (thermal effect)
LIQVOL	Total volume of liquid in the element
GASVOL	Total volume of gas in the element
FLUIDNRJ	Energy contained in the fluid
LIQNRJ	Energy contained in the liquid
GASNRJ	Energy contained in the gas
NRJERROR	Energy error of the fluid in the VOLUME element
WALLPOWR	Power generated by the walls of the VOLUME (instantaneous value)
TOTPOWER	Total power exchanged on wet side (including nuclear power Qneut without the fraction of kinetics power dissipated in the fluid) (ie < 0 if the fluid heats the walls) (instantaneous value)
DRYPOWER	Power exchanged on dry side (instantaneous value)
CWALLNRJ	Energy contained in the walls of the VOLUME(cumulated value)

continued on next page

CWALLGEN	Energy generated by the walls of the VOLUME (cumulated value)
CTOTPOWR	Energy exchanged by the walls on the wet side, given to the fluid (cumulated value)
CTOTLOSS	Energy loss by the walls, exchanged on dry side (cumulated value)
CWENERR	Wall energy error : CWALLNRJ + CTOTLOSS + CTOTPOWR – CWALLGEN
MASACTi	$(1 \leq i \leq 12)$ Total activity or total mass of radio-chemical element #i
MASDEPi	$(1 \leq i \leq 12)$ Total crystallized mass of radio-chemical element #i
XBAERRi	$(1 \leq i \leq 12)$ Activity error of radio-chemical element #i
GREL	Relative gravity
LIQWPWER	Total wall power given to the liquid
GASWPWER	Total wall power given to the gas
INTWPWER	Total wall power given to the interface

For the VFILM directive, the following variables are available for the VOLUME :

CONDSTAT	Flag for special film condensation correlation use : if $= 0$: no use of VFILM or use of STOPVC if $= 1$: use of STARVC
VGMEAN	For velocity used for Copain or Nusselt forced convection correlation

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the volume element
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.5 3-D module

Owing to the staggered grid, water point locations are different according to the observed direction.

3.5.1 3-D vector point

Along X-axis (θ for cylinder coordinates) :	
LIQVX	Velocity of liquid
GASVX	Velocity of gas mixture
LIQFLOWX	Mass flow rate of liquid
GASFLOWX	Mass flow rate of gas mixture
Along Y-axis : (R for cylinder coordinates)	
LIQVY	Velocity of liquid
GASVY	Velocity of gas mixture
LIQFLOWY	Mass flow rate of liquid
GASFLOWY	Mass flow rate of gas mixture
Along Z-axis :	
LIQVZ	Velocity of liquid
GASVZ	Velocity of gas mixture
LIQFLOWZ	Mass flow rate of liquid
GASFLOWZ	Mass flow rate of gas mixture

3.5.2 3-D scalar point

PRESSURE	Pressure
LIQH	Enthalpy of liquid
GASH	Enthalpy of gas mixture
ALFA	Void fraction
XiFRACT	$(1 \leq i \leq 4)$ Mass fraction of non condensable gas #i
GSINS	Gravity * sin (vertical, Z-axis,)
GHEIS	Potentail Gravity at scalar node (m/s^2)
LIQTEMP	Temperature of liquid
GASTEMP	Temperature of gas mixture
SATTEMP	Saturation temperature of water at gas total pressure
TSATPV	Saturation temperature of water at partial steam pressure
LIQDENS	Density of liquid
GASDENS	Density of gas mixture
AVGDENS	Density of two phase mixture
DGS	Droplet diameter at scalar nodes
IQL	(q_{le}) index (liquid-interface heat transfer)
IQV	(q_{ge}) index (steam-interface heat transfer)
EQL	Rate of entrainment used in (q_{le}) calculation
QVEBCCOR	Multiplicative term of (q_{ge}) in bubble to churn flow in case of vaporisation
LIQFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase
GASFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase
	continued on next page

XSOLIDi	($1 \leq i \leq 12$) Crystallized mass of radio-chemical element #i
XLMAXi	($1 \leq i \leq 12$) Maximum concentration of radio-chemical element #i
EVAPORi	($1 \leq i \leq 12$) Evaporation constant
CONDENi	($1 \leq i \leq 12$) Condensation constant
DEGASAi	($1 \leq i \leq 12$) Degassing constant
DISSOLi	($1 \leq i \leq 12$) Dissolution constant
SIGMA	Surface tension (N/m)
MULIQ	Dynamic viscosity for liquid (kg/m/s)
MUVAP	Dynamic viscosity for vapour (kg/m/s)
KL0	Liquid turbulent kinetic energy (in K-ε model)
EPSL0	Liquid turbulent dissipation (in K-ε model)
KG0	Gas turbulent kinetic energy (in K-ε model)
EPSG0	Gas turbulent dissipation (in K-ε model)

Call :

ev = CHRONO element VARIABLE integ1 tmin tmax ;

ev = PHOTO element VARIABLE 45rient integ1 time ;

ev	: Name of the evolution
element	: Name of the **3-D** element
VARIABLE	: Name of the variable
orien	: Correspond to the direction of the photo : X (θ), Y ® or Z
Integ1	: Integer corresponding to a vector or scalar mesh number of the element.
Tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.
Time	: Real number corresponding to the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

Examples :

PvsTIME= CHRONO DUCT PRESSURE 15 (scalar node number) 1.0 5.0 ;

VZvsY = PHOTO DUCT LIQVZ Y 121 (Z-vector face number) 5.0 ;

3.5.3 3-D boundary condition point

LIQV	Velocity of liquid
GASV	Velocity of gas mixture
LIQFLOW	Mass flow rate of liquid
GASFLOW	Mass flow rate of gas mixture
GHEIJ	Potential gravity at junction (m/s^2)

Call :

ev = CHRONO element VARIABLE integ1 tmin tmax ;

ev : Name of the evolution

element : Name of the **3-D** element
VARIABLE : Name of the variable
Integ1 : Integer corresponding to a vector/scalar mesh number of the **3-D** -element.
Tmin tmax : (optional) Real numbers defining the time interval of interest for the post-treatment.

3.5.4 3-D global variables

DTCFL	Courant-Friedrich-Lewy time step limitation
LIQMASS	Mass of liquid
STEAMASS	Mass of steam
XiMASS	$(1 \leq i \leq 4)$ Mass of noncondensable gas #i
XiMASERR	$(1 \leq i \leq 4)$ Mass error of noncondensable gas #i
MASERROR	Mass error
FLUIDNRJ	Energy contained in the fluid
LIQVOL	Total volume of liquid in the element
GASVOL	Total volume of gas in the element
TOTPOWER	Total power exchanged on wet side (including nuclear power Qneut without the fraction of kinetics power dissipated in the fluid) (ie < 0 if the fluid heats the walls) (instantaneous value)
DRYPOWER	Power exchanged on dry side (instantaneous value)
WALLPWR	Power generated by the walls of the **3-D** element (instantaneous value)
CWALLNRJ	Energy contained in the walls of the **3-D** element (cumulated value)
CWALLGEN	Energy generated by the walls of the **3-D** element (cumulated value)
CTOTPOWR	Energy exchanged by the walls on the wet side, given to the fluid (cumulated value)
CTOTLOSS	Energy lost by the walls, exchanged on dry side (cumulated value)
CWENERR	Wall energy error : CWALLNRJ + CTOTLOSS + CTOTPOWR – CWALLGEN
MASACTi	$(1 \leq i \leq 12)$ Total activity or total mass of radio-chemical element #i in the **3-D** element
MASDEPi	$(1 \leq i \leq 12)$ Total crystallized mass of radio-chemical element #i in the **3-D** element
GX	Absolute gravity projection on x-axis (m/s^2)
GY	Absolute gravity projection on y-axis (m/s^2)
GZ	Absolute gravity projection on z-axis (m/s^2)
GREL	Relative gravity

Call :

```
ev =    CHRONO element    VARIABLE    tmin  tmax ;
```

ev : Name of the evolution
element : Name of the **3-D** element
VARIABLE : Name of the variable
tmin tmax : (optional) Real numbers defining the time interval of interest for the post-treatment.

3.6 Boudary condition (BC) module

The following global variables are available :

PRESSURE	Pressure
LIQH	Enthalpy of liquid
GASH	Enthalpy of gas mixture
ALFA	Void fraction
XiFRACT	$(1 \leq i \leq 4)$ Mass fraction of noncondensable gas #i
LIQTEMP	Temperature of liquid
GASTEMP	Temperature of gas mixture
SATTEMP	Saturation temperature of water at current pressure
TSATPV	Saturation temperature of water at partial steam pressure
LIQDENS	Density of liquid
GASDENS	Density of gas mixture
AVGDENS	Density of two phase mixture
GREL	Relative gravity
GV	Absolute gravity (m/s^2)
LIQV	Velocity of liquid
GASV	Velocity of gas mixture
LIQFLOW	Mass flow rate of liquid
GASFLOW	Mass flow rate of gas mixture
BULKH	Average enthalpy for the two phases
BULKTEMP	Average temperature for the two phases
BULKDENS	Average density for the two phases
LIQFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase
GASFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the boundary condition element
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.7 Rupture (RG) module

The following global variables are available :

UPRESSUR	Pressure - upstream side of the RG
DPRESSUR	Pressure - downstream side of the RG
ULIQH	Enthalpy of liquid - upstream side of the RG
DLIQH	Enthalpy of liquid - downstream side of the RG
UGASH	Enthalpy of gas mixture - upstream side of the RG
DGASH	Enthalpy of gas mixture - downstream side of the RG
UALFA	Void fraction - upstream side of the RG
DALFA	Void fraction - downstream side of the RG
UXiFRACT	$(1 \leq i \leq 4)$ Mass fraction of noncondensable gas #i -upstream side
DXiFRACT	$(1 \leq i \leq 4)$ Mass fraction of noncondensable gas #i -downstream side
ULIQTEMP	Temperature of liquid - upstream side of the RG
DLIQTEMP	Temperature of liquid - downstream side of the RG
UGASTEMP	Temperature of gas mixture - upstream side of the RG
DGASTEMP	Temperature of gas mixture - downstream side of the RG
USATTEMP	Saturation temperature of water at gas total pressure - upstreamside
DSATTEMP	Saturation temperature of water at gas total pressure - downstream side
UTSATPV	Saturation temperature of water at partial steam pressure - upstream side
DTSATPV	Saturation temperature of water at partial steam pressure - downstream
ULIQDENS	Density of liquid - upstream side of the RG
DLIQDENS	Density of liquid - downstream side of the RG
UGASDENS	Density of gas mixture - upstream side of the RG
DGASDENS	Density of gas mixture - downstream side of the RG
ULIQV	Velocity of liquid - upstream side of the RG
DLIQV	Velocity of liquid - downstream side of the RG
UGASV	Velocity of gas mixture - upstream side of the RG
DGASV	Velocity of gas mixture - downstream side of the RG
ULIQFLOW	Mass flow rate of liquid - upstream side of the RG
DLIQFLOW	Mass flow rate of liquid - downstream side of the RG
UGASFLOW	Mass flow rate of gas mixture - upstream side of the RG
DGASFLOW	Mass flow rate of gas mixture - downstream side of the RG
ULIiFRA	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase upstream side of the RG
DLIiFRA	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase downstream side of the RG
UGAiFRA	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase upstream side of the RG
DGAiFRA	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase downstream side of the RG
GREL	Relative gravity
	continued on next page

GV	Absolute gravity (m/s^2)

NB: The orientation (UPSTREAM or DOWNSTREAM) is the orientation as defined for the RUPTURE element in the input deck
Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the rupture element
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.8 Wall sub-module

The following variables are available :

3.8.1 Axial node of the wall

WALLWETT	Temperature of wall wet side
WALLDRYT	Temperature of wall dry side
LIQFLUX	Heat flux exchanged with liquid (PHIL)(W/m2)
STMFLUX	Heat flux exchanged with steam (PHIV) (W/m2)
INTFLUX	Interface heat flux (PHIWI) (W/m2)
TOTFLUX	Total heat flux (W/m2)
LOSSFLUX	Heat losses on the dry side of the wall (W/p)
PHIFC	Liquid forced convection flux
PHINE	Total nucleate boiling flux
PHICR	Critical heat flux
PHIFB	Film boiling heat flux
PHIRL	Radiation heat flux to liquid
PHIRV	Radiation heat flux to gas
PHIVS	Radiation heat flux to interface (rewetting)
TBO	Burn out temperature
TMF	Minimum film stable temperature
IECH	Wall-fluid exchange index

3.8.2 Other wall variables for 1-D and 3-D modules

ZPOWNR	Power axial normalized profile (0<x<1) if this data has been input using the PNRSHAPE and PNRSHAPX directives. This data is not available when PNRSHAPE and PNRSHAPX directives are not used.
QBOS	Special fuel ballooning burn out flux

3.8.3 Other wall variables for 1-D module

TLFILM	Film temperature of liquid
TGFILM	Film temperature of gas
ROLFILM	Film density of liquid
ROGFILM	Film density of gas
FDX	Weight factor of the heat transfer coefficient due to geometric effect in transient operating ("NONETABL" option) (available only if fluid is H2)

3.8.4 Other wall variables for 0-D module

GMLCOND	Water mass flow rate dues to film condensation
WHSURF	Exchange area

3.8.5 Radial node of the elementary wall

WALLTEMP	Temperature inside the wall
LAMBDA	Thermal conductivity

3.8.6 Medium of the elementary wall in case of HTR application only

WTMOYMED	Average temperature of the medium

Call :
for an Axial element type:

ev =	CHRONO element		VARIABLE ELEV real	integ2 tmin tmax ;
		or	VARIABLE integ1	integ2 tmin tmax ;
ev =	PHOTO element		VARIABLE	integ2 time ;

For a Volume element type

ev =	CHRONO element		VARIABLE [INF]	integ2 tmin tmax ;
		or	VARIABLE [SUP]	integ2 tmin tmax ;

For 3-D element type

ev =	CHRONO element	VARIABLE integ1	integ2 tmin tmax ;
ev =	PHOTO element	VARIABLE orien integ1	integ2 time ;

ev	: Name of the evolution
element	: Name of the wall
VARIABLE	: Name of the variable
INF	: Keyword for the lower sub volume
SUP	: Keyword for the upper sub volume
orien	: Correspond to the direction of the photo X (θ), Y (R) or Z
real	: Real number corresponding to an axial location along the wall. The variable is extracted at the nearest scalar or vector point.
integ1	: Integer corresponding to the mesh number of an axial or 3-D element.
integ2	: Integer corresponding to the radial mesh number, to use only in the case of [WALL-TEMP] or [LAMBDA] variable. or Integer corresponding to the medium number, to use only in the case of [WT-MOYMED] variable (HTR application).
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.
Time	: Real number corresponding to the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

Global variables :

WALLGENR	Power generated in the wall
WALLENRJ	Power contained in the wall
TOTPOWER	Power delivered to the fluid (exchanged on wet side)
	continued on next page

TOTLOSS	Power exchanged on dry side
WENERROR	Instantaneous power error : TOTLOSS + TOTPOWER + WALLENRJ - WALLGENR
AGMINI	Dry out criteria

In case of a wall for an axial element, other accessible variables :

MAXWTEMP	Maximum temperature of the wall
MAXRTEMP	Radial mesh number corresponding to the maximum temperature of the wall
MAXZTEMP	Axial mesh number corresponding to the maximum temperature of the wall

Call :

```
ev =      CHRONO element      VARIABLE            tmin  tmax ;
```

ev	: Name of the evolution
element	: Name of the wall
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.9 Heat exchanger sub-module

3.9.1 Exchanger on 1-D module

The accessible variables of an EXCHANGER are similar to the variables of a standard WALL (see section 3.8).

Call :

ev =	CHRONO element	[VARIABLE ELEV real]	integ2 SIDE tmin tmax ;
		or [VARIABLE integ1]	
ev =	PHOTO element	VARIABLE	integ2 SIDE time ;

ev	: Name of the evolution
element	: Name of the exchanger
VARIABLE	: Name of the variable
real	: Real number corresponding to an axial location along the exchanger. The variable is extracted at the nearest scalar or vector point.
Integ1	: Integer corresponding to an axial mesh number of the exchanger
Integ2	: Integer corresponding to the radial mesh number, to use only in the case of [WALL-TEMP] variable
SIDE	: Keyword corresponding to the circuit (PRIMARY or SECONDARY)
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.
Time	: Real number corresponding to the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

3.9.2 Exchanger on 3-D module

Exchanger on **3-D** module are built using the standard **3-D** WALL element data structures. Therefore in order to access to the variables corresponding to the **3-D** WALL element, refer to section 3.8.

Call :

ev =	CHRONO element	VARIABLE integ1	integ2 SIDE tmin tmax ;
ev =	PHOTO element	VARIABLE 53rient integ1	integ2 SIDE time ;

ev	: Name of the evolution
element	: Name of the exchanger
VARIABLE	: Name of the variable
Integ1	: Integer corresponding to a scalar mesh number of the **3-D** element
Integ2	: Integer corresponding to the radial mesh number, to use only in the case of [WALL-TEMP] variable
orien	: Corresponds to the direction of the photo (X, Y, Z)
SIDE	: Keyword corresponding to the circuit (PRIMARY or SECONDARY)
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.
Time	: Real number corresponding to the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

3.10 Fuel rod sub-module

Fuels rods are built using the standard WALL element data structures that allow thermal conduction modelling. Therefore, in order to access other variables corresponding to the WALL element (see section 3.8).
Accessible variables corresponding to the FUELCHAR element type are given hereafter.

3.10.1 Elementary fuel

UO2TEMP	UO2 mean temperature (half sum of the centred and surface temperature)
UO2MEAN	UO2 mean temperature calculated from all the radial temperatures
UO2CTEMP	UO2 centred temperature
UO2STEMP	UO2 surface temperature
EXOXTEMP	Temperature of external oxide layer
CLADAVGT	Mean cladding temperature
CLADINTT	Internal cladding temperature
CLADEXTT	External cladding temperature
CLADRADI	Mean cladding radius
CLADTHIC	Cladding thickness
GAP	Width of gap
INOXTHIC	Thickness of internal oxide layer
EXOXTHIC	Thickness of external oxide layer
UO2RADIU	Outside radius of the pellet
HGAPC	Conductance of gas in the gap
DRSRO	Strain
STRESS	Stress
SIGRUP	Rupture stress
ALFRAC	Fraction of alfa phase in the cladding
ZPOWRES	Residual power axial normalized profile (0<x<1)
XNEUT	Neutron kinetics power distribution coefficient (fraction of kinetics power dissipated in the rod / kinetics power)
XRES	Residual power repartition coefficient profile between hydraulics and fuel
CLADTHB	Thickness of clad at the time of rupture (m)

3.10.2 Other variables for the spot model

TEMPCHAU	Hot spot temperature
DEFOCHAU	Strain at the hot spot
DEFOMOYE	Mean strain
SIGMCHAU	Stress at the hot spot
SIGRCHAU	Rupture stress at the hot spot
BETAKEUS	Keusenhoff's model Beta parameter
FRACALPC	Alpha phase fraction at the hot spot

3.10.3 Other variables for the OXRATE model

OXRATE	Oxidation rate (%)
EXOXGEN	Thickness of external oxide created during the transient (m)
INOXGEN	Thickness of internal oxide created during the transient (m)

For a Fuelchar in an **1-D** element
Call :

ev =	CHRONO element		[VARIABLE ELEV real]	integ2 tmin tmax ;
		or	[VARIABLE integ1]	integ2 tmin tmax ;
ev =	PHOTO element		VARIABLE	integ2 time ;

For a Fuelchar in a **3-D** element
Call :

ev =	CHRONO element		[VARIABLE ELEV real]	integ2 tmin tmax ;
		or	[VARIABLE integ1]	integ2 tmin tmax ;
ev =	PHOTO element		VARIABLE orien integ1	integ2 time ;

ev	: Name of the evolution
element	: Name of the fuelchar element
VARIABLE	: Name of the variable
orien	: correspond to the direction of the photo :X (θ), Y (R) or Z
real	: Real number corresponding to an axial location along the fuel element. The variable is extracted at the nearest scalar or vector point.
Integ1	: Integer corresponding to the mesh number of the fuel element
Integ2	: Integer corresponding to the radial mesh number, to use only in the case of [WALL-TEMP] variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.
time	: Real number corresponding to the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

3.10.4 FUEL global variables

GAPP	Pressure in the gap
MAXCLTMP	Maximum temperature of the clad
MAXCRTMP	Radial mesh number corresponding to the maximum temperature of the clad
MAXCZTMP	Axial mesh number corresponding to the maximum temperature of the clad
POWNEUT	Neutron kinetics power (or non residual power)
POWRESID	Residual power
REACTMOD	Moderator density (PWR application) or temperature effect (HTR application) on reactivity ($)
REACTDOP	Fuel temperature (Doppler) effect on reactivity ($)
REACTBOR	Boron concentration effect on reactivity ($)
REACTREF	Reflector temperature effect on reactivity ($) (HTR application)
REACTCOO	Coolant density effect on reactivity ($) (SFR application)
	continued on next page

REACTDUC	Hexagonal duct thermal expansion effect on reactivity ($) (SFR application)
REACTCLA	Fuel cladding thermal expansion effect on reactivity ($) (SFR application)
REACTFUE	Fuel pin thermal expansion effect on reactivity ($) (SFR application)
CORMOY	Average density of the coolant (Kg/m3) in front of the FUEL
COTMOY	Average temperature of the fuel (°C)
RELOCDGA	Diameter of fuel fragments used to calculate the residual gap
RELOCDCO	Diameter of fuel fragments used to calculate the equivalent thermal conductivity
RELOCTXO	Volume fraction of balloon filled by fuel after relocation
RELOCGAP	Value of the gap calculated by relocation model and imposed after the cladding burst at the rupture location
RELOCPWR	Value of the power coefficient calculated by relocation model after the cladding burst at the rupture location

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev : Name of the evolution
element : Name of the fuelchar element
VARIABLE : Name of the variable
tmin tmax : (optional) Real numbers defining the time interval of interest for the post-treatment.

3.11 Plate fuel (FUELPLAQ) sub-module

Fuelplaq sub modules are built using the standard WALL element data structures that allow thermal conduction modelling. Therefore, in order to access other variables corresponding to the WALL element (see section 3.8).
Accessible variables corresponding to the FUELPLAQ element type are given hereafter.

3.11.1 FUELPLAQ scalar mesh

ZPOWNR	Power axial local value (input deck user power profiles are normalized, 0<x<1)
ZPOWRES	Residual power axial local value (input deck user power profiles are normalized, 0<x<1)
XNEUT	Neutronic repartition coefficient profile between hydraulics and fuel
XRES	Residual power repartition coefficient profile between hydraulics and fuel

Call :

ev =	CHRONO element		[VARIABLE ELEV real]	integ2 tmin tmax ;
		or	[VARIABLE integ1]	integ2 tmin tmax ;
ev =	PHOTO element		VARIABLE	integ2 time ;

ev	: Name of the evolution
element	: Name of the fuelplaq element
VARIABLE	: Name of the variable
real	: Real number corresponding to an axial location along the fuel element The variable is extracted at the nearest scalar or vector point.
Integ1	: Integer corresponding to the mesh number of the fuel element
Integ2	: Integer corresponding to the radial mesh number, to use only in the case of [WALL-TEMP] variable Or Integer corresponding to the medium number, to use only in the case of [WT-MOYMED] variable (HTR application).
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.
time	: Real number corresponding to the computation time for which the photo must be taken. The variable is extracted at the nearest time stored in the result file.

3.11.2 FUELPLAQ global variables

POWNEUT	Prompt fission power release (W)
POWRESID	Residual power release (W)
REACTMOD	Moderator density (PWR application) or temperature effect (HTR application) on reactivity ($)
REACTDOP	Fuel temperature (Doppler) effect on reactivity ($)
REACTBOR	Boron concentration effect on reactivity ($)
REACTREF	Reflector temperature effect on reactivity ($) (HTR application)
REACTCOO	Coolant density effect on reactivity ($) (SFR application)
REACTDUC	Hexagonal duct thermal expansion effect on reactivity ($) (SFR application)
REACTCLA	Fuel cladding thermal expansion effect on reactivity ($) (SFR application)
REACTFUE	Fuel pin thermal expansion effect on reactivity ($) (SFR application)
	continued on next page

CORMOY	Average density of the coolant (Kg/m^3) in front of the FUELPLAQ
COTMOY	Average temperature of the fuel (°C)

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the fuelplaq element
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.12 Reflooding sub-module

The following variables are available :

QFLEVEL	Level of bottom-top or top-down quench front
QFVELOC	Velocity of bottom-top or top-down quench front
QFIND	reflooding index : QFIND = 1 is corresponding to a 1-D reflooding QFIND = 2 is corresponding to a 2-D reflooding
QFZSUP	Elevation of scalar node upstream quench front
QFZSDO	Elevation of scalar node downstream quench front
QFTWUP	Wetted temperature upstream quench front
QFTWDO	Wetted temperature downstream quench front
QFTBDO	Burn out temperature downstream quench front
QFTMDO	Minimum film stable temperature downstream quench front
QFZSUPO	Initial elevation of scalar node upstream quench front
QFZSDOO	Initial elevation of scalar node downstream quench front
QFTWUPO	Initial wetted temperature upstream quench front
QFTWDOO	Initial wetted temperature downstream quench front
QFTBDOO	Initial burn out temperature downstream quench front
QFTMDOO	Initial minimum film stable temperature downstream quench front

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev : Name of the evolution
element : Name of the reflchar object
VARIABLE : Name of the variable
tmin tmax : (optional) Real numbers defining the time interval of interest for the post-treatment.

3.13 CORE (neutronics) sub-module

The following variables are available:

POWER	Core effective power generation (W)
RESPOWER	Actinides and fission products decay power (residual power) (W)
FISPOWER	Fission power (part of the instantaneous fission power given to the actinides and fission products) (W)
REACTIVE	Core reactivity in \$ (\$ is pcm/BETA)
REACTEXT	Control rod effect on reactivity (\$)
REACTMOD	Moderator density (PWR application) or temperature effect (HTR application) on reactivity (\$)
REACTDOP	Fuel temperature (Doppler) effect on reactivity (\$)
REACTBOR	Boron concentration effect on reactivity (\$)
REACTREF	Reflector temperature effect on reactivity (\$) (HTR application)
REACTCOO	Coolant density effect on reactivity (\$) (SFR application)
REACTDUC	Hexagonal duct thermal expansion effect on reactivity (\$) (SFR application)
REACTCLA	Fuel cladding thermal expansion effect on reactivity (\$) (SFR application)
REACTFUE	Fuel pin thermal expansion effect on reactivity (\$) (SFR application)
REACTPAD	Core geometry modification related to contact pads effect on reactivity (\$) (SFR application)
REACTCSP	Diagrid thermal expansion effect on reactivity (\$) (SFR application)
REACTROD	Control rod insertion effect on reactivity (\$) (SFR application)
SOURCNEU	Power increase due to external neutron source (W/s)
COREDENS	Average density of the coolant over the core region (Kg/m^3)
CORETEMP	Average temperature of the fuel over the core region (°C)

```
ev =      CHRONO element      VARIABLE              tmin  tmax ;
```

ev	: Name of the evolution
element	: Name of the core object
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.14 CONTROL ROD sub-module

The following variables are available:

3.14.1 Control Rod Group variables

INSERT	Control rod group insertion depth in the core imposed by user (m)
INSERTOT	Total control rod group insertion depth in the core, taking into account thermal expansion effects (m)
COOLTEMP	Average temperature of coolant in contact with control rod group (°C) (SFR application)
RODTEMP	Average temperature of control rod absorber bar (°C) (SFR application)
TIPTEMP	Average temperature of control rod tip (°C) (SFR application)
TIPTAU	Characteristic time of control rod tip thermal diffusion (s) (SFR application)

3.14.2 Control Rod mechanism variables

MECTEMP	Temperature of control rod mechanism (°C) (SFR application)
MECTAU	Characteristic time of control rod mechanism thermal diffusion (s) (SFR application)

Call:

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the accu object
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.15 Accumulator sub-module

The following variables are available :

LIQFLOW	Flow rate of liquid injected by accumulator
GASFLOW	Flow rate of gas injected by accumulator
ENTHFLOW	Total enthalpy flow injection rate
PRESSURE	Accumulator pressure
GASVOL	Volume of gas of accumulator
LIQVOL	Volume of liquid of accumulator
LIQMASS	Liquid mass of accumulator
GASMASS	Gas mass of accumulator
GASTEMP	Temperature of gas
LIQTEMP	Temperature of liquid
LIQH	Liquid enthalpy
TOTFLOW	Total flow rate injected by accumulator
LIQFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase

Call:

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the accu object
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.16 Break sub-module

The following global variables are available :

TOTFLOW	Break flow rate
LIQFLOW	Break liquid flow rate
GASFLOW	Break gas flow rate
STMFLOW	Break vapor flow rate
ENTHFLOW	Break total enthalpy flow rate
XiFLOW	$(1 \leq i \leq 4)$ Break flow rate of non condensable gas #i
LIQTEMP	Liquid temperature at break
GASTEMP	Gas temperature at break
LIQH	Liquid enthalpy at break
GASH	Gas enthalpy at break
ALFA	Void fraction at break
LIQFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase
GASFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase
XLFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the liquid phase
XGFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the gas phase

Call :

```
ev =    CHRONO element    VARIABLE    tmin  tmax ;
```

ev	: Name of the evolution
element	: Name of the break object
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.17 Candle sub-module

The following global variables are available :

ENECANDL	Total power injected by the candle
LIQPOWER	Power injected into liquid phase without changing the interface heat flux
GASPOWER	Power injected into steam phase without changing the interface heat flux
INTERLIQ	Power injected into liquid phase by changing the interface heat flux
INTERGAS	Power injected into gas phase by changing the interface heat flux
INJECVOL	Power injected into gas or liquid phase without changinig the interface heat flux
SLIPRATE	VG/VL

Call :

```
ev =    CHRONO element    VARIABLE    tmin  tmax ;
```

ev	: Name of the evolution
element	: Name of the candle object
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.18 0-D steam generator sub-module

For the accessible variables corresponding to the linked **1-D** element type, refer to section 3.3.
The additional accessible variables corresponding to the 0-D steam generator are given hereafter.
For the element as a whole (global variables) :

SGLIQMAS	Liquid mass of secondary side (kg)
SGGASMAS	Gas mass of secondary side (kg)
SGPRES	Secondary side pressure (bar)
SGPOWER	Power exchanged through the S.G. (W)
SGTEMP	Secondary fluid temperature (°C)
SGFOUL	Fouling factor

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the 0-D steam generator
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.19 PIQBREK, PIQSOUP, PIQSEB and PIQVANNE sub-modules

3.19.1 PIQ* global variables

The accessible global variables are available :

TOTFLOW	BVSI flow rate
LIQFLOW	BVSI liquid flow rate
GASFLOW	BVSI gas flow rate
STMFLOW	BVSI steam flow rate
ENTHFLOW	BVSI total enthalpy flow rate
XiFLOW	$(1 \leq i \leq 4)$ BVSI flow rate of non condensable gas #i
	In case of injection (for reversible sub-modules), additional values (which are the user imposed values) related to the external fluid :
LIQTEMP	Liquid temperature
GASTEMP	Gas temperature
LIQH	Liquid enthalpy
GASH	Gas enthalpy
ALFA	Void fraction
LIQFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase
GASFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase
	Flows through the PIQxxx element :
XLFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the liquid phase
XGFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the gas phase

3.19.2 PIQBREK sub-module

DTOPEN	Time to reach full opening after TOPEN
TOPEN	Time of sub-module opening start
SECTMAX	Full opening section
SECTBREC	Opening ratio of the PIQBREK requested by the user (normalized section of the break)

3.19.3 PIQSOUP sub-module

REALSEC	Opening section calculated by Cathare
REALPU	Opening ratio (position of the stem : $0 \leq x \leq 1$)
XFAILURE	Failure rate

3.19.4 PIQSEB sub-module

EQUIVSEC	Opening section calculated by Cathare
EQUIVPU	Opening ratio (position of the stem : $0 \leq x \leq 1$)

3.19.5 Safety valve of the PIQSEB sub-module

REALSEC	Opening section calculated by Cathare
REALPU	Opening ratio (position of the stem : $0 \leq x \leq 1$)
IFAILURE	Failure index
XFAILURE	Failure rate

3.19.6 PIQVANNE sub-module

EQUIVSEC	Opening section
EQUIVPU	Opening ratio (position of the stem : $0 \leq x \leq 1$)
EQUIVKM	Equivalent head loss coefficient

3.19.7 Valve of the PIQVANNE sub-module

PU	Opening ratio (position of the stem : $0 \leq x \leq 1$)
REALPU	Opening ratio taking into account the failure (position of the stem : $0 \leq x \leq 1$)
REALKM	Head loss coefficient
IFAILURE	Failure index
XFAILURE	Failure rate

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev : Name of the evolution
element : Name of the sub-module
VARIABLE : Name of the variable
tmin tmax : (optional) Real numbers defining the time interval of interest for the post-treatment.

3.20 PIQREV and PIQARE sub-modules

3.20.1 PIQREV sub-module

The accessible global variables are available for the PIQREV gadget :

TOTFLOW	Nozzle flow rate
LIQFLOW	Nozzle liquid flow rate
GASFLOW	Nozzle gas flow rate
STMFLOW	Nozzle steam flow rate
ENTHFLOW	Nozzle total enthalpy flow rate
XiFLOW	$(1 \leq i \leq 4)$ Nozzle flow rate of non condensable gas #i
	In case of injection (for reversible gadgets), additional values (which are the user imposed values) related to the external fluid :
LIQTEMP	Liquid temperature
GASTEMP	Gas temperature
LIQH	Liquid enthalpy
GASH	Gas enthalpy
ALFA	Void fraction
LIQFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the liquid phase
GASFRAi	$(1 \leq i \leq 12)$ Concentration of radio-chemical element #i in the gas phase
	flows through the PIQxxx element :
XLFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the liquid phase
XGFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the gas phase

3.20.2 PIQARE sub-module

The accessible global variables are available for the PIQARE gadget :

ARESTATE	State of Steam generator feed water (ARE) overflowing model activation
TXDEB	Overflowing ratio
AREFLOW	Nozzle flow rate

3.20.3 PIQARE and PIQREV sub-modules

TOTFLOW	Flow rate
LIQFLOW	Liquid flow rate
GASFLOW	Gas flow rate
STMFLOW	Steam flow rate
ENTHFLOW	Total enthalpy flow rate
XiFLOW	$(1 \leq i \leq 4)$ Flow rate of non condensable gas #i
	In case of injection (for reversible gadgets), additional values (which are the user imposed values) related to the external fluid :
LIQTEMP	Liquid temperature
GASTEMP	Gas temperature
LIQH	Liquid enthalpy
GASH	Gas enthalpy
	continued on next page

ALFA	Void fraction
LIQFRAi	($1 \leq i \leq 12$) Concentration of radio-chemical element #i in the liquid phase
GASFRAi	($1 \leq i \leq 12$) Concentration of radio-chemical element #i in the gas phase
	flows through the PIQxxx element :
XLFLOWi	($1 \leq i \leq 12$) Mass flow rate of radio-chemical element #i in the liquid phase
XGFLOWi	($1 \leq i \leq 12$) Mass flow rate of radio-chemical element #i in the gas phase

Call :

```
ev =    CHRONO element    VARIABLE    tmin  tmax ;
```

ev	: Name of the evolution
element	: Name of the gadget
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

N.B.: For global variables of one PIQARE gadget it is necessary to give the name of one of the two PIQREV. The evolution is the same for the two PIQREV.

3.21 0-D pump sub-module

For the accessible variables corresponding to the linked **1-D** element type, refer to chapter 3.3.
The additional accessible global variables corresponding to the 0-D pump are given below :

PMPDENS	Pump average density
PMPMFLOW	Mass flow rate
PMPVFLOW	Volume flow rate

3.21.1 Standard 0-D pump

CLICK	Position index of the latch arm: 0 for raising 1for fall down
PMPSPEED	Reduced pump speed
MTORQUE	Pump torque (Nm)
EXTORQ	Electrical torque (Nm) COMETE application
PMPELEV	Pump elevation (manometric height * gravity)(p/s)
PMPDP	Pump pressure drop (Pa) COMETE application
PMPHDEG	Pump degradation coefficient
PMPCDEG	Pump degradation coefficient due to cavitation
INTENSIT	Stator supply intensity
FACTPUIS	Factor of power
VNOMIN	Nominal supply voltage
FREQALIM	Power supply frequency

3.21.2 Electromagnetic 0-D pump

TENSALIM	Supply voltage
SLIP	Pump slip ratio

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the pump
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.22 Sensor sub-module

The accessible global variables depend on the sensor type :

3.22.1 Wall temperature sensor

(related to a WALL sub module or a **0-D** element) :

TEMPWALL	Wall temperature given by the sensor

3.22.2 Temperature sensor

(related to an **1-D** or a **0-D** element) :

TEMP	Temperature given by the sensor

3.22.3 Pressure sensor

(related to an **1-D** or a **0-D** element) :

PRESSURE	Pressure given by the sensor

3.22.4 Flowrate sensor

(related to an **1-D** or a **0-D** element) :

LIQMFLOW	Liquid mass flow rate given by the sensor
GASMFLOW	Gas mass flow rate given by the sensor
LIQVFLOW	Liquid **0-D** flow rate given by the sensor
GASVFLOW	Gas **0-D** flow rate given by the sensor

3.22.5 MAILSIPA sensor

(related to an **1-D** or a **0-D** element) :

VL	Liquid velocity
VG	Gas velocity
LIQDENS	Liquid density
GASDENS	Gas density
UMALFA	Liquid **0-D** fraction
ALFA	Void fraction

3.22.6 Activity sensor

(related to an **1-D** or a **0-D** element) :

XBAMOYi	($1 \leq i \leq 12$) Activity of radio element #i given by the sensor (GBq/kg)
LIQFRAi	($1 \leq i \leq 12$) Activity of radio element #i in the liquid phase (GBq/kg)
GASFRAi	($1 \leq i \leq 12$) Activity of radio element #i in the gas phase (GBq/kg)

3.22.7 SIPA activity sensor

(related to an **1-D** or a **0-D** element) :

XBAMOYi	($1 \leq i \leq 12$) Activity of radio element #i given by the sensor (GBq/m^3)

3.22.8 SIPA flowrate activity sensor

(related to an **1-D** or a **0-D** element):

XBFLOWi	($1 \leq i \leq 12$) Flow rate of the radio-chemical element #i (GBq/s)

3.22.9 Ultrasonic sound sensor

(related to an **1-D** element) :

PRESSURE	Pressure
ALFA	Void fraction
LIQTEMP	Temperature of liquid
GASTEMP	Temperature of gas
TXSTRAT	Stratification rate
TXENT	Entrainment rate
XiFRACT	($1 \leq i \leq 4$) Mass fraction of noncondensable gas #i

3.22.10 Swell level sensor

(related to an **1-D** or a **3-D** element) :

SWLLEVEL	Swell level according to the bottom of the considered zone (first defined in the sensor definition) (m)
QGMNIV	Gas mass flow rate on the vector point below the swell level reported to the reference zone area (kg/s)
QGPNIV	Gas mass flow rate on the vector point over the swell level reported to the reference zone area (kg/s)
HLIN	Liquid enthalpy at the bottom of the considered zone (J/kg)
HGIN	Gas enthalpy at the bottom of the considered zone (J/kg)
ALIN	Void fraction at the bottom of the considered zone
LIQFIN	Liquid mass flow rate at the bottom of the considered zone reported to the reference zone area (kg/s)
GASFIN	Gas mass flow rate at the bottom of the considered zone reported to the reference zone area (kg/s)
HLOUT	Liquid enthalpy at the top of the considered zone (J/kg)
HGOUT	Gas enthalpy at the top of the considered zone (J/kg)
	continued on next page

ALOUT	Void fraction at the top of the considered zone
LIQFOUT	Liquid mass flow rate at the top of the considered zone reported to the reference zone area (kg/s)
GASFOUT	Gas mass flow rate at the top of the considered zone reported to the reference zone area (kg/s)
PRESSOUT	Pressure in the fluid at the top of the considered zone (Pa)
PUISZONE	Total power generated by the walls in the reference zone (W)
IPOSNIV	Scalar node number corresponding to the swell level

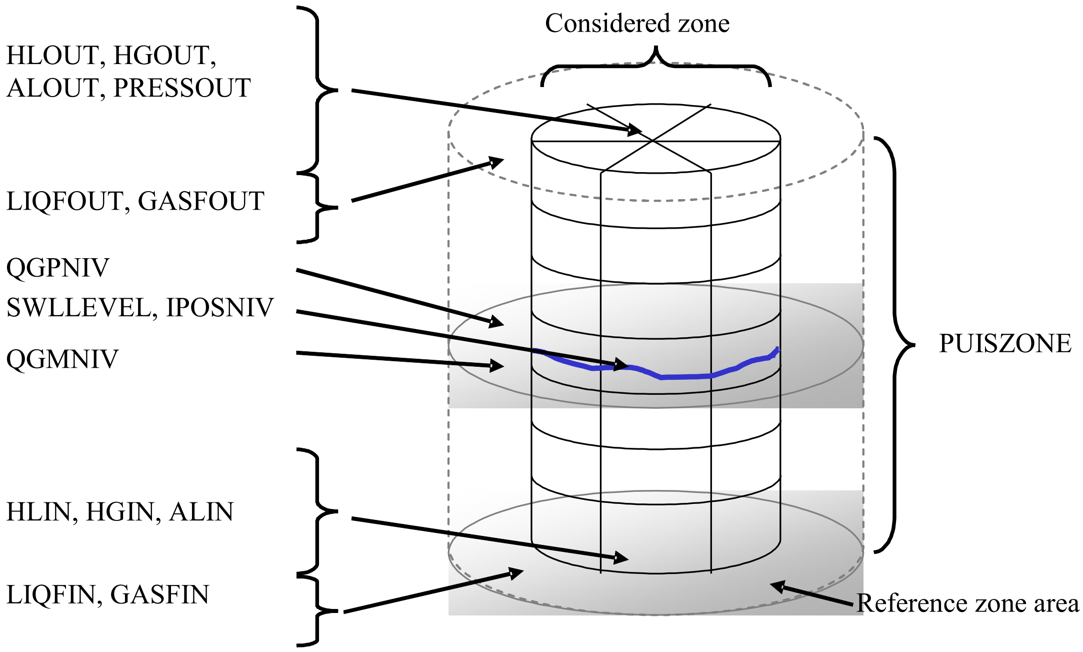

Figure 3.22.1: Swell level sensor sub-module

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the sensor
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.23 SINK, SOURCE, SINKRRI and SOURIS sub-modules

3.23.1 Sink and source common variables

The following global variables are available :

TOTFLOW	Flow rate
LIQFLOW	Liquid flow rate
GASFLOW	Gas flow rate
STMFLOW	Steam flow rate
ENTHFLOW	Total enthalpy flow rate
XiFLOW	$(1 \leq i \leq 4)$ Flow rate of non condensable gas #i
LIQTEMP	Liquid temperature
GASTEMP	Gas temperature
LIQH	Liquid enthalpy
GASH	Gas enthalpy
ALFA	Void fraction
LIQFRAi	$(1 \leq i \leq 12)$ Mass fraction of radio-chemical element #i in the liquid phase
GASFRAi	$(1 \leq i \leq 12)$ Mass fraction of radio-chemical element #i in the gas phase
XLFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the liquid phase
XGFLOWi	$(1 \leq i \leq 12)$ Mass flow rate of radio-chemical element #i in the gas phase

3.23.2 Additional variables for sink safety valve

VALVPRES	Opening pressure
VALVSECT	Cross-section of current opening
VALVSECC	Normalized section (with respect to the maximum section)
PU	Opening ratio

3.23.3 Additional variables for a RRI sink

	Variables for the Low Pressure Safety Injection (LPSI or ISBP):
FLOWISBP	Liquid flow rate of low pressure safety injection (LPSI/ISBP) (kg/s)
TEMPISBP	Temperature of the LPSI injected liquid (°C)
POWISBP	Heat Power exchanged in LPSI/component cooling system (CCCW (RRI)) exchanger (W)

	Variables for the Containment Spray System (CSS (EAS)):
FLOWEAS	Liquid flow rate of the spray (containment spray system source/ CSS (EAS) source) (kg/s)
TEMPEAS	Temperature of the spray injected liquid (°C)
POWEAS	Heat Power exchanged in containment spray system/component cooling system (CSS (EAS)/CCCW (RRI)) exchanger (W)
	Variables at the Component Cooling System (CCCW (RRI)) :
FLOWRRI	Flow rate (at CCCW (RRI)/ESWS (SEC) exchanger outlet) (kg/s)
FLOWREAS	Flow rate (at CSS (EAS)/CCCW (RRI) exchanger outlet) (kg/s)
FLOWRISB	Flow rate (at LPSI/CCCW (RRI) exchanger outlet) (kg/s)
TEMPRRIF	Liquid temperature in the CCCW (RRI) circuit at the CCCW (RRI)/ESWS (SEC) exchanger inlet (°C)
	continued on next page

TEMPRRIC	Liquid temperature in the CCCW (RRI) circuit at the CCCW (RRI)/ESWS (SEC) exchanger outlet (°C)
TEMPREAS	Liquid temperature in the CCCW (RRI) circuit at the CSS (EAS)/CCCW (RRI) exchanger outlet (°C)
TEMPRISB	Liquid temperature in the CCCW (RRI) circuit at the LPSI/CCCW (RRI) exchanger outlet (°C)
XRRRIEAS	Rate of flow rate in CSS (EAS)/CCCW (RRI) exchanger (value between 0. and 1.) : Q(EAS/RRI) / [Q(CSS (EAS)/CCCW (RRI)) + Q(LPSI/CCCW (RRI))]
FLOWAUX	Additional flow rate extracted from CCCW (RRI) (other than CSS (EAS) and LPSI)
POWAUX	Additional power extracted from CCCW (RRI) (other than CSS (EAS) and LPSI)
Variables for the Essential Service Water System (ESWS (SEC)):	
FLOWSEC	Flow rate in CCCW (RRI)/ESWS (SEC) exchanger (kg/s)
TEMPSECF	Liquid temperature at the CCCW (RRI)/ESWS (SEC) exchanger inlet (°C)
TEMPSECC	Liquid temperature at the CCCW (RRI)/ESWS (SEC) exchanger outlet (°C)
POWSEC	Heat flux exchanged in ESWS (SEC)/CCCW (RRI) exchanger (W)
Variables for the Raw Water system (RWS (SEB)):	
FLOWSEB	Flow rate in CSS (EAS)/RWS (SEB) exchanger (kg/s)
TEMPSEBF	Liquid temperature at the CSS (EAS)/RWS (SEB) exchanger inlet (°C)
TEMPSEBC	Liquid temperature at the CSS (EAS)/RWS (SEB) exchanger outlet (°C)
POWSEB	Heat flux exchanged in CSS (EAS)/RWS (SEB) exchanger (W)

3.23.4 Additional variables for a SOURIS source

RESPOWER	Core residual power
CONRATE	Rate of condensation in containment
Security injection characteristics	
POSIRIS	Position of the break
FLOWRISF	Injected liquid flow rate in cold leg
FLOWRISC	Injected liquid flow rate in hot leg
TLRIS	Temperature of injected water (same in hot and cold legs)

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the sink or source gadget
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.24 Steam generator tube rupture (SGTR) sub-module

3.24.1 SGTR global variables

The following global variables are available :

SGTR STAT	State of the SGTR (1 if opened 0 is closed)
NTRUPT	Number of broken tubes
NODEPRIM	Mesh number of the primary element on which the SGTR is defined
NODESEC	Corresponding mesh number of the secondary element
DTOPEN	Time to reach full opening after TOPEN
TOPEN	Time of SGTR opening start
SECTMAX	Full opening section
SECTBREC	Opening ratio of the rupture
LIQFGLOB	Global liquid flow rate
GASFGLOB	Global gas flow rate
TOTFGLOB	Global flow rate
LIQHGLOB	Global liquid enthalpy flow rate
GASHGLOB	Global gas enthalpy flow rate
TOTHGLOB	Global enthalpy flow rate
XiFGLOB	$(1 \le i \le 4)$ Global flow rate of non condensable gas#i

Call :

ev = CHRONO SGTR name VARIABLE SIDE tmin tmax ;

ev	: Name of the evolution
SGTR name	: Name of the SGTR gadget
VARIABLE	: Name of the variable
SIDE	: Keyword equal to PRIMARY or SECONDARY
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

In case of double ended rupture model (keyword GVGUIL), 2 points in the primary element meshing contribute to the following variables for other models they are equal (when they exist) to the corresponding previous global values.

3.24.2 Primary side of a partial SGTR sub-module

LIQFLOW	Liquid flow rate on hot or cold side
GASFLOW	Gas flow rate on hot or cold side
STMFLOW	Steam flow on hot or cold side
TOTFLOW	Total flow rate on hot or cold side
ENTHFLOW	Enthalpy flow rate on hot or cold side
PRESSURE	Pressure
XiFLOW	$(1 \le i \le 4)$ Global flow rate of non condensable gas #i on hot or cold side
XLFLOWi	$(1 \le i \le 12)$ Mass flow rate of radio-chemical element in the liquid phase #i on hot or cold side
XGFLOWi	$(1 \le i \le 12)$ Mass flow rate of radio-chemical element in the gas phase #i on hot or cold side

continued on next page

LIQFRAi	($1 \leq i \leq 12$) Activity or concentration of radio-chemical element #i in the liquid phase on hot or cold side
GASFRAi	($1 \leq i \leq 12$) Activity or concentration of radio-chemical element #i in the gas phase on hot or cold side
MASACTi	($1 \leq i \leq 12$) Cumulated total activity or total mass of radio-chemical element #i on hot or cold side

Call :

ev = CHRONO SGTR name VARIABLE scal PRIMARY tmin tmax ;

ev	: Name of the evolution
SGTR name	: Name of the SGTR gadget
VARIABLE	: Name of the variable
scal	1 for hot side, 2 for cold side for rupture of one or more tubes
	1 for partial rupture (and in that case partial var. are equal to global var.)
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.25 Tee sub-module (T-branch of an axial element)

The following global variables are available :

PRESSURE	Pressure
LIQH	Enthalpy of liquid
GASH	Enthalpy of gas mixture
ALFA	Void fraction
LIQTEMP	Temperature of liquid
GASTEMP	Temperature of gas mixture
SATTEMP	Saturation temperature of water at total pressure
TSATPV	Saturation temperature of water at partial steam pressure
LIQDENS	Density of liquid
GASDENS	Density of gas mixture
AVGDENS	Density of two phase mixture
SIGMA	Surface tension (N/m)
MULIQ	Dynamic viscosity for liquid (kg/m/s)
MUVAP	Dynamic viscosity for vapour (kg/m/s)
XiFRACT	($1 \leq i \leq 4$) Mass fraction of noncondensable gas #i
LIQV	Velocity of fluid
GASV	Velocity of gas mixture
LIQFLOW	Mass flow rate of liquid
GASFLOW	Mass flow rate of gas mixture
ITOVI	Zone index for interfacial friction
LIQFRAi	($1 \leq i \leq 12$) Concentration of radio-chemical element #i in the liquid phase
GASFRAi	($1 \leq i \leq 12$) Concentration of radio-chemical element #i in the gas phase

Call :

```
ev =      CHRONO element          VARIABLE                    tmin  tmax ;
```

ev	: Name of the evolution
element	: Name of the tee
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.26 Turbine sub-module

The following global variables are available :

PTURB	Turbine power (Watt)
FTURB	Pressure drop coefficient
RB1	$\max(Critical\,pressure\,ratio = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}, \frac{P_{outlet}}{P_{inlet}})$
DHIDEAL	Enthalpy variation for an isentropic expansion (J/kg)
VTURB	Velocity in the turbine for a perfect gas and an isentropic expansion (m/s)

Call :

ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the turbine
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.27 0-D turbomachine sub-module

For the accessible variables corresponding to the linked **1-D** element type, refer to §3.3.
The additional accessible global variables corresponding to the 0-D turbomachine are given below :

REDFLOW	Reduced mass flow rate (adimensional)
GREDFLOW	Generalized reduced mass flow rate (adimensional)
ABSFLOW	Absolute mass flow rate (kg/s)
REDSPEED	Reduced turbomachine rotational speed (adimensional)
GREDSPEE	Generalized reduced turbomachine rotating speed (adimensional)
ABSSPEED	Absolute turbomachine rotating speed (rad/s)
REDEXP	Reduced pressure expansion rate (adimensional)
ABSEXP	Absolute pressure expansion rate (adimensional)
REDCOMP	Reduced pressure compression rate (adimensional)
ABSCOMP	Absolute pressure compression rate (adimensional)
REDHTORQ	Reduced hydraulic torque (adimensional)
ABSHTORQ	Absolute hydraulic torque (m^5/s^2)
REDSTORQ	Reduced specific torque (adimensional)
ABSSTORQ	Absolute specific torque (m^5/s^2)
REDEFFIC	Reduced isentropic efficiency (adimensional)
ABSEFFIC	Absolute isentropic efficiency (adimensional)
STAUPRES	Static upstream pressure (Pa)
TOTUPRES	Total upstream pressure (Pa)
STADPRES	Static downstream pressure (Pa)
TOTDPRES	Total downstream pressure (Pa)
STAUTEMP	Static upstream temperature (°C)
TOTUTEMP	Total upstream temperature (°C)
STADTEMP	Static downstream temperature (°C)
TOTDTEMP	Total downstream temperature (°C)
ALTPOWER	Alternator power (W)
ALTTORQ	Alternator electric torque (m^5/s^2)
MTORQUE	Torque (Nm)
TCODENS	Fluid density in the component (kg/m3)
TCOMFLOW	Mass flow rate (kg/s)
TCOVFLOW	Volume flow rate (m^3/s)
TCOSPEED	Rotational speed (rad/s)
TCOELEV	Head in component (m^2/s^2)
IMAPALN1	Interpolation and extrapolation indicator for head or expansion ratio map
IMAPALN2	Interpolation and extrapolation indicator for torque or efficiency map
IMAPXNU1	Interpolation and extrapolation indicator for head or expansion ratio map
IMAPXNU2	Interpolation and extrapolation indicator for torque or efficiency map
ELCTORQ	Electric torque
ELCPOWER	Electric power
IMOTELEC	Index of the motor torque
IFROTM	Index of the friction torque

Call :

```
ev =    CHRONO element    VARIABLE    tmin  tmax ;
```

ev	: Name of the evolution
element	: Name of the turbomachine
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.28 CHECK VALVE, CONTROL VALVE or FLOW LIMITER sub-modules

3.28.1 Valve common variables

TCR	Flag giving the type of flow
TCR	= 0 or 1 sub-sonic condition
TCR	= 2 sonic condition with a flow in the mesh direction
TCR	= 3 sonic condition with a flow opposite to the mesh direction

3.28.2 CHECK VALVE or CONTROL VALVE sub-modules

PU	Position of the stem without taking into account the failure
REALPU	Real position of the stem taking into account the failure
CV	Valve capacity
SR	Reduced surface
KM	Head loss coefficient
DELTAP	Pressure drop through the valve

3.28.3 FLOW LIMITER sub-module

KM	Head loss coefficient
DELTAP	Pressure drop through the valve

3.28.4 ECHECK or ECVALVE sub-modules

EQUIVSCT	Equivalent reduced surface of the group
EQUIVKM	Equivalent head loss coefficient of the group
DELTAP	Pressure drop through the group

call:
ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the valve
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.29 3-D zone sub-module

Warning : in the **3-D** module, only the zones that have been explicitly typed for mass and energy balance with the BILAN**3-D** directive (in the Data Block) are eligible for post-processing with the following keywords ; for these zones, the calculation process performs additional zonal balance calculations and stores the associated results in the FORT21 file.
The other **3-D** zones defined in the data Block are considered only as a user facility to build the **3-D** geometry and characteristics.The following global variables are available:

TOTMASS	Total current mass of the **3-D** zone
LIQMASS	Liquid mass of the **3-D** element
STEAMASS	Steam mass of the **3-D** element
GASMASS	Gas mass of the **3-D** element
SOUMASS	Cumulated mass injected/extracted in the **3-D** zone by their gadgets
JONMASS	Cumulated mass injected/extracted through junctions of the **3-D** zone
FACMASS	Cumulated mass injected/extracted through outer faces of the **3-D** zone
MASERROR	Mass error of the **3-D** zone
XiMASS	$(1 \leq i \leq 4)$ Total mass of noncondensable gas #i of the **3-D** zone
XiMASERR	$(1 \leq i \leq 4)$ Mass error of noncondensable gas #i of the **3-D** zone
XiSOUMAS	$(1 \leq i \leq 4)$ Mass error of noncondensable gas #i injected/extracted of the **3-D** zone by their gadgets
XiJONMAS	$(1 \leq i \leq 4)$ Cumulated mass of noncondensable gas #i injected/extracted through junctions of the **3-D** zone
XiFACMAS	$(1 \leq i \leq 4)$ Cumulated mass of noncondensable gas #i injected/extracted through outer faces of the **3-D** zone
FLUIDNRJ	Fluid current energy of the **3-D** zone
SOUNRJ	Cumulated energy injected/extracted in the **3-D** zone by their gadgets and their **3-D** walls
JONNRJ	Cumulated energy injected/extracted through junctions of the **3-D** zone
FACNRJ	Cumulated energy injected/extracted through outer faces of the **3-D** zone
CWALLGEN	Cumulated energy generated by the **3-D** walls of the **3-D** zone
CWALLNRJ	Cumulated energy currently stored in the **3-D** walls of the **3-D** zone
CTOTPOWR	Cumulated energy exchanged by the **3-D** walls on the wet side (given to the fluid) of the **3-D** zone
CTOTLOSS	Cumulated energy lost by the **3-D** walls (exchanged on dry side) of the **3-D** zone
CWENERR	Cumulated wall energy error of the **3-D** zone
MASACTi	$(1 \leq i \leq 12)$ Total current mass of the radio-chemical element #i in the **3-D** zone.
MASDEPi	$(1 \leq i \leq 12)$ Total crystallized mass of radio-chemical element #i in **3-D** zone
XBAMOYi	$(1 \leq i \leq 12)$ Average concentration of radio-chemical element #i in the **3-D** zone.

Call :

ev = CHRONO **3-D** _zone VARIABLE tmin tmax ;

ev	: Name of the evolution
3-D _zone	: Name of the **3-D** _zone
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.30 Zone sub-module

A zone is a set of Cathare elements. The following variables are available :

TOTMASS	Total current mass of the zone
LIQMASS	Current liquid mass of the zone
SOUMASS	Cumulated mass injected/extracted in all **1-D**, **0-D** or **3-D** elements of the zone by their gadgets (convention : positive if extracted)
JONMASS	Cumulated mass injected/extracted in boundary conditions and ruptures of the zone (convention : positive if extracted)
MASERROR	Mass error : TOTMASS - initial TOTMASS + JONMASS + SOUMASS
XiMASS	$(1 \leq i \leq 4)$: Total mass of noncondensable gas #i
XiMASERR	$(1 \leq i \leq 4)$: Mass error of noncondensable gas #i
XiSOUMAS	$(1 \leq i \leq 4)$: Cumulated mass of noncondensable gas #i injected/extracted in all **1-D**, **0-D** or **3-D** elements of the zone by their gadgets
XiJONMAS	$(1 \leq i \leq 4)$: Cumulated mass of noncondensable gas #i injected/extracted in boundary conditions and ruptures of the zone
TOTNRJ	Total current energy of the zone
SOUNRJ	Cumulated energy injected/extracted in **1-D**, **0-D** or **3-D** elements of the zone by their gadgets (convention : positive if extracted)
JONNRJ	Cumulated energy injected/extracted in boundary conditions and ruptures (convention : positive if extracted)
NRJERROR	Energy error : TOTNRJ - initial TOTNRJ + JONNRJ + SOUNRJ NRJERROR is not available if a **3-D** element is defined within the zone, its value is set to INF
CWALLGEN	Cumulated energy generated by the walls of the zone
CWALLNRJ	Cumulated energy currently stored in the walls of the zone
CTOTPOWR	Cumulated energy exchanged by the walls on the wet side (given to the fluid)
CTOTLOSS	Cumulated energy lost by the walls (exchanged on dry side)
CWENERR	Cumulated wall energy error : CTOTLOSS + CTOTPOWR + CWALLNRJ - CWALLGEN
MASACTi	$(1 \leq i \leq 12)$: Total current mass of the radio-chemical element #i in the zone.
XBAMOYi	$(1 \leq i \leq 12)$: Average concentration of radio-chemical element #i in the zone.

Call :

```
ev =        CHRONO zone                VARIABLE                          tmin  tmax ;
```

ev	: Name of the evolution
zone	: Name of the zone
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

3.31 CATAFUEL sub-module

For the variables corresponding to the fuel rods refer to §3.10.

The following extra variables are available :

TGEN	Time
TIMESTEP	Time step
ITECIR	Number of iterations of the time steps
NPACIR	Number of cumulated time step
NSTOCK	Number of division of the time step
ICUCIR	Total cumulated number of iterations
ITERUTIL	Effective cumulated number of iterations

Call :
ev = CHRONO element VARIABLE tmin tmax ;

ev	: Name of the evolution
element	: Name of the catafuel object
VARIABLE	: Name of the variable
tmin tmax	: (optional) Real numbers defining the time interval of interest for the post-treatment.

Appendices

A POST-PROCESSING FILE SAMPLES

A.1 FORT07 evolution file sample

```
EVOLUTION VOID8      1 CATHARE VERSION V2.5_2
    9999
    9999
       13
 6" SMALL BREAK LOCA
ZS          METERS
  0.00000000E+00  0.99000000E+00  0.34700000E+01  0.64500000E+01  0.81900000E+01
  0.88700000E+01  0.99450000E+01  0.11517000E+02  0.13494000E+02  0.15544000E+02
  0.17355500E+02  0.19954000E+02  0.21741000E+02
       13
ALFA        DOWNCOMI        AT TIME  T =   0.10000000E+03
  0.98531849E+00  0.94479741E+00  0.27991114E+00  0.27500040E-04  0.10283195E-04
  0.56722410E-01  0.77148348E-01  0.14882174E+00  0.95744845E-01  0.84853072E+00
  0.99999900E+00  0.99993224E+00  0.99993224E+00
EVOLUTION PACC       1 CATHARE VERSION V2.5_2
    9999
    9999
       10
 6" SMALL BREAK LOCA
TIME          SECONDS
  0.59991987E+01  0.10017589E+02  0.15320861E+02  0.16952429E+02  0.17000562E+02
  0.18006457E+02  0.19007822E+02  0.20381565E+02  0.21381565E+02  0.22381565E+02
       10
PRESSURE    DOWNCOMI    AT COOR  Z =  0.10000000E+01
  0.41870000E+07  0.41870000E+07  0.41870000E+07  0.41870000E+07  0.41870000E+07
  0.41870000E+07  0.41870000E+07  0.41870000E+07  0.41220000E+07  0.40570000E+07
EVOLUTION PACD       1 CATHARE VERSION V2.5_2
    9999
    9999
        2
 6" SMALL BREAK LOCA
TIME          SECONDS
  0.59991987E+01  0.10017589E+01
        2
TOTMASS     CIRC1     GLOBAL VARIABLE    0.00000000E+00
  0.41870000E+07  0.41870000E+07
```

VOID8	: name of the evolution
9999	: (not used)
9999	: (not used)
13	: number of points to be read
6" SMALL BREAK LOCA	: title of the calculation
ZS METERS	: keyword corresponding to the meshing type and unit in case of PHOTO
ALFA	: name of the y-axis variable
DOWNCOMI	: name of the element
0.10000000E+03	: time in case of PHOTO coordinate in case of CHRONO
PACC	: name of the evolution
9999	: (not used)
9999	: (not used)
10	: number of points to be read
6" SMALL BREAK LOCA	: title of the calculation
TIME SECONDS	: label preceding the time values stored for the PACC evolution
PRESSURE	: name of the y-axis variable
DOWNCOMI	: name of the element
0.10000000E+01	: time in case of PHOTO coordinate in case of CHRONO

A.2 Graphical imput data deck sample

```
============================================
       EVOLUTIONS (RESULTS)
*=>Axial element
PR1W = CHRONO CANAL PRESSURE ELEV 0.45 ;
TR1W = CHRONO CANAL LIQTEMP 5 0. 25. ;
PPR1 = PHOTO CANAL LIQV 10. ;
*=>1-D Wall
TP1 = CHRONO PAR1 WALLWETT ELEV 0.45 ;
TP2 = PHOTO PAR1 WALLTEMP 4 3 10. ;
TP3 = PHOTO PAR1 WALLTEMP ELEV 0.45 4 10. ;
*=>Volume
PR2 = CHRONO VOLUM GASTEMP SUP ;
VR2 = CHRONO VOLUM LIQV 3 ;
*=>Wall
TP4 = PHOTO VOLUM WALLTEMP INF 3 ;
*=>3-D element
TR1 = CHRONO CUVE PRESSURE 16 ;
TR2 = PHOTO CUVE LIQVZ Z 10 0. ;
TR3 = PHOTO CUVE LIQVZ Y 10 0. ;
*=>3-D Wall
UT1 = CHRONO PAROI WALLTEMP 30 3 ;
UT2 = PHOTO PAROI WALLTEMP Y 19 5 10. ;
*=>Exchanger
EC1 = CHRONO ECH WALLWETT ELEV 2.97 PRIMARY ;
EC2 = PHOTO ECH WALLTEMP 2 SECONDARY 2 10. ;
*=> Sgtr
BR1 = CHRONO BRE PRESSURE PRIMARY 0. 25.;
============================================
       EVOLUTIONS (EXPERIM)
EXP1 = CEXPER TEMP1 TSUB 0.5 ;
EXP2 = PEXPER PZ ;
============================================
     OPERATIONS ON EVOLUTIONS
OP1 = PR1W ADD 5.98 ;
OP2 = TL1W SHIFT 10. ;
OP3 = PR1W VERSUS TL1W ;
OP4 = PR1W AND EXP2 ;
============================================
        READ
COMPRESS 60 61 62 IN 63 ;
READ RESULT 63 EXPERIM 64 ;
```

B
RESULT FILE STRUCTURE

This chapter gives an overview on the result file (FORT21) structure.

B.1 The result file in CATHARE code

The result file created by **CATHARE** thermal-hydraulic kernel calculations contains only information used for the analysis of results.
When a restart is carried out, a complete new result file is created which can be used independently of the initial result file.

B.2 Result file characteristics

B.2.1 Generals

The result file is unformatted sequential, therefore it is computer dependent. In CATHARE, data may be stored in DOUBLE or SIMPLE precision depending on the OPTION NCPUSAV specified in the input deck command block.

The result file has a self-descriptive structure. Four types of records exist :

1. Global records corresponding to the USERVAR variables (XUSER, KUSER) which are time-dependent. They are stored with the REACTOR frequency,
2. global records at the reactor level, including time-dependent information,
3. global records per circuit, including time-dependent and non time-dependent information for the whole thermal-hydraulic computation,
4. specific records per object, including non time-dependent information and time-dependent information.

Time-dependent information is stored at times specified by the RESULT [1] directive during the thermal-hydraulic calculation.
Non time-dependent information is automatically stored at the beginning of the calculation.

B.2.2 Structure of the records

The records created during the computation are composed of three blocks :

1. The first block contains the usual information :

   A field defining the real variable type (SIMPLE or DOUBLE) is added. This block contains the following records :

   (a) TYPE$$$FICHIER$SIMPLE$$ (or TYPE$$$FICHIER$DOUBLE$$)
   (b) VERSION$LABEL$$$NONE$$$$
   (c) IDENT$$$<**CATHARE** _version><title_of_calculation><date_of_calculation>.

2. The second block contains the geometrical information of the objects used in the calculation. It begins with the keyword DESCR$$$.
3. The last block contains the thermal hydraulic calculation of the different objects at the times specified by the RESULT [1] directives. It begins with the keyword VARIA$$$ and is repeated as many times as there are result occurences during calculation.

B.2.3 Geometrical block structure

For the geometrical block, the order of records is given hereafter :

- Variable users (XUSER),
- Variable users (KUSER),
- Reactor,
- Circuits,
- All the N objects of the circuits.

Under each DESSTACK keyword, the geometrical variables of the object are described using the basic recording block. The structure of the geometrical block can be summarized with the diagram B.2.1

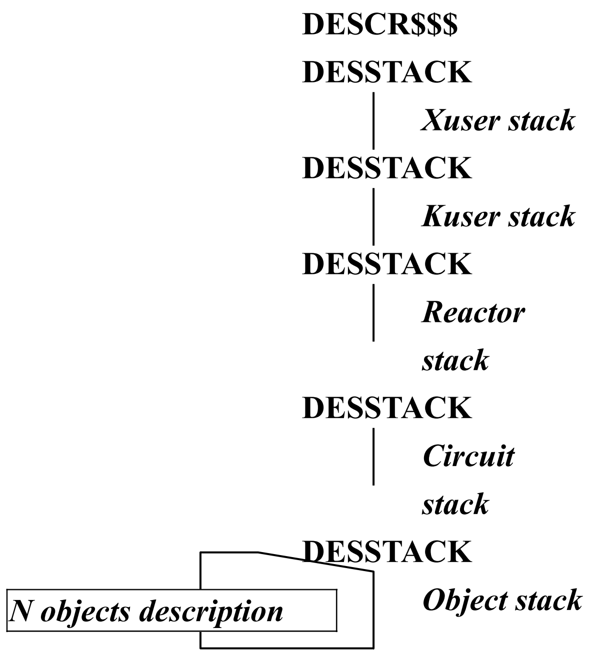

Figure B.2.1: Geometrical block structure of the result file

B.2.4 Result block structure

For one result block, the order of record is given hereafter :

- Variable users (XUSER),
- Variable users (KUSER),
- Reactor,
- Circuits,
- All the N objects of the circuits.

Under each DESSTACK keyword, the physical variables of the object are described using the basic recording block. The result block is written with a periodicity defined in the input deck (RESULT [1] directive). If it is written M times during a calculation, then the structure of the result block can be summarized with the diagram B.2.2:

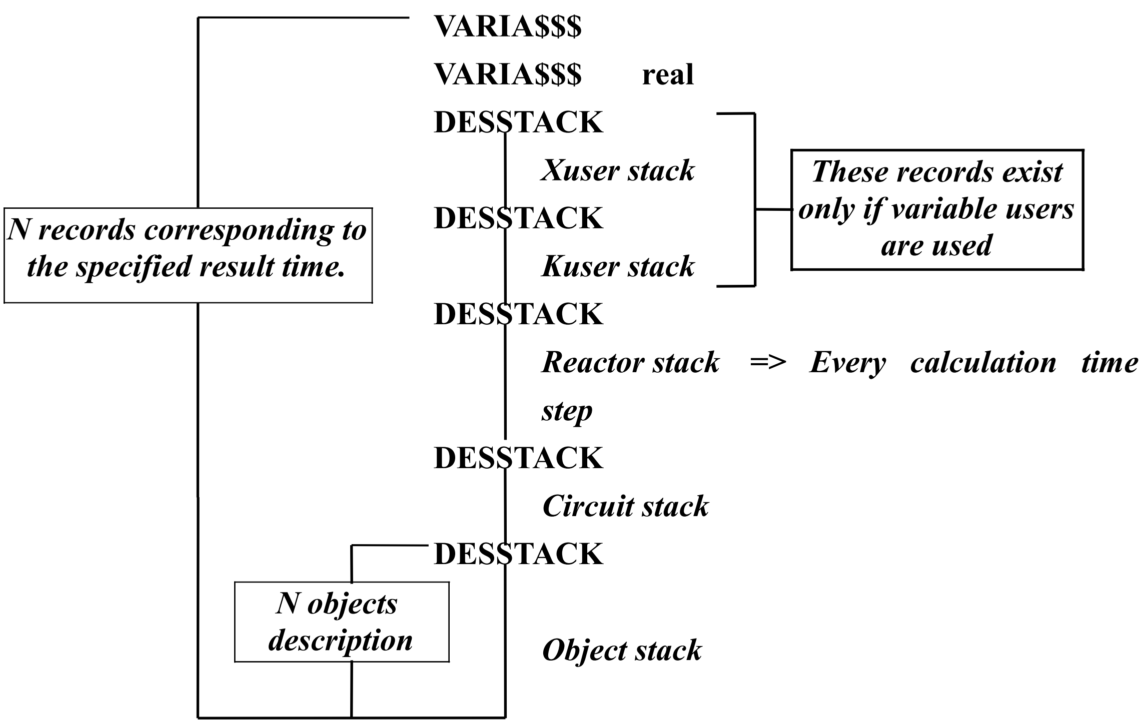

Figure B.2.2: Result block structure of the result file

B.2.5 Basic recording block

An example for an axial element is given in the figure B.2.3.

First, the name and the type of the element are given. In fixed part, the type is kind_of_the_objectRIF (ex : AXIALRIF).

Remark : In the variable part, the type is kind_of_the_objectRAV (ex : AXIALRAV).

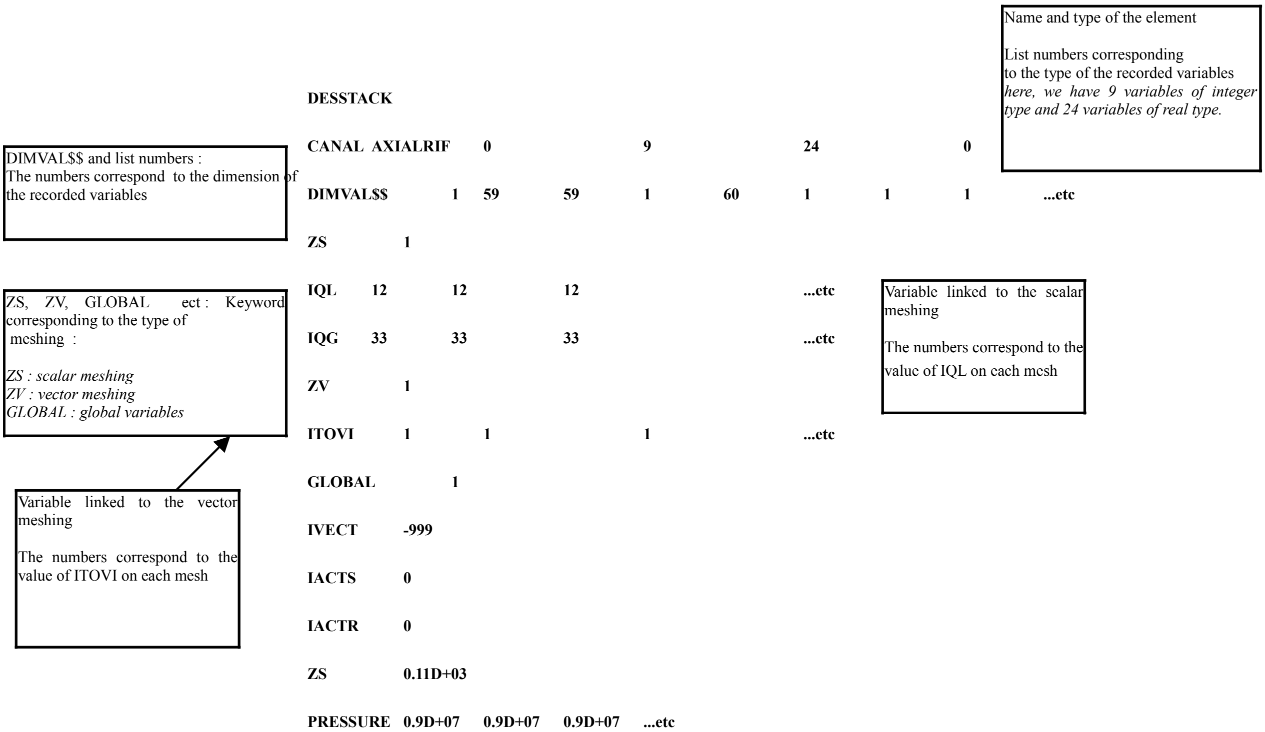

Figure B.2.3: Example of the block structure of the result file

The type and the number of records are also defined: dimensioning numbers (such as NINCON in the circuit), integers, real numbers, characters (*8)... After, we find the dimension of each variable of the stack (DIMVAL$$). Then, the keyword corresponding to the type of the meshing is recorded (ZS, ZV, GLOBAL...). Under this keyword, we find the list of variables which are linked to this meshing. The variables are recorded by type : first pointers then integers, real numbers and at last characters.

B.3 Records of the geometrical and global variables

B.3.1 Circuits

The following global variables are available:
Circuit non condensable i properties ($0 \le i \le 4$) if exist :

Record of size is 1 :	
PRXRi	Perfect gas constant
PRXCP0i	Specific heat at constant pressure
PRXCP1i PRXCP2i PRXCP3i PRXCP4i PRXCP5i PRXCP6i	Real type coefficients for specific heat at constant pressure.
PRXMi	Molar mass
PRXL2i (AC) PRXL1i (BC) PRXL0i (CC)	Coefficients of variation of the thermal conductivity with respect to absolute temperature: $\lambda = AC \cdot T_K^2 + BC \cdot T_K + CC$
PRXM2i (AV) PRXM1i (BV) PRXM0i (CV)	Coefficients of variation of the dynamic viscosity with respect to absolute temperature: $\mu = AV \cdot T_K^2 + BV \cdot T_K + CV$
PRXDVi	Molecular diffusion volume in cm3/mole(only for revision 6 and following)

B.3.1.1 1-D (Axial) module

The following geometrical variables are available:
Variables at junctions :

Record size is the number of junctions :	
IPOIDJ	Weight of the junction
ABSELEVJ	Absolute elevation of the junction (zero is at the first element read by the circuit operator)
JONNAM	Name of the junction

Variables at tees (if exist) :

Record size is the number of tees :	
TNAM	Name of the Tee
MESHTE	Tee connection mesh of the pipe
TECOND	Flag used to indicate that a special condensation model is used (=1) or not (=0)

Variables at scalar nodes :

Record size is the number of internal scalar nodes :	
ZS	X axis coordinate
PMOS	Wet perimeter
DHYDS	Hydraulic diameter
HTOUTS	Overall size of duct
Record size is number of all scalar nodes :	
	continued on next page

GSREF	Gravity of reference (m/s^2)
SPFS	Cross section
DELTAV	Distance between 2 successive scalar nodes

Variables at vector nodes :

Record size is the number of vector nodes (without TEEs) :	
ZV	X axis coordinate
IXFPLA	Indicator of use of steam generator plate model for singular pressure loss coefficient (value = 1 if used)
SMCQM	Cross section
Record size is the number of vector nodes (with TEEs) :	
GV	Gravity
GVREF	Gravity of reference
SPFV	Cross section
PMOV	Wet perimeter
HTOUTV	Overall size of duct
DHYDV	Hydraulic diameter
DELTAS	Distance between 2 successive vector nodes
XFROT1	Head loss coefficient (positive mesh direction)
XFROT2	Head loss coefficient (negative mesh direction)

B.3.1.2 0D (Volume) module

The following geometrical variables are available:
Variables at junctions/ports :

Record size is the number of junctions :	
IPOIDJ	Weight of the port
ABSELEVJ	Absolute elevation of the junction (zero is at the first element read by the circuit operator)
JONNAM	Name of the junction
NUMPAT	Port number
ZPAT	Relative level of the port
ZBOUT	Penetration length of the port
DELPAT	Length between vector node of the port and its related internal scalar node
SPAT	Flow section of the port
GPATREF	Gravity of reference at port vector the node (m/s2)
DHPAT	Hydraulic diameter of the port
DPAT	Overall size of the port
PFRPAT	Wetted perimeter of the port
XFROT1	Port singular head loss coefficient (in→out)
XFROT2	Port singular head loss coefficient (out→in)
ITYPJV	Type of the port (0=STANDARD, 1=ANNULSPA, 2=SEPDRYER)

Variables at scalar nodes :

Record size is the number of internal scalar nodes :	
SUBVOL	Pseudo-coordinate of scalar meshes (INF=-1.;SUP=1.)

Variables at user defined points :

Record size is the number of elevations defined in the input deck :	
COTE	Elevation
DIAMETER	Diameter of the volume section at the corresponding elevation

Other variables :

Record size is 1 :	
OMEG	Total volume of the element
DH	Average hydraulic diameter

B.3.1.3 3-D module

The following geometrical variables are available:
Dimensioning variables :

Record size is 1 :	
NX	Number of scalar meshes with respect to x-axis
NY	Number of scalar meshes with respect to y-axis
NZ	Number of scalar meshes with respect to z-axis
MVX	Number of vector meshes with respect to x-axis
MVY	Number of vector meshes with respect to y-axis
MVZ	Number of vector meshes with respect to z-axis
ICYL	Indicator of cylindrical geometry (value = 1 if true)
IKEL	Indicator of activation of turbulence K-ε model for liquid phase (value = 1 if true)
IKEG	Indicator of activation of turbulence K-ε model for gas phase (value = 1 if true)
GXREF	Reference gravity projection on x-axis (m/s^2)
GYREF	Reference gravity projection on y-axis (m/s^2)
GZREF	e gravity projection on z-axis (m/s^2)
VOL3D	Total volume of the element
RAYON	Internal radius (in annular geometry)

Variables at junctions :

Record size is the number of junctions :	
IPOIDJ	Weight of the junction
ABSELEVJ	Absolute elevation of the junction (zero is at the first element read by the circuit operator)
NUMPAT	Port number
JONNAM	Name of the port
MESHCL	Related 3-D mesh number of the port
LOCBO	Face orientation of the port: 1 : XM, 2 : XP 3 : YM, 4 : YP 5 : ZM, 6 : ZP
JVECT	Related 3-D vector node of the port
ITYPCL	Junction type
GHEIJREF	Potential gravity of reference at junction (m/s2)

Variables at scalar nodes :

Record size is the number of internal scalar nodes :	
DX	X length of the mesh
DY	Y length of the mesh
DZ	Z length of the mesh
VOL	Volume of the mesh
DH	Hydraulic diameter
If cylindrical or annular coordinate :	
THETS	Angle of the each scalar mesh with the reference axis of angular coordinates
THET0	Angle of the first mesh with the reference axis of angular coordinates
Record size is number of all scalar nodes :	
GSINSREF	Gravity of reference* sin
GHEISREF	Potentail Gravity of reference at scalar node (m/s2)
Record size is number of scalar meshes in related direction :	
XS	X-coordinate of scalar meshes
YS	Y-coordinate of scalar meshes
ZS	Z-coordinate of scalar meshes
If cylindrical geometry (in y-direction) :	
RAYS	Radius of each scalar point

Variables at vector nodes :

Record size is the number of X vector points :	
DHX	Hydraulic diameter along x-axis
AX	X-Face flow section
DXENX	X length of the mesh (X vector mesh)
DYENX	Y length of the mesh (X vector mesh)
DZENX	Z length of the mesh (X vector mesh)
IFBX	State of meshes faces in x direction (0 = open ; 1 = closed ; 2 = junction ; 3 = symmetry axis)
Record size is the number of Y vector points :	
DHY	Hydraulic diameter along y-axis
AY	Y-Face flow section
DXENY	X length of the mesh (Y vector mesh)
DYENY	Y length of the mesh (Y vector mesh)
DZENY	Z length of the mesh (Y vector mesh)
IFBY	State of meshes faces in y direction (0 = open ; 1 = closed ; 2 = junction ; 3 = symmetry axis)
Record size is the number of Z vector points :	
DHZ	Hydraulic diameter along z-axis
AZ	Z-Face flow section
DXENZ	X length of the mesh (Z vector mesh)
DYENZ	Y length of the mesh (Z vector mesh)
DZENZ	Z length of the mesh (Z vector mesh)
IFBZ	State of meshes faces in z direction (0 = open ; 1 = closed ; 2 = junction ; 3 = symmetry axis)
Record size is number of vector meshes in related direction :	
XV	x-coordinate of vector meshes
YV	y-coordinate of vector meshes

continued on next page

ZV	z-coordinate of vector meshes
If cylindrical geometry :	
RAYX	Distance between the z-axis and the X-face
RAYY	Distance between the z-axis and the Y-face
RAYZ	Distance between the z-axis and the Z-face
Record size is number of vector meshes + 1 in related direction :	
If cylindrical geometry (in y-direction)	
RAYV	Radius of each vector point

B.3.2 Boundary conditions

The following geometrical variables are available:

Record size is 1 :	
SJON	Section (taking account of weight) of the junction (m2)
DHYDV	Hydraulic diameter of the junction at its vector node (m)
GVREF	Relative value of the reference gravity projection on the rising vertical at the vector node (m/s2).
GSINVREF	Absolute value of the projection on the horizontal of the gravity.
JONNAM	Name of the junction

B.3.3 Rupture (RG)

The following geometrical variable is available:

GVREF	Relative value of the reference garvity

B.3.4 Wall sub-module

For an axial element, The following geometrical variables are available:

Record size is the number of wall meshes along the axial :	
ZSW	Axial coordinate of meshes
IWHYD	Number of the corresponding hydraulic mesh
WHSUR	Fluid-wall exchange surface
For layer number i of the wall :	
RAYON i	Radius of the mesh in the ith layer

Record size is 1 :	
TYPER	Type of the hydraulic element: LTYP1D=61
NAMEPER	Name of the hydraulic element

In the case of an exchanger wall:

TYPAR	Localization of the wall: • Case of 1reactor: = 1 : primary side and implicit treatment = 2 : secondary side and implicit treatment = 3 : primary side and explicit treatment = 4 : secondary side and explicit treatment • Case of 2 reactors: = 5 : primary side and explicit treatment = 6 : secondary side and explicit treatment

For a volume element, the following geometrical variables are available:

Record size is the number of wall meshes along the volume :	
ZSW	Pseudo-coordinate of meshes (INF/SUP)
For layer number i of the wall :	
RAYON i	Radius of the mesh in the ith layer

Record size is 1 :	
WHSURTOT	Total fluid-wall exchange surface
ZPMIN	Wall lower boundary elevation
ZPMAX	Wall upper boundary elevation
TYPER NAMEPER	Type of the hydraulic element: LTYP0D=62 Name of the hydraulic element

For a 3-D element, the following geometrical variables are available:

Record size is the number of wall meshes along the 3D meshing :	
IWHYD	Number of the corresponding hydraulic mesh
WHSUR	Fluid-wall exchange surface
For layer number i of the wall :	
RAYON i	Internal radius of the mesh in the ith layer (identical to the values described in the data bloc)

Record size is 1 :	
TYPER	Type of the hydraulic element: LTYP3D=63
NAMEPER	Name of the hydraulic element

In case of a one dimension wall, the related coordinates of the 3D element (record size is for each direction the number of meshes of the 3 D element) follow :

XSW	Scalar x-coordinate of wall meshes (in cylindrical co-ordinate, values of θ)
YSW	Scalar y-coordinate of wall meshes (in cylindrical co-ordinate, values of r)
ZSW	Scalar z-coordinate of wall meshes

In the case of an exchanger wall:

TYPAR	Localization of the wall: • Case of 1reactor: = 1 : primary side and implicit treatment = 2 : secondary side and implicit treatment

B.3.5 Reflooding sub-module

The following geometrical variables are available:

NAMEPER	Name of the hydraulic element

B.3.6 Core sub-module

The following geometrical variables are available:

ISCRAM	Indicator of scram action (value = 1 if contribution of external anti reactivity is calculated)
PCORO	Initial nuclear power

B.3.7 Accumulator sub-module

The following geometrical variables are available:

IPACCU	position of the injection mesh
ICLOSE	closure index of the accumulator
SECLIG	surge line cross-section
COTLIG	normalized level of injection point
ZBOLIG	In case of an accumulator defined on a volume element, length of penetration of the accumulator
COSANG	cosine of the angle of injection
GAMACC	gas expansion
VACCU	volume of the accumulator
XLACCU	length of surge line
XFACCU	surge line head loss
ENTHALPY	initial accumulator enthalpy
TOAZOT	Dissolved nitrogen rate in injected water
NAMEPER	Name of the hydraulic element
VALCOEFA	Value of the coefficient A of the valve hysteresis model
VALCOEFB	Value of the coefficient B of the valve hysteresis model

B.3.8 Break sub-module

The following geometrical variables are available:

XLONBR	length of the nozzle
SECBRE	section of the break
IPOBRE	position of the break
NAMEPER	Name of the hydraulic element
CTYPE	Type of the hydraulic element

B.3.9 Candle sub-module

The following geometrical variables are available:

IPCAN	number of the hydraulic element scalar point containing the candle
CNCOTE	elevation of the candle in the element (m)

continued on next page

NAMEPER	Name of the hydraulic element

B.3.10 0-D steam generator sub-module

The following geometrical variables are available:

NAMEPER	Name of the hydraulic element

B.3.11 PIQ* sub-modules

For an axial element, the following geometrical variables are available:

IPOPUI	position of the PIQxxx
PUSECT	full opening cross section
NAMEPER	Name of the hydraulic element
CTYPE	Type of the hydraulic element

For a volume element, the following geometrical variables are available:

COTEPUI	level of the PIQxxx
PUSECT	full opening cross section
NAMEPER	Name of the hydraulic element
CTYPE	Type of the hydraulic element

For each valve of the Piqseb gadget :

REALSEC	Section
REALPU	Opening ratio (position of the stem : 0<x<1)
IFAILURE	Failure index
XFAILURE	Failure rate

For each valve of the Piqvanne gadget :

PU	Opening ratio (position of the stem : 0<x<1)
REALPU	Opening ratio taking into account the failure (position of the stem : 0<x<1)
REALKM	Head loss coefficient
IFAILURE	Failure index
XFAILURE	Failure rate

B.3.12 0D pump sub-module

The following geometrical variables are available:

IPPOM	pump vector node
NAMEPER	Name of the hydraulic element

For standard pump:

IMOT	index of rotation speed : 1 : calculated 2 : imposed

IDEGRP	index of degradation use : 1 : degraded 2 : nominal
ICAVIP	Index of cavitation 1 : active 2 : stopped
OMREF	nominal rotation speed
QREF	nominal flow rate
HREF	nominal specific head
GREF	nominal torque
OMS	imposed rotation speed

B.3.13 Sensor sub-module

for an axial or a volume element, the following geometrical variables are available

IPSR	position of the axial mesh the sensor is connected to
SRCOTE	elevation of the sensor in the axial
CTYPSR	sensor type
NAMEPER	Name of the hydraulic element

for a volume wall module, the following geometrical variables are available

IPSV	pseudo-coordinate of the connection mesh (INF/SUP)
SVCOTE	elevation of the sensor in the volume
CTYPSV	sensor type
NAMEPER	Name of the hydraulic element

for an axial wall module, the following geometrical variables are available

IPSW	position of the mesh the sensor is connected to
SWCOTE	elevation of the sensor on the wall
CTYPSW	sensor type
NAMEPER	Name of the hydraulic element

B.3.14 Sinks sub-modules

for an axial element, the following geometrical variables are available:

IPOPUI	position of the sink
PUSECT	full opening cross section
NAMEPER	Name of the hydraulic element
CTYPE	Type of the hydraulic element

for a volume element, the following geometrical variables are available:

COTEPUI	level of the sink
PUSECT	full opening cross section
NAMEPER	Name of the hydraulic element
CTYPE	Type of the hydraulic element

continued on next page

B.3.15 Source sub-modules

The following geometrical variables are available:

SOSECT	cross-section of the source
COTE	standard elevation of injection point
COSANG	cosine of the angle of injection
ZLSOU	length of penetration (volume)
IPSINT	position of the source (mesh number) (axial only)
NAMEPER	Name of the hydraulic element
CTYPE	Type of the hydraulic element

B.3.16 Steam Generator Tube Rupture (SGTR) sub-module

The following geometrical variables are available:

SERTGV	section
XK1RGV	head loss coef. (primary side)
XK2RGV	head loss coef. (secondary side)
IP1RGV	position of the sgtr (primary side)
IP2RGV	position of the sgtr (secondary side)
NAMEPER	Name of the hydraulic element

B.3.17 TE sub-module

The following geometrical variables are available:

SECT	section of the tee duct
G	gravity of the tee duct
PFRPAT	friction perimeter of the tee duct
DHPAT	hydraulic diameter of the tee duct
DPAT	overall size of the tee duct
XKPAT1	singular head loss coefficient of the tee duct (in→out)
XKPAT2	singular head loss coefficient of the tee duct (out→in)
ANGLE	angle between main duct and tee duct
COTPI	elevation of the tee duct
ZBOUT	Length of the tee duct

B.3.18 Turbine sub-module

The following geometrical variables are available:

IPTURB	position of the [1]turbine
SNOZ	nozzle section of the turbine (m2)
NAMEPER	Name of the hydraulic element

B.3.19 0D Turbomachine sub-module

The following geometrical variables are available:

IMOT	index of rotational speed : 1 : calculated 2 : imposed
IDEGRP	index of degradation use : 1 : degraded 2 : nominal
TYPETCOM	index of turbomachine type : 1 : turbine 2 : compressor
MOD	index of modelling for alternator: 1 : simple 2 : detailed
ALTERNAT	index of alternator presence in the shaft: 0 : absence 1 : presence
IMASTER	index of slave/master state: 0 : the turbomachine is the slave 1 : the turbomachine is the master
IPTCO	turbomachine vector node
OMREF	nominal rotational speed
QREF	nominal flow rate
HREF	nominal specific head
GREF	nominal torque
OMTCS	imposed rotational speed
NAMEPER	Name of the hydraulic element

B.3.20 Valves sub-modules

The following geometrical variables are available:

IPVEC	position of the valve
TYVEC	Valve "junction" type (Axial-Axial, Axial-Volume,...)
TVECN	Type of the valve (flow limiter, check valve or control valve)
NAMEPER	Name of the hydraulic element

B.3.21 Zone sub-module

The following geometrical variables are available:

NAMEPER	Name of the hydraulic element

B.3.22 3-D zone sub-module

The following geometrical variables are available:

MESHSCA	The list of the scalar meshes
MESHVECX	The list of the vector meshes in X direction
MESHVECY	The list of the vector meshes in Y direction
MESHVECZ	The list of the vector meshes in Z direction
NAMEPER	Name of the hydraulic element

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[3] G.LAVIALLE. CATHARE 2 V2.5_3 mod2.1 code : User's manual and guide lines. Technical Report STMF/LMES/12-XXX, CEA, 2012.

NOTATIONS

P : Pressure (Pa). 79
q_{ge} : Interface to gas heat flux (W.m^{-2}). 37, 40, 44
q_{le} : Interface to liquid heat flux (W.m^{-2}). 37, 40, 44
T : Temperature ($^{\circ}C$). 94

λ : Conductivity (W.m^{-1}.K^{-1}). 94

ACRONYMS

CSS (EAS) : Containment Spray System (EAS). 74, 75
LPSI : Low Pressure Safety Injection. 74, 75
CCCW (RRI) : Component cooling water system (RRI). 74, 75
RWS (SEB) : Raw Water System (SEB). 75
ESWS (SEC) : Essential Service Water System (SEC). 74, 75
SGTR : Steam Generator tube Rupture. 76, 77

HTR : High Temperature Reactor. 55, 57, 60
PWR : Pressurized Water Reactor. 55
SFR : Sodium Cooled Fast Reactor. 55–57, 60, 61

END OF DOCUMENT